SOUTH GALILEE COAL PROJECT (SGCP) GROUNDWATER ASSESSMENT AND MODELLING

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Our ref: A302C\600\R001e
Date: 5 October 2012

Document Status

	Issue Date	Purpose of Document
Revision a	21 September 2012	Initial draft for MetServe review
Revision b	28 September 2012	Updated draft with model results
Revision c	2 October 2012	Updated draft with impact assessments
Revision d	3 October 2012	Updated draft with sensitivity analysis
Revision e	5 October 2012	Updated draft with post mining results

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EXECUTIVE SUMMARY

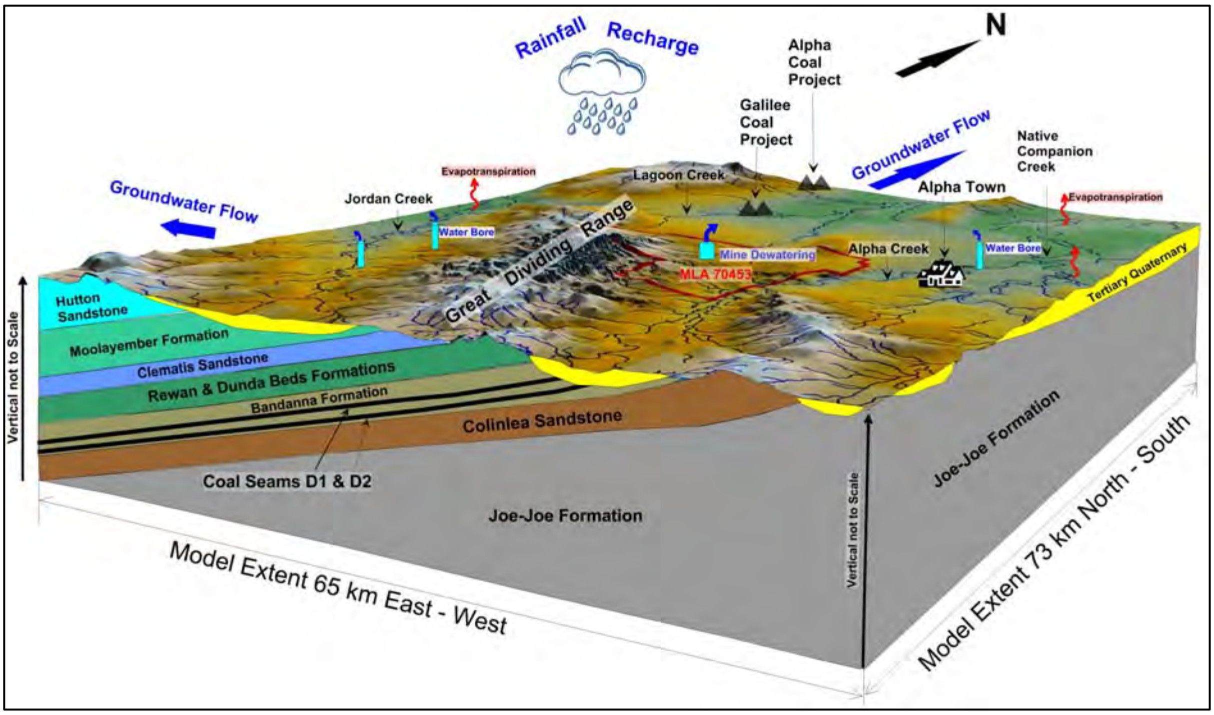
The South Galilee Coal Project (SGCP) Mining Lease Application (MLA) 70453 is located some 10 km to the west of the town of Alpha in the southern arm of the Burdekin Valley in central Queensland, and geologically within the Galilee Basin. The Project is a proposed open-cut and underground coal mining operation with an estimated operating mine life of 33 years. This groundwater investigation addresses the groundwater-related Terms of Reference (ToR) issued by the Office of the Coordinator-General, including the following:

- the prediction of potential impacts on the groundwater system due to the proposed mining and dewatering activities at the SGCP
- the post-mining groundwater recovery
- accounting for the cumulative impacts due to other mining projects in the region (the Galilee Coal Project located about 47 km north of the SGCP, the Alpha Coal Project (ACP), 62 km north and the Kevins Corner Coal Project (KCCP), 68 km north).

This report provides an integrated assessment of the data from the previous studies, the new information obtained during recent investigations, and use of this data to design and calibrate a multi-layered groundwater flow model for use in prediction simulations of the effects of mining and the development of mitigation and management plans. The key elements of the conceptual hydrogeological model are summarised below:

- the SGCP site lies within the Galilee Basin, a large scale intracratonic basin with sediments of Triassic, Permian and Carboniferous age. The Galilee Basin strata are essentially flat lying and dip to the west and south west at less than one degree, with the D1 and D2 coal seam targets occurring within the Bandanna Formation
- the western parts of the Galilee Basin are overlain by onlapping sediments of the younger sediments of the younger Jurassic-Cretaceous material of Eromanga Basin, which forms part of the Great Artesian Basin (GAB). In the Project area, these two basins are separated by the 250 m thick and low permeability Rewan Formation and Dunda Beds that form the base to the GAB, and substantial restrict the potential for hydraulic interaction between the two basins. Nevertheless, the eastern margin of the GAB has been included in the numerical modelling undertaken for the SGCP impact assessment, along with the Alpha township area and groundwater extraction for water supply
- the economic coal seams at SGCP (D1 and D2 seams) occur below and to the east of the Rewan/Dunda units. To the west and above the Rewan/Dunda units, the Clematis Sandstone forms a recharge/intake bed to the GAB that outcrops along the Great Dividing Range
- recharge occurs mainly through rainfall infiltration, at relatively low fractions (<5%) of annual rainfall and with the highest recharge rates in areas of higher topography, notably the Clematis Sandstone outcrop aligned with the Great Dividing Range
- groundwater flow may be summarised as occurring away from the main recharge area formed by the Clematis Sandstone outcrop along the Great Dividing Range:
  - to the east and north and into the Galilee (geological) Basin and Burdekin Drainage Basin on the eastern side of the Range
  - down-dip to the west and out into the GAB system on the western side of the Range
- surface and groundwater interaction processes are limited, as streams are ephemeral, flowing only when rainfall generates adequate runoff, and provide low volumes of recharge to the water table, which is typically more than 10 metres below ground level and thus evapotranspiration from terrestrial vegetation is not a key aquifer discharge process. No groundwater dependent ecosystems have been identified from the investigations, including stygofauna, mainly due to the depth to water table typically exceeding 10 m
- groundwater salinity is typically greater than 1,000 mg/L and in some places greater than 2,000 mg/L (i.e. not within drinking water guidelines, but nominally suitable for irrigation and stock). There are small areas of fresh groundwater (< 1,000 mg/L) in places along the major creeks, presumably recharged by leakage from streams

The 3D conceptual model below provides the best summary of the key groundwater numerical model features, including the 7 layers used to represent the geology. The model was calibrated in steady state transient (40-years) modes, consistent with best practice guidelines (Middlemis et al, 2011; Barnett et al, 2012), and benchmarked to monitoring data, with a scaled root mean square error of 8.1% that is within the 5-10% guideline range.



The model predictions include open-cut and underground mining, and subsequent post-mining groundwater recovery, for the SGCP mine as well as the GCP (located 47 km north of the SGCP and within the SGCP model domain). The more remote Alpha and Kevins Corner Coal projects (62 and 68 km north of the SGCP) are represented in the SGCP model with a boundary condition.

The predicted SGCP mine dewatering rates under a cumulative impacts simulation are less than 10 ML/day for the first 5 years and the final 8 years of mine life, and range between 10 and 20 ML/day for mine years 6 to 26. The cumulative volume extracted for mine dewatering is predicted to be 147 GL over 33 years, which is understood to be broadly consistent with the other mining projects in the area.

Maximum drawdowns of around 100 metres are predicted at the northern end of the SGCP mine site, reducing to the order of 10-20 m regionally, and developing at a fairly slow rate over the life of mine of 33 years. This indicates that, while there is substantial drawdown at the mine site, there would remain substantial saturated aquifer resources regionally (and locally within the deeper Bandanna Formation at SGCP), that would support potential GDEs if they occur in the area (noting that GDE stygofauna have not been identified, there are no mapped springs, and the surface-groundwater interaction volumes due not change materially from pre-mining, through mining to post-mining).

The predicted drawdowns will have a substantial impact on any bores within the mine lease areas, and these bores may need to be deepened or replaced. Deepening of bores is a viable option as saturated aquifer conditions remain below the water table that is drawn down by mine dewatering (i.e. the Colinlea Sandstone underlying the D seams remains an effective aquifer).

However, the drawdown at the Alpha township area (and notably at the town water supply bores) is predicted to be less than 1 m (mainly due to the influence of the low permeability Joe Joe Formation outcrop limiting the eastern extent of drawdown). There should be no need for mitigation on extraction bores within 5 km of Alpha township.

The drawdown effects extend mainly to the north because it is limited by low permeability units outcropping to the west, east and south:

- the low permeability Rewan Formation and Dunda Beds limit the western (and southern) extent of water table drawdown
- the low permeability Joe Joe Formation limits the eastern extent of water table drawdown

The model results show that the major change to the water balance is the discharge for dewatering purposes, which is drawn from aquifer storage (and then subsequently replenished during post-mining recovery). Other elements of the water balance are largely not affected. For example, the results show no change to stream leakage during mining compared to the pre-mining condition, which indicates that there is no induced leakage due to mining. This is essentially because the depth to water table is typically in excess of 10 m and the stream features are recharging the water table at maximum potential rate. The results also show that the evapotranspiration discharge has reduced only very slightly from a rate of 9 to 10 ML/day for the steady state and transient calibration to a minimum of 8.6 ML/day. This indicates that the drawdown due to dewatering has no significant affect on the evapotranspiration feature in the model, which is a surrogate for discharge from groundwater-dependent vegetation. Similarly, the extraction for the Alpha town water supply also remains unchanged and the predicted drawdown effect is less than 1 m in the Alpha area, which is within the natural seasonal range. Finally, the recharge to the system remains unchanged throughout these simulations, confirming that the GAB recharge through the Clematis Sandstone is unaffected by mining.

The results demonstrate that the maximum drawdown under the Clematis Sandstone is in the order of 5 m, and that is a conservative estimate due to the relatively high assumptions of hydraulic conductivity parameter values. Nevertheless, even with this minor drawdown, there would be no significant environmental effects, as there are no mapped springs in the area, no known groundwater dependent ecosystems, and the depth to water table in this area is in excess of 10 m.

A 100 year post-mining run simulates the groundwater level recovery after mining stresses are removed and assuming changes to the aquifer parameters within the open pit mined and backfilled areas to represent the different properties of backfill, as well as the underground areas to represent subsidence impacts. This post-mining run also adds an evaporation feature to the residual open pit void. The model predicts a residual pit void lake level of 308 to 313 mAHD, which is 7 to 12 metres below the pre-mining groundwater level, confirming that the residual pit void would remain a local groundwater sink, with inflows balance by evaporation. The final void extends over about 8 km south to north, and within a groundwater flow regime from south-west to north-east, and thus the final lake level is higher in the south than in the north (as are the original groundwater levels). The final evaporative flux from the pit void lake is 1580 kL/day (0.58 GL/year). The water balance and salinity of the final void is being addressed in detail by others (WRM).

Using the results of the investigation as a guide, groundwater management and monitoring plans are detailed herein.

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APPENDICES

1. INTRODUCTION

1.1 GROUNDWATER INVESTIGATION SCOPE

This report presents the groundwater and modelling investigation undertaken by RPS Aquaterra for the South Galilee Coal Project (SGCP, or 'the Project').

The groundwater investigation is designed to address the groundwater-related Terms of Reference (ToR) issued by the Office of the Coordinator-General. More detail on the ToR is given in Section 2, along with cross-references to where this report addresses the ToR issues specifically. In that context, this report addresses the following broad issues (in summary):

- the prediction of potential impacts on the groundwater system due to the proposed mining and dewatering activities
- the post-mining groundwater recovery
- accounting for the cumulative impacts due to other mining projects in the region (the nearest being the Galilee Coal Project located about 47 km north of the SGCP)

1.2 SGCP PROJECT DESCRIPTION

While the SGCP Environmental Impact Statement (EIS) is the definitive source of information on the exact details of the SGCP (e.g. project description, etc) the following summary information is provided for context.

The SGCP Mining Lease Application (MLA) 70453 is located some 10 km to the west of the town of Alpha in the southern arm of the Burdekin Valley in central Queensland (Figure 1). The Project is a proposed open-cut and underground coal mining operation with an estimated operating mine life of 33 years. About 498 Mt of run-of-mine coal will be mined, yielding approximately 447 Mt of product coal. Operations are expected to commence in 2015 with a scheduled mine life of 33 years until 2047. Product coal output is anticipated to ramp up to a peak of approximately 17 Mtpa when both open cut and underground components are operational. However, it is possible that there will be sufficient economic coal reserves to extend the operational life of the Project beyond the currently planned 33 years.

Open cut mining at the SGCP will involve conventional strip mining using draglines with pre-stripping undertaken by conventional truck and shovel. Underground operations will utilise the longwall mining method, extracting coal in panels 350 m wide, and up to 5,000 m in length, with a minimum depth of cover of 140 m. Coal contained in underground pillars and development workings will be sterilised along with coal below Endangered Regional Ecosystems (ERE) which will be avoided for conservation purposes. Rehabilitation activities will be undertaken progressively throughout the mine life.

Open cut and underground mining will result in groundwater inflow from the surrounding aquifers into the workings. A dewatering system comprising electric and air operated pumps established in open pit and underground sumps and also dewatering boreholes will be used to pump accumulated water through mains dewatering pipelines to storage facilities or dams on the surface.

For the purposes of this groundwater investigation, the main elements of the Project may be summarised as:

- coal mining operations by open cut and underground methods, including placement of waste rock and rejects in out-of-pit waste rock emplacement facilities and progressive backfilling of the open pits with waste rock and rejects as mining develops
- open pit and underground mine dewatering works (bores, drains, sumps, pipelines, dams, etc), and ongoing groundwater monitoring and management
- raw water supply infrastructure (e.g. pipeline, groundwater bores and Raw Water Dam), and development of a mine water management system including clean water drainage channels, mine affected runoff collection, sediment dams, pit water management process, on-site water reuse procedures and a permanent diversion of Sapling Creek

- Mine Industrial Area (administration facilities, vehicle parking, workshops, storage, refuelling, washdown, controls and communication infrastructure) and underground services area
- Coal Handling and Preparation Plant and related infrastructure (including conveyor systems, raw coal and product coal stockpiles)
- other associated minor infrastructure, plant, equipment and activities, including fuel, oil and explosives storage facilities; soil stockpiles, laydown areas and a gravel borrow pit; electrical and telecommunications infrastructure, sewage and waste water treatment infrastructure and on-site landfill facility

1.3 BROAD METHODOLOGY

This report provides an integrated assessment of the data from the previous studies, the new information obtained during recent investigations, and use of this data to design and calibrate a multi-layered groundwater flow model for use in prediction simulations of the effects of mining and the development of mitigation and management plans. Detailed methodologies are presented in subsequent sections of this report, and below is a broad summary of the investigation framework.

The modelling approach accounts for cumulative impacts from the SGCP as well as following proposed mines in the region:

- Galilee Coal Project (also known as China First Coal Project), proposed by Waratah Coal Pty Ltd, located about 47 km north of SGCP
- Alpha Coal Project, proposed by the GVK Group, located about 62 km north of SGCP
- Kevins Corner Coal Project, proposed by the GVK Group, located 68 km north of SGCP

1.3.1 Previous Studies

Information from previous studies for this investigation was compiled from a variety of sources, including:

- published regional geological maps
- government groundwater database (Department of Natural Resources and Mines (DNRM))
- reports on geological, geotechnical and environmental investigations of the SGCP area
- digital terrain model and geological framework model for the SGCP area and surrounds

Previous groundwater investigations in the Galilee Basin have been undertaken for proposed coal projects to the north of the SGCP including the Alpha Coal Project (ACP), Kevin's Corner Coal Project (KCCP) and the Galilee Coal Project (GCP). These studies built on early groundwater investigations related to coal resource studies undertaken in the 1980s.

Groundwater investigations for the SGCP were also conducted in recent years by consultants including Geoaxiom and Heritage Computing (unpublished), including installation of groundwater monitoring bores and vibrating wire piezometers, slug tests, and groundwater modelling.

A geological framework model was developed by SGCP consultants (Collective Experience, 2012). This was used by RPS Aquaterra, along with the digital terrain model to establish the geological structure and layer elevations (including topography) of the numerical groundwater flow model.

1.3.2 SGCP Groundwater Investigations and Modelling

The SGCP groundwater investigation by RPS Aquaterra used a phased approach, including:

- review of existing data, previous groundwater investigations, and other EIS reports
- reviewing the regulatory framework as it relates to groundwater
- field work, including siting and construction of groundwater monitoring bores, installation of electronic data loggers, and undertaking a bore survey (most of which was done by contractors to SGCP, not by RPS Aquaterra)

- characterisation of the existing groundwater environment, such as aquifer types (including Great Artesian Basin aquifers to the west), groundwater levels, groundwater flow directions and aquifer interconnectivity, recharge and discharge processes, water quality, bore yields
- characterisation of the environmental values/uses of groundwater in the region
- development of conceptual and numerical groundwater models to assess the pre-mining, mining and post-mining groundwater environments and changes associated with each stage
- assessment of mine dewatering requirements in relation to the mining schedule
- assessment of the predicted impacts of the mine operation on the groundwater resource in terms of potential impacts on groundwater levels, quality and environmental values/uses, and outlining potential mitigation measures where appropriate
- assessment of the final open pit void effects in relation to predicting water levels and salinity
- development of monitoring and mitigation strategies for input into the Environmental Management Plan (EMP).

2. LEGISLATIVE FRAMEWORK AND TERMS OF REFERENCE

2.1 LEGISLATIVE FRAMEWORK

The Coordinator-General declared the South Galilee Coal Project to be a 'significant project' requiring an Environmental Impact Statement (EIS) under section 26(1)(a) of the State Development and Public Works Organisation Act 1971.

The objective of the EIS is to ensure that all potential environmental, social and economic impacts of the project are identified and assessed and that adverse impacts are avoided or mitigated.

The EIS process is being coordinated by the Department of Infrastructure and Planning (DIP) on behalf of the Coordinator-General.

Terms of reference (TOR) set out the requirements, both general and specific, that has been addressed in preparing this report, as described in Section 2.2. The ToR for the SGCP indicate a number of legislated Acts, regulatory guidelines and other water management documents, which have been considered and addressed herein.

These acts, plans and guidelines include the following:

- *Water Act 2000*
- *Water Regulation 2002*
- *Environmental Protection Act 1994*
- *Environmental Protection (Water) Policy 2009*
- *Water Supply (Safety and Reliability) Act 2008*
- *Water Resource (Burdekin Basin) Plan 2007*
- *Water Resources (Great Artesian Basin) Plan 2006*
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000)*
- *Queensland Water Quality Guidelines 2009*
- *Australian Drinking Water Guidelines.*

The Water Act 2000 is the key piece of legislation that regulates the sustainable use of groundwater in Queensland. It is notable that the Project is located within the Highlands declared sub-artesian area, where the authorisation for groundwater use is required for any purpose other than stock or domestic.

Further to these acts and guidelines, the protection of groundwater environment is regulated by:

- *Environmental Protection Act 1994 (EP Act)*, with its main object to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends (ecologically sustainable development)
- *The Environmental Protection (Water) Policy 2009 (EPP [Water])*, which provides a framework for defining the environmental values and guidelines for water quality including groundwater, and aims to protect water resources to designated environmental values
- *Sustainable Planning Act 2009*, which promotes development based on the concept of ecological sustainability.

While the SGCP is located within the area covered by the Water Resource (Burdekin Basin) Plan 2007 (WRP), no direct requirements for groundwater protection within the Project area have been identified in this WRP.

2.2 SPECIFIC TERMS OF REFERENCE REQUIREMENTS

The Final Terms of Reference (ToR) requirements for groundwater assessment for the SGCP area are summarised in Table 2.1, along with the report sections where those requirements are addressed herein.

Table 2.1: Groundwater ToR Requirements and where addressed in this Report

ToR Section	Requirements	Section(s)
Section 3.3.4 Aquatic Ecology	Identification of all types of groundwater dependent ecosystems (GDE) occurring within and outside the project area and potentially impacted by project activities.	5.1
Section 3.4.1 Description of Environmental Values (as identified in the EPP (Water) guideline)	Present and potential users and uses of groundwater in areas potentially affected by the project, including municipal, agricultural, industrial and recreational uses of water, and reference to any licences held by users.	5.2
	Quality and quantity of groundwater resources in the area potentially affected by the project including seasonal variations in depth and flow.	4.3 & 4.4
	The relationship between groundwater and surface water and any implications of the proposed mine that would affect the interaction.	3.3 & 5.1
	Comprehensive hydrogeological description covering: the coal seams and surrounding aquifers, both artesian and sub-artesian (including the Great Artesian Basin, GAB);	3.4 & 3.5
	Inter-aquifer connectivity; flow of water; recharge and discharge mechanisms	4.3
	Current groundwater extraction regime	5.2 & 5.3
	Geology/stratigraphy, aquifer type (confined and unconfined), depth to and thickness of the aquifers, groundwater flow directions (defined from water level contours)	3.4, 3.5 & 4.5
	Potential exposure to pollution	4.4
	The significance of groundwater in the project area	5.2 & 5.3
	Current access to groundwater resources in the form of bores, springs, ponds, including quantitative yield of water and locations of access.	5.2 & 3.5 (springs)
	Location, type and status of existing water entitlements and associated infrastructure (bores, wells or excavations)	5.2
	Pumping parameters (drawdown, pumping rates)	4.2 & 5.3
	How current users and the aquifer itself and any connected aquifers will be affected	7.3 – 7.5
	Specific reference to relevant legislation or water resource plans for the region	2.2
	A network of observation points which would satisfactorily monitor groundwater resources both before and after commencement of operations.	4.2 & 9.9
	The major ionic species present in the groundwater, pH, electrical conductivity and total dissolved solids.	4.4
Section 3.4.2 Potential Impacts and mitigation measures	Potential impacts on the flow and the quality of groundwaters from all phases of the project.	8.2
	The likely volume of groundwater to be dewatered during the operations, and its likely quality characteristics, including salinity	7.2
	An assessment of the impacts on groundwater resources as a result of the mine's	7.3 - 7.5

ToR Section	Requirements	Section(s)
	operation	
	Measures to prevent, mitigate and remediate any impacts on existing users or groundwater	9.1 – 9.8
	An assessment the project's impact on the local ground water regime caused by the altered porosity and permeability of any land disturbance	7.3 & 7.4
	Monitoring programs, which will assess the effectiveness of management strategies for protecting water resources during the construction, operation and decommissioning of the project including parameters to be monitored, the frequency of monitoring and the proposed recording mechanisms and reporting arrangements.	9.9
Section 7 Cumulative Impacts	Assessment of the project's cumulative impacts in combination with those of existing or proposed project(s) publicly known or advised by Department of Infrastructure and Planning (DIP) to be in the region, and identification of the SGCP impacts in isolation.	5.1 & 8.5
	Assessment of cumulative impacts on the groundwater resources in the area, including impacts on existing users and any groundwater dependent ecosystems.	8.5
Section 9 Matters of national environmental significance - requirements of the Environment Protection and Biodiversity Conservation Act 1999 (the EPBC Act)	Subsidence (relating to groundwater): c) a detailed description of the known or likely subsidence effects on surface and groundwater hydrology and f) a description of the known impacts of subsidence on groundwater;	7.1
	Water resources and pollution a) a description of the expected impacts upon surface and ground water from the mine b) a summary of the cumulative impacts on water resources for the proposed action with regard to present water use in the region, expected water consumption from the mine, loss of ground or surface water from subsidence, and indirect increases in water demand that may result from the mine;	7.1 – 7.4 8.5
	Monitoring and Reporting – a) outline the environmental impacts to be monitored, b) identify any baseline monitoring that will be required before the proposal commences and c) identify the parameters to be monitored, and their response trigger values and response activities, along with procedural and compliance audit programs and reporting requirements and arrangements to be implemented.	9.9

3. REGIONAL SETTING

3.1 CLIMATE

According to the Australian Bureau of Meteorology (BoM), the SGCP area is classified as 'Subtropical (Moderately Dry Winter)', based on the Köppen classification system.

The nearest BoM weather station is located at the Barcaldine Post Office (Station Number 36007), approximately 140 km west of Alpha. There is a BoM rainfall station located about 10 km east of the SGCP at Alpha Post Office (Station Number 35000).

The Patched Point Dataset of rainfall obtained from the Department of Natural Resources and Mines (DNRM), uses BoM station data, with missing data 'patched' with interpolated values. Mean annual rainfall from this dataset is 562 mm over the 123 year period of record to 2011. The majority of rainfall occurs between December and March and the least rainfall falls between July and September.

Mean annual pan evaporation is estimated to be 2,246 mm (with annual totals ranging between 1,677 mm and 2,614 mm). This rainfall and evaporation information has been used to design features to represent these key hydrological processes in the numerical groundwater model.

3.2 TOPOGRAPHY

The major topographical features in the broader landscape are the Drummond Range located approximately 60 km to the east of the SGCP and the Great Dividing Range, located approximately 10 km to the west of the SGCP, as shown in Figure 3-1 (source: Explanatory Notes for the Jericho 1:250,000 Geological Map).

The SGCP site is surrounded on the west, south and south-east east by ridges and hills, and open to undulating plains to the north and north-east. The topography of the region ranges from 600 to 350 mAHD. A digital elevation model is incorporated into the groundwater model to ensure the validity of features for depth-dependent evapotranspiration and surface-groundwater interaction.

3.3 WATER COURSES

The two major creek systems near SGCP project are the Sandy Creek and Native Companion Creek, which are both tributaries of the Belyando River. The Belyando River is part of the Suttor River sub-basin, which forms the main southern tributary to the Burdekin surface drainage basin (Figure 1). The nearest regional surface water gauging station to the SGCP site is the Native Companion Creek at Violet Grove gauge (station 120305A). It is located on the Native Companion Creek some 5 km to the north (downstream) of Alpha township (Figure 1).

The monitoring data collected by the station includes water level, rainfall, electrical conductivity, discharge and water temperature. Figure 3-2 presents a relationship between the creek flow and rainfall data, which clearly shows that substantial periods of zero flow coincides with the absence of rainfall. As the typical depth to water table is 10 metres, it is concluded that this major creek is ephemeral. As this gauging station is positioned downstream from the tributary junction with Alpha Creek, it is concluded that Alpha Creek is also ephemeral.

In summary, the rainfall, streamflow and depth to groundwater data confirm that the Native Companion Creek and Alpha Creek systems are ephemeral (i.e. creek flow is not maintained by groundwater discharge), and the groundwater model has been designed accordingly.

3.4 REGIONAL GEOLOGY

The SGCP site lies within the Galilee Basin which comprises sediments of Triassic, Permian and Carboniferous age. The Galilee Basin is a large scale intracratonic basin with predominantly fluvial sediment infill. The Galilee Basin strata are essentially flat lying and dip to the west and south west at less than one degree. The western parts of the Galilee Basin are overlain by onlapping sediments of the younger Jurassic-Cretaceous material of Eromanga Basin (which forms part of the Great Artesian Basin), while the eastern margin is covered by Tertiary and/or Quaternary sediments.

Figure 3-3 presents an excerpt from the 1:250,000 Jericho Geological map, along with a cross-section through the SGCP region, showing the onlapping sediments of the GAB on the western margins, coincident with the Great Dividing Range. The stratigraphic setting of the area is presented in Table 3-1 (see next page).

3.4.1 Eromanga Basin and Great Artesian Basin (GAB)

The Great Artesian Basin (GAB) is a large hydrogeological basin consisting of the Eromanga, Surat and Carpentaria Basins as well as parts of the Bowen, Surat and Galilee Basins. The GAB consists of confined artesian and sub-artesian groundwater and the confined aquifers of the Basin are bounded at the base by the Rewan Group sediments, with the Winton Formation acting as the upper confining layer. Figures 3-4, 3-5 and 3-6 show the relationship between the Eromanga/GAB and the Galilee Basins and their sedimentary units, and further discussion is presented in Section 3.5.2.

3.4.2 Galilee Basin

Within the project area the rocks of the Galilee Basin are represented by the following geological formations (from older to younger):

- The Upper Carboniferous-Lower Permian Joe Joe Formation - it consists of mudstone with interbedded labile and commonly argillaceous siltstone grading to fine sandstone
- Lower Permian Colinlea Sandstone - the dominant rock type is sandstone with minor siltstone and coal; Colinlea Sandstone unconformably overlies the rocks of the Joe-Joe Formation
- The Upper Permian Blackwater Group which is represented by Bandanna Formation (or its equivalents) conformably overlies the Colinlea Sandstone Formation and comprises sandstone, fossiliferous siltstone, shale and coal (including SGCP D1 and D2 seams)
- The Lower Triassic Rewan Formation unconformably overlies sediment of the Bandanna Formation and is represented by argillaceous mudstone, siltstone and labile sandstone
- The Rewan formation is conformably overlain by Dunda Formation material represented by labile sandstone, mudstone and siltstone; the Rewan Formation is regarded as the low permeability base to the GAB sediments, which onlap the western margins of the Galilee Basin in the SGCP region
- The Lower to Middle Triassic Clematis Sandstone sediments unconformably overlies the low permeability Dunda Formation and in places rests on the similar low permeability Rewan Formation; the Clematis Sandstone strata are primarily represented by quartz sandstone with minor siltstone and mudstone and form a major aquifer within the GAB
- The Clematis Sandstone is overlain with apparent conformity by the Middle to Upper Triassic Moolayember Formation; the Moolayember Formation is represented by mudstones, siltstones sandstones and shales

Figure 3-3 and Table 3-1 show that thin Tertiary and Quaternary sediments are overlain on Galilee basin strata. The thickness of the Tertiary/Quaternary cover ranges between several metres to several tens of metres. Quaternary deposits generally comprise colluvial material (weathered and transported by gravity) and alluvial material (transported and deposited by surface water streams) and consist of sand, gravel and clay sequences. Thicker Quaternary sediments are associated with current creek valleys. Tertiary sediments comprise interbeds of clays and sands with sandstone and mudstone layers.

Triassic strata generally crop out along the Great Dividing Range and have limited distribution within the SGCP project area, which is mostly underlain by the older Permian Bandanna and Colinlea Formations.

Table 3.1: Stratigraphic Summary

Period		Rock Unit and Map Symbol	Rock Type	Thickness (m)	Environments	Basin Sequences
Quaternary		Qa	Alluvium, some gravel	10	Alluvial	
		Qs	Sand, gravel, rubble	15	Colluvial	
Tertiary		T	Argillaceous, sandstone, sandy mudstone, limestone; partly lateritized	30	Fluvial, colluvial, aeolian	
		Tb	Basalt	5	Terrestrial	
Lower Cretaceous	Rolling Downs Group	Allaru Mudstone Kla	Mudstone, siltstone, minor labile sandstone	80	Shallow marine	EROMANGA BASIN
		Toolebuc Limestone Klo	Limestone, calcareous shale	3	Shallow marine	
		Wallumbilla Formation Klu	Mudstone, siltstone, limestone, calcareous shale	170	Shallow marine	
		Doncaster Member Kld	Mudstone, glauconitic mudstone and siltstone, limestone	80	Shallow marine	
Jurassic to Lower Cretaceous		Ronlow Beds JKr	Quartz and labile sandstone, mudstone, minor coal	50	Fluvial, lacustrine, paludal	
Middle to Upper Jurassic		Injune Creek Group Jmi	Labile sandstone, mudstone	200	Fluvial, lacustrine, paludal	
Lower Jurassic		Hutton Sandstone Jlh	Quartz sandstone	120	Fluvial	
Middle to Upper Triassic		Moolayember Formation Re	Quartz sandstone, minor siltstone and mudstone	190	Fluvial, lacustrine	GALILEE BASIN
Lower to Middle Triassic		Clematis Sandstone Re	Quartz sandstone, minor siltstone and mudstone	190	Fluvial	
Lower Triassic		Dunda Beds Rld	Labile sandstone, siltstone, mudstone	130	Fluvial	
		Rewan Formation Rlr	Mudstone, siltstone, labile sandstone	130	Lacustrine, fluvial	

Table 3-1 (continued): Stratigraphic Summary (continued)

Period		Rock Unit and Map Symbol	Rock Type	Thickness (m)	Environments	Basin Sequences
Upper Permian		Blackwater Group (Bandanna Formation) Puw	Labile siltstone, carbonaceous sandstone, minor limestone and coal	300	Terrestrial, lacustrine, minor paludal	
		Peawaddy Formation Pup	Carbonaceous labile sandstone, siltstone, shale	40	Lacustrine, fluvial	
Lower Permian		Colinlea Sandstone Plo	Labile and quartz sandstone, minor siltstone and coal	300	Fluvial	
Upper Carboniferous to Lower Permian		Joe Joe Formation CPj	Mudstone, labile sandstone, siltstone, shale	1250	Fluvial lacustrine; contemporaneous volcanism	
Lower Carboniferous	DRUMMOND GROUP	Ducabrook Formation Clu	Interbedded feldspathic sandstone and green and brown mudstone; minor limestone and tuff	750	Fluvial lacustrine; contemporaneous volcanism	DRUMMOND BASIN
		Star of Hope Formation Cls	Quartz sandstone, minor pebbly sandstone, conglomerate, lithic sandstone, oolitic limestone	300	Fluvial lacustrine; contemporaneous volcanism	
		Raymond Formation Clr	Quartz sandstone, minor siltstone	300	Fluvial lacustrine; contemporaneous volcanism	
		Telemon Formation Clt	Tuff, agglomerate, basalt, conglomerate, algal limestone, feldspathic sandstone, mudstone	150	Fluvial, (alluvial fan and flood plain); contemporaneous volcanism	
Upper Devonian to Lower Carboniferous		Silver Hills Volcanics DCs	Flow-banded and spherulitic rhyolite	1000	Terrestrial volcanism	
Upper Devonian		Buckabie Formation DCb	Pink feldspathic sandstone, siltstone, mudstone, varicoloured in part; minor conglomerate	1000	Continental, shallow marine	ADVALE BASIN?
		Pzl	Partially welded acid vitric-crystal tuff	?		BASEMENT
Lower Palaeozoic		Anakie Metamorphics Pza	Schist, slate, fine-grained sandstone, shale	3000+		

3.4.3 Coal Seams

Widespread development of peat swamps resulted in the deposition of coal seams during the Permian. During coal exploration, the encountered coal seams were named alphabetically from A to F. The major target of the Project is coal seam D which comprises two sub-seams D1 and D2, located within the Permian Bandanna Formation.

Figure 3-4 shows the west-east schematic geological section including the D1 and D2 coal seams.

3.5 REGIONAL HYDROGEOLOGY

Based on the review of available publications and groundwater bore data sourced from Department of Natural Resources and Mines (DNRM) (and the previous Department for Environment and Resource Management (DERM)), groundwater in the area has been encountered in all geological formations, although it is the Quaternary/Tertiary and the GAB sediments that provide almost all groundwater sources in this region.

The Quaternary/Tertiary and Permian sediments on the regional scale are generally regarded as not a significant groundwater resource. However, on the local scale, Tertiary and Quaternary alluvial sediments appear to contain groundwater resource sufficient to provide water supply to local farms and small townships (e.g. Alpha),

The most significant groundwater resources in the area are attributed to the Great Artesian Basin (GAB), and the eastern margin of the nearest part of the GAB to the SGCP project is thus represented in the groundwater model, along with the Rewan Formation aquitard that separates the GAB aquifers from the Galilee Basin units hosting the SGCP.

3.5.1 Quaternary and Tertiary Cover

Based on the bore logs provided in DNRM database, Quaternary/Tertiary sediments comprise a thin cover of several metres and up to several tens of metres, consisting of interbedded clay/sand sequences where the groundwater supply is obtained from sand layers. The majority of groundwater bores which source groundwater from these sediments are located within creek valleys where there is a greater thickness of alluvial material.

3.5.2 Great Artesian Basin (GAB)

The Queensland extent of Triassic-aged GAB in relation to the underlying older basins is shown on Figure 3-5 (sourced from DNRM 2005), along with the SGCP lease area.

The DNRM report 'Hydrogeological Framework Report for the Great Artesian Basin Water Resource Plan Area' (DNRM, 2005) presents the following overview of the GAB:

- the GAB is one of the largest artesian groundwater basins in the world. With an area of over 1.7 million square kilometres the basin underlies approximately one-fifth of the Australian continent. The GAB stores a huge volume of water estimated to be 64,900 million ML
- the aquifers of GAB are recharged by infiltration of rainfall, and leakage from streams, into outcropping sandstone mainly on the eastern margins of the Basin along the Great Dividing Range (in this region, the Clematis Sandstone forms the recharge/intake beds)
- groundwater flows naturally from these recharge areas toward springs in the west and southwest. Much further to the north, flow is to the north and northwest

DNRM (2005) also indicates that the Triassic Rewan Formation is the base confining bed of the GAB which separates the GAB from the aquifer system in the Permian strata that hosts the coal seams at SGCP further east. DNRM (2005) provides a hydrogeological description of the major Triassic aquifer/aquitard formations as follows:

- the basal unit, the Rewan Formation, consists of interbedded mudstone, siltstones and lithic sandstones with minor amounts of conglomerate. Silicification and clay alteration has significantly reduced the porosity and permeability in this formation and no significant aquifers exist. The base of this unit is at the boundary between the Permian and Triassic ages

- the Clematis Sandstone and equivalents form the only aquifer of significance within the Triassic sequence. This is the oldest and deepest aquifer in the GAB. Recharge to this unit occurs were it crops out on the eastern margin of the Galilee Basin and the northern margin of the Bowen Basin. Good yields and water quality are extracted from bores dominantly on the eastern margins of the basin in and close to these outcrop areas; elsewhere the unit is deep and rarely tapped
- the Moolayember Formation conformably overlies the Clematis and equivalent sandstones and comprises shales, mudstones, siltstones and lithic sandstone deposited in rivers, lakes and estuarine environments. This is dominantly a confining bed as the sandstones are generally poor aquifers with limited yields and varying water quality. The thickness of the formation varies from 200 to nearly 1500 m

3.5.3 GAB Springs

In principle, some natural discharge of GAB groundwater can occurs via springs in some areas. However, DNRM (2005) does not identify any natural springs attributed to the Triassic GAB aquifers in the SGCP region. The mapped locations of known springs are shown on Figure 3-6, although these springs are not associated with Triassic formation outcrops and are considered to emerge from the younger formations such as the Hutton Sandstone (which does not occur in the SGCP area). The nearest spring to the SGCP site is located over 100 km to the south-east.

3.5.4 Permian Galilee Basin

The Permian deposits of the Galilee Basin within the SGCP region comprise shale, siltstone, sandstone and coal of the Bandanna Formation and the underlying Colinlea Sandstone. These units are not regarded as comprising a significant groundwater resource as only limited and minor flows have been encountered.

4. SGCP CONCEPTUALISATION

4.1 GEOLOGICAL AND HYDROGEOLOGICAL SETTING

The regional geological and hydrogeological setting is described in Section 3, and is summarised by the following points in relation to the SGCP area (see also Figure 4-1 and 4-2, and Figure 4.9):

- the primary geological units within the SGCP area can be divided into Quaternary, Tertiary, Triassic and Permian age sediments (from younger to older)
- the Quaternary-Tertiary sediments have an average thickness of 21 m (range of 3 to 52 m)
- Triassic units outcrop/subcrop in the western part of the SGCP area, where the elevation rises into the Great Dividing Range, coincident with the outcrop of the Clematis Sandstone (a GAB recharge bed)
- the Lower to Middle Triassic Clematis Sandstone is underlain by the low permeability Rewan Formation and Dunda Beds (Lower Triassic), which itself outcrops/subcrops on the eastern flank of the Range, separating the Clematis Sandstone (GAB) from the SGCP area (Galilee Basin proper)
- east of the Great Dividing Range, the Triassic to Permian units are generally overlain by a thin cover of younger Quaternary-Tertiary units across the broad catchment floor; the average depth to the base of weathering in this area is 51 m (range of 18 to 95 m)
- the coal seams within the SGCP MLA 70453 occur in the Upper Permian Bandanna Formation; the D1 and D2 are the primary target coal seams for the SGCP (refer Table 3.1 – Blackwater Group)
- underlying the coal seams is the Lower Permian Colinlea Sandstone
- the Lower Permian Joe Joe formation is a low permeability base to this package; it outcrops/subcrops in the east (including near Alpha township), again with a thin cover of Quaternary-Tertiary sediments
- groundwater flows away from the main recharge area formed by the Clematis Sandstone outcrop along the Great Dividing Range, and
  - to the west and into the GAB system on the western side of the Range
  - to the east and north-east and into the Galilee Basin on the eastern side of the Range.

4.2 GROUNDWATER LEVELS

4.2.1 DNRM database search results

Registered bore data was obtained through an information request to DNRM for a rectangle with the following coordinates (consistent with the groundwater model domain boundaries):

- Easting (MGA, zone 55) – 409,000 to 475,000 (approx. 66 km)
- Northing (MGA, Zone 55) – 7,347,000 to 7,420,000 (approx. 73km)

The information indicated that 149 out of 381 bores registered have depth to groundwater level records, which were used to plot the elevation of groundwater levels (Figure 4-1) in all formations within the study area. In some cases, where there is no ground surface elevation information for the bores that have groundwater levels in the database, the surface elevation was estimated using the Shuttle Radar Topography Mission (SRTM) digital terrain model (DTM) constructed for Australia (NASA, 2012). The SRTM DTM is available on a horizontal grid of about 90 metres, and has vertical elevation errors typically in the order of 5 to 10 metres, which can reduce the accuracy and reliability of the groundwater level data.

Table 4-1 summarises the available information from the DNRM groundwater level database.

Table 4-1 shows that groundwater levels in alluvial material is generally shallower than in other units (e.g. Tertiary and Permian), although the average depth to water table is in excess of 10 metres. This confirms the interpretation that the streams (which are hosted within alluvial deposits) are ephemeral ('losing streams'), that may provide low volumes of recharge during intermittent periods when there is flow in the stream.

Table 4-1 also indicates that there is a substantial degree of consistency in the data from bores constructed in different formations (alluvial, Tertiary and Permian) in terms of the range of groundwater levels (see also Figure 4-1) and bore yields (typically 1 to 2 L/sec). This confirms the characterisation of the SGCP area as not containing significant aquifer resources (as distinct from the GAB, for example).

Table 4.1: Bores with groundwater levels from DNRM Groundwater Database

Geological Unit	Number of bores	Number of Bores near Alpha town	**Depth to groundwater range** (average shown in brackets) from-to (m)	**Groundwater Elevation range** from-to (mAHD)	**Range of bore yield** (average shown in brackets) from-to (L/sec)
Alluvial Material	52	16	3 – 39 (14.9)	304 -382	0.01 – 5 (1.5)
Tertiary Sediments	42	19	8 – 52 (27)	300 – 380	0.01 – 16 (2.3)
Triassic Sediments	22	-	10 – 93 (46.9)	317 – 355	0.1 – 9 (1.5)
Permian Sediments	33	-	10 – 86 (34.3)	300 - 389	0.06 – 6 (1.7)

The low-yielding groundwater system in the study area (east of the Great Dividing Range) can be characterised as flowing generally northerly and north-easterly from high groundwater levels in the uplands on the west, south and south-east.

4.2.2 SGCP Exploration drilling data

Water level data measured in exploration holes drilled to the base of the deepest coal seam D2 are shown on a west-east cross-section plotted along Northing MGA 7378600 (Figure 4-2), together with water levels measured in (overburden or interburden) monitoring bores MB2 to MB4. This cross-section demonstrates that the groundwater flow system within the formations hosting the coal measures is consistent with the more regional DNRM data (Figure 4-1), but also indicates the potential for easterly sub-gradients in some local areas close to the SGCP.

4.2.3 SGCP Groundwater Monitoring

To date, 10 monitoring bores have been installed at the SGCP site: four open (standpipe) monitoring bores (MB) sites and six grouted-in vibrating wire piezometer (VWP) sites (Figure 4-3).

The standpipe monitoring bores have been established in a line along the dip of the Permian strata in an east-west direction. These bores are constructed with 100 mm diameter PVC casing which has been slotted over a discrete target horizon in each bore, and they are fitted with pressure transducers which provide a continuous record of groundwater level fluctuations. The standpipe bores also enable the collection of groundwater water quality samples.

The VWP sites provide piezometric pressure data via pressure sensors grouted at specific depths below ground level at each monitoring site. The sensors measure the pressure of the overlying groundwater column at discrete points, which is captured by data loggers at the surface and subsequently converted to groundwater level data. The boreholes into which the VWP sensors have been placed have been fully grouted with a cement-bentonite grouting mix, and thus cannot be used for water quality measurement.

Two rounds of groundwater quality sampling were conducted for MB01-04 and water level information from the electronic water transducers was downloaded. The results of the groundwater sampling are discussed in Section 4.4. The downloaded groundwater level records have not been subject to detailed analysis at this stage because the reference levels of the monitoring bores and vibrating wire piezometers have not yet been professionally surveyed.

Initial analysis identified some discrepancies in the groundwater levels (assuming topography from the digital elevation model). A program of further investigation (including surveys) is planned as part of the implementation of the Groundwater Monitoring Program.

4.2.4 Aquifer Hydraulic Properties

Aquifer tests were conducted in the Monitoring bores MB03 and MB04.

A 90 minute constant discharge pumping test was conducted in MB03 at a rate of 1 L/sec. The water levels were measured by an electronic water level transducer during pumping and post pumping water level recovery. The data from the pumping test in MB03 were analysed using Cooper-Jacob method (drawdown curve) and Theis method (residual drawdown/recovery).

A slug test was conducted in MB04, which involved the near instantaneous removal of a 'slug' of water which created a water level drop (displacement) in the bore of 14.18 m. Water level recovery after the displacement was monitored for 27 minutes. The data from the slug test were analysed using the Bouwer-Rice method.

The results were analysed using the Aqtesolv Pro software (Appendix A) to estimate aquifer transmissivity (T) and horizontal hydraulic conductivity (Kh), as summarised in Table 4.2.

Table 4.2: Aquifer Tests at SGCP

Bore	Method	Kh (m/day)	T (m^2/day)	Formation
MB03	Jacob	0.2	15	Colinlea, D1/D2/interburden combined
MB03	Recovery	0.23	16.1	Colinlea, D1/D2/interburden combined
MB04	Bouwer-Rice	0.29	7.4	Colinlea, to the east of the D1/D2 extent

Previous groundwater work conducted by others (JBT Consulting, 2010) identified hydraulic conductivities of geologic materials at the ACP some 62 km to the north from the SGCP site, as summarised in Table 4.3.

Table 4.3: Hydraulic conductivity from investigations at Alpha Coal Project (JBT, 2010)

Geologic Material	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)
Alluvium/Tertiary	3.7e-4 to 50	1.5e-6 to 40
Dunda Beds and Rewan Formation	1e-4 to 1.4	1e-5 to 1.4e-1
GAB (Clematis Sandstone)	8e-4 to 5	8e-5 to 5e-1
Bandanna Formation	1e-5 to 1	1e-5 to 1e-1
Colinlea Sandstone (incl coal seams)	1e-4 to 10	1e-4 to 1

Another assessment of aquifer hydraulic parameters was included in the groundwater modelling report (URS, 2012) for the ACP, summarised in Table 4.4.

Table 4.4: Hydraulic conductivity from Alpha Coal Project groundwater model (URS, 2012)

Geologic Material	Horizontal Hydraulic Conductivity (m/d)	Vertical Hydraulic Conductivity (m/d)
Alluvium/Tertiary	5	0.5
Dunda Beds and Rewan Formation	4e-3 to 4e-4	2e-4 to 4e-5
GAB (Clematis Sandstone)	1e-1 to 5	5e-1
Bandanna Formation	4e-3	2e-4
Colinlea Sandstone (incl coal seams)	1e-3 to 1.5	1e-2 to 1e-5
Joe-Joe Formation	4e-4	4e-5

Another assessment of aquifer hydraulic parameters was undertaken during investigations for the Galilee Coal Project ('China First'), summarised in Table 4.5. (URS, 2012). Measured values for vertical hydraulic conductivities are not provided in the GCP/China First report. In the URS modelling it was assumed that vertical hydraulic conductivity values are an order of magnitude lower than horizontal values, which is a typical assumption on coal projects.

Table 4.5: Hydraulic conductivity from GCP/China First project (URS, 2012)

Geologic Material	Range of Horizontal Hydraulic Conductivity values (m/d)
Alluvium/Tertiary	1e-3 to 3e-3
Dunda Beds and Rewan Formation	1e-3 to 1.4e-1
GAB (likely Clematis Sandstone)	2.9 to 12
Bandanna Formation and/or Colinlea Sandstone (interbeds)	1e-3 to 1e-1
Coal Seams B, C, D, E	0.25 to 6.8
Joe-Joe Formation	Not tested

This information was used to benchmark the parameters adopted for the SGCP groundwater model (refer Section 6).

4.2.5 SGCP Relationship to Great Artesian Basin (GAB)

The GAB onlaps the western margin of the Galilee Basin in the SGCP area, coincident with the Great Dividing Range, and the Clematis Sandstone outcrop that forms a GAB recharge/intake bed. Figures 3-3 and 4-2 present schematic cross-sections.

The base of the GAB is formed by the low permeability Rewan Formation, which is itself underlain by the low permeability Dunda Formation. The economic coal seams at SGCP (D1 and D2 seams) occur below and to the east of the Rewan/Dunda units. To the west and above the Rewan/Dunda units, the Clematis Sandstone forms a recharge/intake bed to the GAB that outcrops along the Great Dividing Range.

As described herein, groundwater flow may be summarised as occurring away from the main recharge area formed by the Clematis Sandstone outcrop along the Great Dividing Range:

- to the west and into the GAB system on the western side of the Range
- to the east and north-east and into the Galilee Basin on the eastern side of the Range.

The Rewan and Dunda Formations form the regional aquitard at the base of the GAB and separate groundwater in GAB from groundwater in the Galilee Basin. The combined thickness of the aquitard is around 250 m. The Rewan aquitard has a very low vertical hydraulic conductivity in the order of 1×10^{-4} to 1×10^{-3} m/day, based on previous investigations during an early phase of GAB groundwater modelling (Audibert, 1976).

These units outcrop several kilometres west of the western limit of the SGCP underground coal mining, and form an effective barrier to the potential for drawdown due to mine dewatering to extend towards the GAB aquifers. Nevertheless, the eastern extent of the GAB has been included in the numerical modelling undertaken for the SGCP impact assessment (refer Section 6).

4.3 GROUNDWATER RECHARGE AND DISCHARGE

4.3.1 Recharge

The aquifer systems in the SGCP area are generally recharged from rainfall infiltration, with small volumes of leakage from the losing/ephemeral stream system.

The cumulative rainfall deviation (CRD) method, based on the water-balance principle, is often used to identify whether observed water level fluctuations are due to rainfall recharge or other processes. Cumulative rainfall deviation is the accumulated difference between the actual rainfall recorded (e.g. in a month or a year) and the long term mean. If there is poor correlation between groundwater level hydrographs and the CRD, then it may be concluded that rainfall recharge is not significant, or that some other recharge processes are dominant (e.g. regional inflow, upward leakage from the deeper aquifer systems etc.).

The closest BoM rainfall station is located in Alpha Town roughly 10 km to the east of SGCP. The data from this station was used in the CRD analysis, along with long term DNRM groundwater level data from bores installed in alluvial, Tertiary and Permian strata. No long term groundwater levels were available the bores installed in Triassic sediments. The CRD plots of rainfall and long term groundwater level trends presented on Figure 4-4 show a good correlation to groundwater levels, which indicates that recharge to groundwater in all strata is likely to be strongly associated with rainfall infiltration.

The greatest rainwater infiltration typically occurs at high elevation areas where rocks outcrop. Figure 4-1 showed the general decrease in groundwater level elevations from the upland areas in the west and south-east (the high elevation areas associated with the Great Dividing Range) to the east and north-east (into the Galilee Basin), and also further to the west (into the GAB). The high hills of the Range are thus identified as the main groundwater recharge area.

As it is difficult to estimate the recharge rate due to the absence of direct measurements (e.g. lysimeters), a broad estimate was made using the Chloride Mass Balance (CMB) best practice method. CMB inputs are annual rainfall precipitation, concentration of chloride in either soil pore water or actual rain water and chloride concentration in groundwater in the potential recharge region.

The CMB formula is written as $R=QCr/Cgw$, where Q is annual rainfall, Cr is chloride concentration in rainwater and Cgw is chloride concentration in groundwater.

Annual average rainfall of 560 mm/year is based on the Alpha Town Post Office weather station records (refer Section 4.1).

Appendix B presents groundwater quality analysis included in the data set obtained from DNRM.

The registered bores from which multiple groundwater samples were available were selected for the CMB recharge estimate (i.e. more than three samples to exclude no-representative values). These bores with chloride values and sampling dates are included in Table 4.6.

Table 4.6: Chloride Concentration (DNRM data; co-ordinates in MGA)

Bore	Cl (mg/L)	Date	East	North
12030076	7200	11/08/1977	445752	7414375
	7700	7/11/1978		
	7300	13/12/1983		
17299	215	4/03/1969	412755	7384479
	214	1/02/1967		
	570	20/03/1986		
	212.6	27/09/1999		
90084	1552	15/12/1993	426778	7348221
	362.3	15/12/1993		
	270.7	15/12/1993		
38112	455	22/07/1970	463003	7384549
	448	22/03/1976		
	424	22/03/1977		
51099	328	13/12/1977	462904	7384747
	390	11/03/1980		
	386	10/03/1981		
	350	20/12/1983		
	330	3/04/1984		
	320	26/06/1984		
51401	190	20/05/1980	462923	7384306
	290	21/05/1980		
	136	29/09/1980		
	380	20/12/1983		
	495	3/04/1984		
	495	26/06/1984		
	400	11/12/1984		

Bore	Cl (mg/L)	Date	East	North
51402	205	29/06/1990	463167	7384105
	350	14/11/1990		
	375	14/10/1991		
	385	20/01/1992		
	385	9/03/1992		
	370	27/04/1992		
	360	7/07/1992		
	365	24/08/1992		
	385	1/12/1992		
	330	17/02/1997		
	330	1/07/1998		
	355	22/07/1996		
	387.3	20/10/1999		
	300	13/03/2001		
51408	469	3/04/1981	462840	7384874
	469	5/04/1981		
	485	6/04/1981		
	489	7/04/1981		
	490	8/04/1981		
	495	9/04/1981		
	400	4/10/1983		
51881	405	30/12/1983	462871	7384873
	380	31/12/1983		
	390	1/01/1984		
	395	2/01/1984		
51881	390	3/01/1984	462871	7384873

Bore	Cl (mg/L)	Date	East	North
51968	66	12/06/1990	462997	7384549
	320	14/11/1990		
	320	19/03/1991		
	365	19/03/1991		
	335	14/10/1991		
	345	10/12/1991		
	335	20/01/1992		
	330	9/03/1992		
	195	27/04/1992		
	340	7/07/1992		
	325	24/08/1992		
	315	1/12/1992		
	340	12/10/1993		
	425	22/07/1996		
	420	17/02/1997		
	390	1/07/1998		
	375	13/02/2001		
103113	230	15/12/1997	462890	7384873
	325	1/07/1998		
	40.5	13/03/2001		
103183	180	27/04/1992	461747	7384605
	150	1/04/1997		
	195	9/12/1998		
103184	96	25/11/1990	458197	7381893
	140	8/07/1998		
103184	150	9/12/1998	458197	7381893

Bore	Cl (mg/L)	Date	East	North	Bore	Cl (mg/L)	Date	East	North	Bore	Cl (mg/L)	Date	East	North
51401	475	19/02/1985	462923	7384306		330	3/04/1984			103225	250.1	14/09/1999	463342	7384062
	150	14/06/1985				375	19/02/1985				354.7	15/09/1999		
	490	21/01/1986				365	2/01/1986				360.6	14/09/1999		
	360	30/09/1987				350	30/09/1987			103226	342.2	12/09/1999	463279	7383774
	465	6/03/1990				195	6/03/1990				364.2	12/09/1999		
	290	29/05/1990				280	29/05/1990				453.5	12/09/1999		
	205	12/06/1990				41	12/06/1990			51099	328	13/12/1977	462904	7384747
	255	14/11/1990				320	14/11/1990				390	11/03/1980		
	360	19/03/1991				345	19/03/1991				386	10/03/1981		
	465	14/10/1991				385	14/10/1991				350	20/12/1983		
	455	10/12/1991				390	10/12/1991				330	3/04/1984		
	255	9/03/1992				385	20/01/1992				320	26/06/1984		
51402	437	26/05/1980	463167	7384105		395	9/03/1992			69749	248.7	18/05/1992	462920	7384293
	424	27/05/1980				415	27/04/1992				282.3	17/05/1992		
	440	10/04/1981				385	7/07/1992				265	7/07/1992		
	420	11/04/1981				395	1/12/1992				395	21/06/1993		
	420	12/04/1981			51968	365	19/03/1981	462997	7384549		365	12/10/1993		
	423	13/04/1981				420	24/01/1984				330	22/07/1996		
	425	20/12/1983				425	25/01/1984				355	17/02/1997		
	420	11/02/1984				440	25/01/1984				470	1/07/1998		
	420	3/04/1984				400	26/01/1984				340	13/02/2001		
	420	26/06/1984				395	27/01/1984			12030036	20	10/08/1977	464808	7383722
	480	11/12/1984				390	28/01/1984				20.4	3/07/1998		
	365	14/06/1985				360	14/06/1985				10.4	20/10/1999		
51402	380	30/09/1987	463167	7384105		385	21/01/1986			12030040	380	10/08/1977	463182	7384105
	215	29/05/1990			51968	385	30/09/1987	462997	7384549	12030040	382.7	3/07/1998	463182	7384105
	375	10/12/1991				43	29/05/1990				428.6	20/10/1999		

The locations of the bores with chloride concentration data are shown on Figure 4-5. The average chloride concentration calculated for all bores was 350 mg/L, with the exception of data for bore 12030076, where it was 7,400 mg/L, as this bore is located further from the Great Dividing Range than other bores (i.e. it is more remote from the main recharge areas). The concentration of chloride in rainfall was obtained from Ransley et al (2010), which includes data measured in various areas in Australia.

Using this information, the recharge to the groundwater at the Project area can be estimated to be in the range 1 to 20 mm/year (roughly 1% to 4% of the annual rainfall). The groundwater recharge rates used in the model were benchmarked against these estimates (refer Section 6).

4.3.2 Discharge

The main groundwater discharge process is regional throughflow along hydraulic gradients, and this is best assessed through the numerical model (Section 6), which also accounts for other minor discharge processes (e.g. groundwater pumping, evapotranspiration).

4.4 GROUNDWATER QUALITY

The groundwater quality information was obtained from both regional data (from DNRM – see Appendix B) and local data (exploration drilling and monitoring – see Appendix C).

Groundwater samples collected from the SGCP monitoring bores (MB01-MB04) were tested for a full suite of analytes. The table of results and the adopted water quality criteria (i.e. ANZECC 2000 guideline for fresh aquatic ecosystems, recreational use, irrigation and livestock watering) are presented in Appendix C.

4.4.1 Groundwater Salinity and pH

Groundwater salinity values expressed in total dissolved solids (TDS, mg/L) and/or electrical conductivity (EC) were combined to assess a regional distribution of groundwater salinity at the SGCP area. The EC values measured during the exploration drilling were converted into TDS values using 0.6 multiplier (standard practice when using this type of data; Chaffey, 1992).

This data was used to plot groundwater salinity contours (expressed in TDS). These contours together with TDS values for individual bores and exploration holes are shown on Figure 4-6.

Figure 4-6 shows that groundwater salinity pattern generally follows the groundwater flow pattern, in that the salinity of groundwater is fresher at the hills and ridges of the Great Dividing Range and increases to the north and east. Groundwater salinity at the SGCP site is greater than 1,000 mg/L and in some places greater than 2,000 mg/L (i.e. not within drinking water guidelines, but nominally suitable for irrigation and stock). Figure 4-6 also shows the presence of fresh groundwater (< 1,000 mg/L) in places along the major creeks (notably along Alpha Creek and Native Companion Creek).

The most recent field sampling and measurement for pH of groundwater was conducted in August 2012 on existing monitoring bores MB01 to MB04:

- MB01 pH = 5.9, and EC = 5770 µS/cm
- MB02 pH = 4.9, and EC = 1910 µS/cm
- MB03 pH = 6.4, and EC = 4840 µS/cm
- MB04 pH = 7.2, and EC = 1030 µS/cm

This indicates that the groundwater pH ranged from slightly acidic to neutral, although the low pH values were not supported by the laboratory measurements (refer Appendix C). The field measurements noted that the groundwater temperature is generally stable at about 24 ^{o}C, and salinity values ranged from relatively fresh to brackish (which is supported by the laboratory measurements – see Appendix C).

4.4.2 Major Cations and Anions

Water samples tested for major cations (calcium, magnesium, sodium and potassium) and major anions (bicarbonate, carbonate, sulphate and chloride) were applied to Piper diagram analysis to assess whether groundwater within the project area is associated with similar or potentially different groundwater recharge sources.

The main purpose of the Piper diagram is to show clustering of data points to indicate samples that have similar major cation/anion ratios and therefore similar origin source (e.g. identifying groundwater from different geological units). The Piper diagram plots the major ions as percentages of milli-equivalents in two base triangles. The total cations and the total anions are set equal to 100% and the data points in the two triangles are projected onto an adjacent grid.

The distribution of the bores with major ions tested is shown on Figure 4-7 and the Piper plot is shown on Figure 4-8. Piper diagram shows that majority of groundwater samples from one cluster of sodium-chloride type, indicating groundwater in alluvial, Tertiary, Triassic and Permian sediments are of similar origin (assessed to be rainwater infiltration).

Some samples collected from groundwater in alluvial and Tertiary sediments plot distinctly from the major cluster. The dominant anion in those samples is bicarbonate (HCO3) and dominant cations are calcium and sodium. The dominance of these ions indicates a minor influence on groundwater quality from localised recharge sources associated with losing streams and irrigation activities.

4.4.3 Baseline Groundwater Quality Assessment

The results of groundwater sampling from regional bores (DNRM data, Appendix B) shows that the groundwater in the area generally has elevated concentrations of nitrate and some metals (e.g. iron, zinc and manganese) which exceed ANZECC environmental guideline criteria for fresh aquatic ecosystems and/or and irrigation (refer Appendix C).

The results of groundwater sampling from the onsite monitoring bores (MB01 to MB04) shows that all tested analytes were reported to be either below the laboratory reporting limits or below the adopted ANZECC environmental criteria, with the exception of zinc, boron and ammonia.

The exceedances for the onsite monitoring bores (MB01 to MB04) were as follows:

- concentrations of zinc were reported to exceed the fresh aquatic ecosystem 95% species protection limit of 0.008 mg/L in all four bores MB01 to MB04
- concentrations of boron were reported to exceed the fresh aquatic ecosystem 95% species protection limit of 0.37 mg/L in one monitoring bore MB03
- concentrations of ammonia were reported to exceed the fresh aquatic ecosystem 95% species protection limit of 0.9 mg/L in monitoring bores MB01 and MB04

The overall groundwater quality analysis results indicate that the baseline groundwater is generally but not universally compliant with irrigation and stock water criteria (where the salinity of groundwater allows), but is not generally suitable for drinking purposes due its high salinity, and is generally not complaint with 95% fresh aquatic ecosystems criteria for zinc, boron and ammonia.

4.5 HYDROGEOLOGICAL CONCEPTUALISATION SUMMARY

The key elements of the conceptual hydrogeological model are summarised below, with reference to the 3D conceptual model of Figure 4-9:

- the aquifer system is recharged mainly through rainfall infiltration, at relatively low fractions (<5%) of annual rainfall and with the highest recharge rates in areas of higher topography, notably the Clematis Sandstone outcrop aligned with the Great Dividing Range
- the groundwater flow patterns reflect surface topography generally, extending from the co-aligned Great Dividing Range and GAB intake beds of the Clematis Sandstone west and south of the SGCP, and extending into the two main basins, with the main flow components:
  - groundwater flow to the east and north and into the northern Galilee Basin and Burdekin Drainage Basin
  - groundwater flow down-dip to the west and out into the Great Artesian Basin (GAB) system
- surface and groundwater interaction processes are limited, as streams are ephemeral, flowing only when rainfall generates adequate runoff, and providing low volumes of recharge to the water table, which is typically more than 10 metres below ground level and thus

evapotranspiration from terrestrial vegetation is not a key aquifer discharge process.

This conceptual hydrogeological model forms the basis for the design and implementation of the numerical groundwater flow described in Section 6, which is used for impact assessment and to develop mitigation and management plans.

5. EXISTING ENVIRONMENTAL VALUES AND GROUNDWATER USES

5.1 ENVIRONMENTAL VALUES

The ToR requires the consideration of environmental values in relation to groundwater.

The following environmental values are recognised by the National Water Quality Management Strategy (NWQMS):

- aquatic ecosystems
- primary industries
- recreation and aesthetics
- drinking water
- domestic use other than drinking
- industrial water
- cultural and spiritual values.

5.1.1 Aquatic and Groundwater Dependent Ecosystems

In the SGCP region, including the GAB recharge beds formed by the Clematis Sandstone outcrop west of the SGCP, there are no springs or permanent creeks/streams in which the baseflow is maintained by groundwater discharge. Aquatic ecology surveys in the region have not identified any stygofauna (ALS, 2011). Therefore, there are no identified groundwater dependent ecosystems (GDE) within the SGCP area.

5.1.2 Primary Industries/Agricultural Use

Groundwater sourced from the bores within and adjacent to the SGCP is primarily utilised for stock watering.

5.1.3 Drinking, Recreational, Aesthetic and Domestic Use

Groundwater from the SGCP is generally not compliant with drinking water guidelines due to its high salinity. There are some isolated exceptions where the salinity is within guidelines, and it is noted that some users may choose to ignore guidelines or may not test the water source.

Recreational and aesthetic groundwater use may be considered as valid environmental value where groundwater is used by local households.

5.1.4 Industrial Use

New proposed mines in the surrounding area (e.g. Alpha Coal Project, Kevins Corner Coal Project, and Galilee Coal Project) will intersect groundwater within some aquifers and will actively extract water from the resource to facilitate mining. This water may then be reused for industrial purposes, where practicable.

5.1.5 Cultural and Spiritual Values

It is not known whether cultural or spiritual values of groundwater at and in the vicinity of the SGCP site have been identified, but it is presumed not because of the lack of springs and the substantial depth to water table (typically 10 m).

5.2 EXISTING GROUNDWATER USERS

5.2.1 Registered Groundwater Bores

The DNRM Groundwater Database lists 381 registered bores within 40 km of the SGCP. Of these, 331 bores are either existing or still viable and are equipped for groundwater extraction. The location of each of these bores is shown on Figure 5-1, and further information is presented in Appendix D.

Not all registered bores included in the database have logs or formation interpretations. There are 186 bores for which geological/stratigraphic interpretation was included in the DRNM database.

The number of bores of each identified formation type is included in Table 5.1.

Table 5.1: DNRM Registered Bores

Target Aquifer	Number of Registered Bores	Yield Range (L/sec)
Unconsolidated Alluvial	69	0.01 to 4
Weathered and Consolidated Tertiary Sediments	67	0.01 to 7.6
Weathered and Consolidated Triassic Sediments	23	0.01 to 16.4
Consolidated Permian Sediments	27	0.01 to 6.3
No formation description provided	195	1 to 4.6

Table 5.1 shows that majority of the bores were constructed to source groundwater from shallow units such as alluvial and Tertiary material. These bore locations are shown on Figure 5-1, clearly clustering in concentrations along the alluvial channels of major creeks (e.g. Alpha Creek).

5.2.2 Licensed Groundwater Bores

The DNRM Water Management System (WMS) database includes all licensed groundwater bores for different catchment areas. The study area is located within two major river catchments: Suttor River (code 1203) and Barcoo River (code 0033). Altogether 28 licensed bores were identified within 40 km radius of the SGCP site, with the locations shown on Figure 5-2.

The majority of the licences are for stock and domestic water use. A few bores have an irrigation licence water use. The summary for licensed bores including geological formation, depth and water use is shown in Table 5.2. There is no groundwater usage (i.e. volumetric groundwater allocation) information available for licensed bores, as no flow meters are required by DNRM to be installed.

5.2.3 Water Supply

The closest cluster of licensed bores to the Project are those near the Alpha township, roughly 10 km to the east of the SGCP, and these are interpreted as the major existing groundwater user.

Information on the Alpha township water supply bores was received from Barcaldine Regional Council, including:

- there are 10 groundwater bores installed at Alpha for the town water supply
- the bores source groundwater from unconsolidated Tertiary and alluvial sediments
- annual volumes extracted were 87 ML in 2010/11 and 164 ML in 2011/12 (i.e. equivalent to pumping rates of less than 1 L/sec per bore)

Extraction for Alpha town water supply is included in the groundwater model (Section 6).

Table 5.2: Licensed Groundwater Bores (DNRM data)

RN	EASTING	NORTHING	Formation name	Water Use	Bore Summary	Status
13852	410058	7370090	Clematis Sandstone	Stock	Sub-artesian Bore Depth 228.00m Local Name SUMMERDELL BORE	Installed
103441	421354	7411207	Clematis Sandstone		Sub-artesian Bore Depth 128.00m Local Name Native Bee Bore	Installed
103253	421464	7358686	Clematis Sandstone	Stock	Sub-artesian Bore Depth 168.00m Local Name RN 103253	Installed
103175	422412	7386289	Clematis Sandstone		Sub-artesian Bore Depth 97.50m Local Name CORNER BORE	Installed
118257	423806	7353279	Clematis Sandstone		Sub-artesian Bore Depth 97.50m Local Name 6 MILE BORE	Installed
90372	425609	7385301	Clematis Sandstone	Domestic Supply, Stock	Sub-artesian Bore Depth 172.20m Local Name NEW NO 2 BORE	Installed
90084	426778	7348221	Clematis Sandstone		Sub-artesian Bore Depth 169.00m Local Name NEW HOMESTEAD	Installed
51102	427101	7409511	Clematis Sandstone	Domestic Supply, Stock	Sub-artesian Bore Depth 179.80m Local Name SHED BORE	Installed
90085	436088	7344227	Clematis Sandstone		Sub-artesian Bore Depth 156.60m Local Name NEW DINNER CREEK	Installed
1174	432972	7388298	Dunda Beds	Domestic Supply, Stock	Sub-artesian Bore Depth 29.00m Local Name CORN TOP WELL	Installed
69744	415752	7362478	Formation Name Not Specified	Stock	Sub-artesian Bore Depth 87.00m Local Name ALLANARD HOUSE	Installed
7662	419675	7398448	Formation Name Not Specified	Stock	Sub-artesian Bore Depth 42.70m Local Name ROSEFIELD No.3B	Installed
69745	423295	7360240	Formation Name Not Specified		Sub-artesian Bore Depth 109.70m Local Name SANDY BORE	Installed
17020	409426	7385038	Moolayember Formation		Sub-artesian Bore Depth 72.50m Local Name RN 17020	Installed
118232	409793	7401233	Moolayember Formation	Domestic Supply, Stock	Sub-artesian Bore Depth 65.70m Local Name INVERURIE HOUSE,	Installed

RN	EASTING	NORTHING	Formation name	Water Use	Bore Summary	Status
1117	420777	7386160	Moolayember Formation	Stock	Sub-artesian Bore Depth 222.50m Local Name NO.1 BORE	Installed
103203	410560	7389533	Tertiary - Undefined		Sub-artesian Bore Depth 124.00m Local Name RN 103203	Installed
51594	410989	7388977	Tertiary - Undefined		Sub-artesian Bore Depth 86.80m Local Name RN 51594	Installed
103202	411203	7389458	Tertiary - Undefined		Sub-artesian Bore Depth 119.80m Local Name RN 103202	Installed
17299	412755	7384479	Tertiary - Undefined	Domestic Supply, Irrigation, Stock	Sub-artesian Bore Depth 99.10m Local Name RN 17299	Installed
69286	458523	7381585	Tertiary - Undefined	Domestic Supply, Irrigation	Sub-artesian Bore Depth 47.00m Local Name HOUSE BORE	Installed
103199	462857	7384873	Tertiary - Undefined		Sub-artesian Bore Depth 70.00m Local Name RN 103199	Installed
103198	462931	7384311	Tertiary - Undefined		Sub-artesian Bore Depth 70.00m Local Name RN 103198	Installed
103201	462999	7384551	Tertiary - Undefined		Sub-artesian Bore Depth 70.00m Local Name RN 103201	Installed
90192	463013	7384371	Tertiary - Undefined		Sub-artesian Bore Depth 32.00m Local Name OVAL BORE	Installed
69715	463074	7384089	Tertiary - Undefined	Irrigation	Sub-artesian Bore Depth 45.70m Local Name CARAVAN PARK BORE	Installed
103200	463172	7384101	Tertiary - Undefined		Sub-artesian Bore Depth 70.00m Local Name RN 103200	Installed
90193	463504	7384433	Tertiary - Undefined		Sub-artesian Bore Depth 32.00m Local Name SCHOOL BORE	Installed

5.2.4 Bore Census

A bore census was undertaken by Matrixplus (2009) on properties close to the SGCP lease. This involved visiting each property and locating, where possible, all operating and abandoned bores. Observations were made at each bore including the location, condition of the bore, pumping equipment and groundwater flow and quality data if possible.

The property which comprises a significant proportion of the SGCP area is Creek Farm in the central and eastern portion of the SGCP. The remaining neighbour properties are Sapling Farm to the south west, Betanga in the west and Chesalon in the northwest. Based on discussions with landholders in and adjacent to the SGCP lease, groundwater is used primarily for cattle watering.

The landholder bores identified during census are shown in Table 5.3. The full census results reported by Matrixplus are included in Appendix E. The bore census did not locate some of the bores registered in DNRM database.

Table 5.3: SGCP Landholder Bore Census

Property	Number of Bores in Use	Total Number of Bores
Creek Farm	5	16
Betanga	3	12
Sapling Farm	2	4
Chesalon	2	5

The census reports indicate a range of bore yield between 0.1 and 2 L/sec. The operation hours for farm bores do not usually exceed 10 hours a day. Therefore the maximum annual pumping rate from a single bore may be up to 26 ML/year (depending on how many operating days per year).

5.3 Summary of Existing Users

The groundwater in the area has been used primarily for town water supply for Alpha stock and domestic water supply, and some small scale irrigation, where quality of groundwater is adequate.

The majority of the registered bores are clustered along the major creek valleys (e.g. Alpha Creek or Native Companion Creek). Despite the presence of the 28 licensed bores in the area, data on volumetric groundwater usage of groundwater from these bores was not available as these licensed bores do not have flow meters installed.

Information available indicates that average bore yields are typically 1 to 2 L/sec, which could equate to 13 ML/year if it was assumed that bore operation is 10 hours/day for 6 months per year. However, the bore yields vary within a wide range from 0.01 L/sec to 16 L/sec, indicating significant hydraulic heterogeneity of the aquifer materials. The available groundwater level data does not indicate extensive drawdown in the area, indicating that the extraction that is occurring is not a significant component of the water balance.

The average yield is considered to be insignificant compared to the overall groundwater recharge estimate. As there is a lack of specific data (e.g. bore locations, depths, volumes, etc), the licensed bore extraction is not included in the model, other than for the Alpha township, as that is the major user (refer Section 6 of the report for more details on the model).

6. South Galilee Coal Project Groundwater Flow Model

6.1 MODELLING APPROACH

6.1.1 Objectives

The methodology for predicting the impacts on groundwater by the South Galilee Coal Project (SGCP) involves the construction and calibration of a multi-layered groundwater flow model and then using that model to predict changes to the hydrological systems resulting from the coal mining activities, notably mine dewatering and cumulative impacts assessment. The results of the modelling were used to develop appropriate impact management and mitigation plans.

The objectives of the groundwater flow modelling were to:

- assess the impact of open cut and underground mining on local and regional groundwater levels, including on the Great Artesian Basin (GAB) formations west of the SGCP
- assess regional impacts on groundwater levels after the cessation of mining operations
- provide mitigation measures where appropriate to address the life of project potential impacts over the life of the project

The SGCP groundwater flow model developed by RPS Aquaterra uses the industry-standard MODFLOW numerical code (McDonald and Harbaugh, 1988; Harbaugh et al, 2000), coupled with the SURFACT code for unsaturated conditions (HydroGeoLogic Inc.), and operating under the Groundwater Vistas graphical user interface (ESI, 2011).

6.1.2 Cumulative Impact Assessment

The SGCP model extent covers an area of about 65 km east-west and 73 km north-south (Figure 6-1). This extent allows for assessment of the potential for impacts on existing groundwater use near the Alpha township to the east, and on GAB formations to the west, as well as allowing for cumulative impact assessment due to other mining operations to the north (Alpha, Kevins Corner and Galilee Coal Projects).

The SGCP model extends to these boundaries:

- east to the Alpha township (the model includes representation of groundwater extraction at Alpha township)
- west to the range of hills that form the catchment divide (the Great Dividing Range), to represent the Great Artesian Basin aquifers in this area
- north to the Alpha Coal Project (ACP); the representation in the SGCP model of impacts at the ACP includes the effects of the Kevins Corner Coal Project immediately north of ACP, as well as the Galilee Coal Project (GCP) which is located within the model domain, and
- south to the topographic boundary about 13 km from the SGCP

6.1.3 Consistency with Guidelines

The SGCP groundwater model was developed as a medium to high complexity model consistent with best practice guidelines.

The 2012 national guidelines (Barnett et al, 2012) build on the 2001 MDBC guide (Middlemis et al, 2001), with substantial consistency in the model conceptualisation, design, construction and calibration principles, and the performance and review criteria, although there are differences in some details. One notable difference with the 2012 guide is the new method of model complexity classification. Under this system, the SGCP model may be categorised with a Class 2 to Class 3 model confidence level (Barnett et al, 2012). Similarly, under the MDBA modelling guidelines (Middlemis *et al,* 2001), the model is best categorised as an Impact Assessment Model of medium to high complexity.

6.1.4 Model Code Selection

The multi-layered finite difference groundwater flow model has been built using the industry standard MODFLOW code (McDonald and Harbaugh, 1988; Harbaugh et al, 2000). The basic flow model was coupled with the MODFLOW-SURFACT (version 4; HydroGeoLogic Inc.) code to allow for both saturated and unsaturated flow conditions, and also the simulation of variable aquifer parameters to represent mining and backfilling with overburden. The modelling has been undertaken using the Groundwater Vistas (Version 6.26) pre/post-processor software package (ESI, 2012).

6.2 CONCEPTUAL MODEL

The hydrogeological investigations detailed herein were used to develop the hydrogeological conceptualisation of how the groundwater system surrounding the SGCP operates, and that understanding forms the basis for the numerical groundwater flow model.

The conceptual model is an idealised representation of the real system, identifying the most important geological units and hydrogeological processes, while acknowledging that the real system is hydrologically and geologically more complex. The conceptual model forms the basis for the computational groundwater flow model.

The hydrogeological conceptualisation for the SGCP was described in detail in previous sections, and may be summarised by the following key points, with reference to Figure 4-9:

- the aquifer system is recharged mainly through rainfall infiltration, at relatively low fractions of the annual rainfall (generally less than 5%; (e.g. Kellett *et al,* 2003)), and with the highest recharge rates in areas of higher topography, notably the Clematis Sandstone outcrop immediately west of the SGCP
- the groundwater flow patterns reflect surface topography generally, extending from higher topography areas south of the SGCP and also along the ridge immediately west of the SGCP formed by the Great Dividing Range, flowing generally towards the north (outflow boundary) and the east (partial outflow boundary) consistent with Burdekin drainage basin, and also down-dip to the west and out into the Great Artesian Basin (GAB) system
- streams are ephemeral, flowing only when rainfall generates adequate runoff, providing low volumes of recharge to the water table, which is typically more than 10 metres below ground level
- in some areas where the water table is shallow, evapotranspiration can become an aquifer discharge process

The key conceptual model features of the SGCP model are graphically illustrated in the following figures:

- figure 4-9 shows the conceptual hydrogeological model
- figure 6-2 shows the model domain and key model features including boundary conditions and conceptual groundwater flow patterns (for more detail on boundary conditions, see Appendix F)

Calibration simulations were performed with various combinations of model boundary conditions, hydraulic conductivity and recharge distributions before selecting the final configuration.

6.3 NUMERICAL MODEL DESIGN AND CONSTRUCTION

6.3.1 Model Geometry and Domain Boundary

The model domain covers an area of more than 65 x 73 km (or more than 4500 km2) as shown in Figure 6-1, and 7 layers are used to represent the geology and hydrogeology (refer to Table 6.1 and also Figure 4-9).

The northern extent of the model is bound by the southern extent of the Alpha Coal Project mine lease. The western extent of the model domain is aligned with the Jordan Creek, and the eastern boundary is aligned with Native Companion Creek, which passes close to Alpha township.

The southern extent of the model domain is located approximately 13 km to the south of the SGCP mine lease area. This model domain contains the SGCP mine lease area, the entire Galilee Coal Project area, and the township of Alpha. The boundaries of this model domain are designed to be sufficiently distant from mining operations that boundary effects will not affect the results.

The size of the model grid is spatially variable, with grid refinement in the SGCP mine lease (Appendix F). The SGCP mine lease area is covered by a 50 × 50 metre grid which increases up to a 1000 × 1000 metre grid more regionally. Each of the seven layers (Table 6.1) consists of 605 rows and 585 columns (approximately 350,000 cells). The entire model contains approximately 2.5 million cells, which is relatively large for a groundwater model.

6.3.2 Aquifer Units and Model Layers

The hydrogeological units of relevance have been represented in the groundwater model by seven model layers, as detailed in Table 6.1 (see also Appendix F and Figure 4-9). Separate model layers are specified for the D1 and D2 coal seams and interburden, although this level of detail was subsequently shown to be not warranted (arguably) as the aquifer parameters for these units are not significantly different. Key GAB formations are included in the model structure in the south-western corner of the model, as shown in Figure 4-9.

Table 6.1: South Galilee Coal Project Model Layers

Layer	General Lithology	Inclusive Lithology	Comments
1	Quaternary Alluvium and Regolith	Alluvium, Weathered Tertiary	Minor aquifers
2	Triassic to Permian overburden	Clematis Sandstone, Rewan Formation, Dunda Beds, and Bandanna Formation	Clematis aquifer recharge to GAB at outcrop; other units poor aquifers, and Rewan Formation is aquitard
3	Coal seam D1	D1 seam	Typical 2m thickness
4	Bandanna Formation / Colinlea Sandstone interbeds	Bandanna / Colinlea	Typical 10m thickness
5	Coal seam D2	D2 seam	Typical 2m thickness
6	Bandanna Formation / Colinlea Sandstone interbeds	Bandanna / Colinlea	Minor aquifer
7	Joe Joe Formation	Joe Joe Formation	Poor aquifer, subcrops near Alpha township

Appendix F presents plots of the spatial distribution of the modelled aquifer parameters in each layer. Layer 1 comprises alluvium, colluvium and regolith, with varying hydraulic properties. Layers 2 to 6 are generally represented with uniform hydraulic properties. However, the plots of hydraulic conductivity in Appendix F also show the presence of 'dummy' properties, where the particular hydrogeological unit is absent but the layer has been maintained across the model by assigning properties from the highest underlying lithology that is present. These plots should aid in understanding how each model layer has been set up to represent a single hydrogeological units, other than for Layer 1 where both alluvium and regolith are represented where they occur, each assigned different hydraulic parameters.

The coal measures are split into layers comprising both coal seams and interburden lithologies, to allow a better representation of mining across the different seams, including the poor aquifer interburden unit, although it is possible that local heterogeneities are not well represented by the model.

Within the model, all layers were designated as MODFLOW-SURFACT 'Type 3' layers, which allows for each to behave as unconfined or confined dependent on water levels relative to layer elevations. Model simulations involved variably-saturated flow conditions using the pseudo soil function as an unsaturated flow modelling option provided by the MODFLOW-SURFACT package.

6.3.3 Model Layer Elevations

The top elevation of Layer 1 was specified from the surface topography Digital Elevation Model, which comprises highly accurate Lidar in the SGCP area and less accurate SRTM data more regionally.

The geological layer structure was developed by a specialist geological consultant (Collective Experience, 2012) and imported directly to the groundwater flow model. Layer elevations are presented in Appendix F.

For groundwater modelling purposes, the basal layer of the Joe Joe Formation (Layer 7) has been assumed to have a uniform thickness of 100 m (i.e. this basal layer is represented with uniform (low) transmissivity as its saturated thickness will not be affected by mining, given that it underlies the Colinlea Sandstone).

6.3.4 Boundary Conditions and Model Stresses

Regionally, groundwater levels reflect surface topography but with less relief, extending generally towards the north (outflow boundary) from the higher topography areas south of the SGCP and also along the central ridge formed by the Great Dividing Range immediately west of the SGCP. There is also some flow to the east (partial outflow boundary), and also down-dip to the west and out into the Great Artesian Basin (GAB) system.

In the model, boundaries to the south, north-west, and the central part of the eastern boundary of the model domain are specified as 'no-flow' in all layers. Other boundaries, notably the north, north-east and south-east, and south-west, are specified as general head boundaries (GHB), or 'head-dependent flow' boundaries in layers 2 to 7, representing regional outflow (GHB conductance parameter varies with cell size from a maximum of 1000 m^2/d (e.g. for 1000 x 1000m cells) to a minimum of 50 m^2/d; Figure 6-2 shows the boundaries and conditions). In the uppermost layer 1, where the boundary is aligned with a mapped stream, then a river feature is specified in the model allowing leakage to or from the aquifer (although most streams in this model act as minor recharge features).

Apart from recharge, evapotranspiration and stream features, the main stresses in the model relate to mining.

There is also minor groundwater extraction from the shallow Quaternary/Tertiary units for the Alpha town water supply. This is specified in the model at a long term average rate of 200 kL/day. During the model development, data was not available on actual pumping for Alpha town, and an estimate was made on the following basis: assuming 500 L per person per day, and a population of 400 gives a total extraction rate of 200 kL/day or 73 ML/year. At the prediction stage of model development, some data became available from Barcaldine Shire Council, indicating that extraction was 87 ML in 2010/11 and 164 ML in 2011/12, which is basically consistent with the model assumptions (noting that this is a very minor volume in terms of the catchment water balance, and groundwater level measurements do not show significant perturbations due to extraction in this area). It was also assumed for model purposes that the extraction bore is located near the existing Alpha bores 69749 and 38111 in the Alpha Creek alluvial channel.

6.3.5 Rainfall Recharge

The percentage of rainfall that recharges the water table varies depending on the type and extent of surficial outcrop, and local topography. For the steady-state (long term average) model, the annual average recharge rate has been modelled by applying a spatially-variable effective rainfall percentage recharge rate to different lithologies and specific areas, to reflect the presence (or absence) of alluvium or other more permeable units.

Modelled recharge rates to the water table due to rainfall may be summarised as:

- where alluvium is present, 0.7 mm/year, which is 0.12% of annual average rainfall
- where the Clematis Sandstone outcrops (top of Great Dividing Range), 13.7 mm/year, which

is 2.5% of annual average rainfall

- elsewhere, recharge due to rainfall is assumed to be zero

The same percentage recharge rates have been carried forward to the transient (time-varying) calibration ('history match') model, but applied to the annual rainfall recorded in each year. For the forward prediction of mine dewatering, the adopted recharge rates are based on a long term rainfall assumption of 550 mm/year.

These recharge values specified in the model are broadly consistent with previous studies, notably Kellett et al. (2003), who estimated recharge in the GAB area to be:

- Alluvium: 1.1 mm/year, 0.21 % annual precipitation
- Clematis Sandstone: 30 mm/year, 5.40 % annual precipitation
- Rewan Formation and Dunda Beds: 6.7 mm/year, 1.2 % annual precipitation
- Bandanna Formation: 1.0 mm/year, 1.8 % annual precipitation

6.3.6 Evapotranspiration

Evapotranspiration has been included in the model using the Evapotranspiration (EVT) package of MODFLOW. The maximum EVT discharge rate adopted reflects the average annual rates of 1500 mm/year (equivalent to BoM estimates for potential evapotranspiration in the area). The maximum EVT rate applies where groundwater levels exceed the specified EVT surface (the model topography data), and an extinction depth of 10 m has been adopted over the model domain (refer Appendix F), below which level EVT ceases to occur within the model. This arrangement effectively means that evapotranspiration in the model will occur predominantly in areas of shallow depth to the water table, which will generally align with some stream valleys, and is designed to help account for the inaccuracies associated with the regional SRTM topographical elevation data (±10m).

6.3.7 Stream-Aquifer Interaction

The numerical model design incorporates river/aquifer interaction features to allow representation of baseflow (groundwater discharge to streams) and/or leakage or induced flow (flow from the streams to the groundwater), as well as quantification of the impacts of proposed mine dewatering on surface water features, subject to the simulated variations in groundwater levels.

The depth to groundwater is generally more than 10 m, and thus is insufficient to support baseflow discharge to streams in the area, which are known to be ephemeral from extensive periods recorded of zero flow. Hence, the model stream features are designed to provide some leakage to recharge the water table, although if groundwater levels rise sufficiently high, the stream features are also designed to allow for groundwater-fed baseflow to occur.

The surface drainage network has been represented in the model using the River (RIV) package of the MODFLOW software (Figure 6-2 and Appendix F). River cells allow flow in both directions between the groundwater and the stream, depending on relative heads at any time in a simulation.

Most river stages (water levels) in the model were set at 5 m below the river bank elevation represented by the topographic data (e.g. for Alpha Creek, Native Companion Creek, Tallarenha Creek, Lagoon Creek, Sandy Creek and Thirsty Creek).

The river bed of Native Companion Creek has been set a further 1 metre below the river stage, while all other river beds have been set at 0.1 metres below the river stage. (see Appendix F for the location of the location of the modelled streams). This approach allows for Native Companion Creek to provide leakage to the water table based on a driving head of 1 m, while the tributary creeks have a much lower driving head of 0.1 m. Although the streams are ephemeral and would only provide leakage when rainfall is high enough to cause runoff and stream flow, this model approach allows for the creeks to provide a small amount of leakage all the time.

6.3.8 Representative Model Parameters

Representative aquifer properties of the lithological units in the study area, as determined from the field testing and hydrogeological assessment programs to date, are detailed in Section 4.2.4. Through the calibration process, the parameter values specified in the model have been adjusted while still retaining consistency with these representative values.

Where a hydrogeological unit is absent within the model area (e.g. due to geological processes), the relevant model layer has been assigned 'dummy' status, to enable the layer to be retained as a continuous layer across the model area (to make for simpler plotting and interpretation of results). In these 'dummy' areas, the layer has been reduced in thickness to a nominal minimum of 1 m, and the hydraulic properties have been changed to those applying to the next underlying active model layer. In this way, each hydrogeological unit is represented in a single model layer, which facilitates the extraction of model impacts by hydrogeological unit across the entire model.

Within the coal seams, the groundwater flows predominantly through cleat fractures, and/or bedding related fractures, with very little evidence of structure-related fracturing. Due to the laminar nature of the coal measures, groundwater flow generally occurs within, or along the boundaries between, stratigraphic layers. This means that effective rock mass vertical permeability can be significantly lower than horizontal permeability. Vertical hydraulic conductivities are assumed to be at most one tenth of the horizontal hydraulic conductivity, and in some cases several orders of magnitude lower.

6.4 MODEL CALIBRATION AND SENSITIVITY ANALYSIS

6.4.1 Calibration Criteria

Calibration of the steady state and transient models has been evaluated using a range of methods as recommended in the best practice guides to achieve model performance criteria and address potential model uniqueness issues (Middlemis et al, 2001; Barnett et al, 2012), including:

- the calculation of the Scaled Root Mean Squared (SRMS) error term, targeting a value of 5% to 10% as indicating acceptable model calibration (Middlemis et al, 2001; Barnett et al, 2012)
- comparing modelled transient water level contours and/or time series plots against the observed water levels
- ensuring a model water balance error term of less than 1% at all times
- ensuring consistency between adopted model parameter values and representative values for the hydrogeologic units

During the calibration process, hydraulic parameters have been modified to improve the model performance, but always keeping the model parameters consistent with the representative parameter values (refer to Section 4.2.4) that are based on field and modelling investigations and experience gained through previous projects in the region.

Appendix F shows the final calibrated parameter distribution and values for each of the model layers (including the 'dummy' areas where underlying layer values have been assigned).

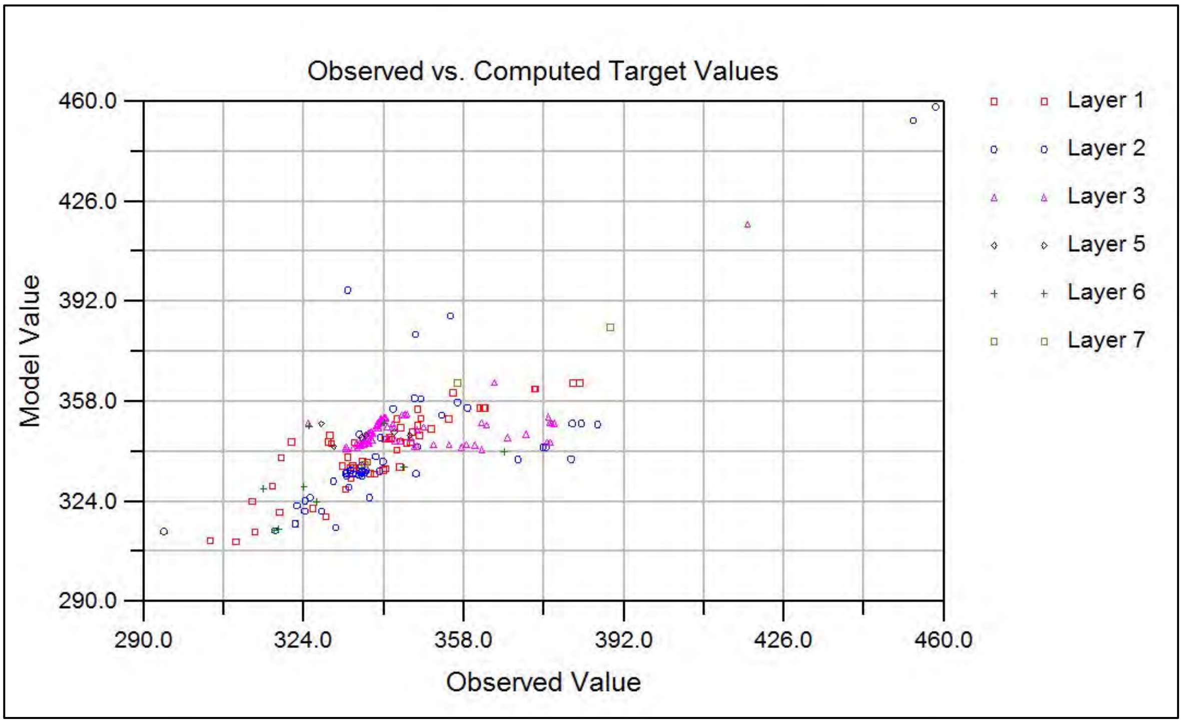
Appendix G contains time series and contour plots of model results.

6.4.2 Steady State Calibration Performance

The Steady State model run represents the long term average catchment conditions without any active mining operations. There is no data set of regional groundwater levels taken at the one time ('synoptic') to use as targets representing long term average conditions. The available measured groundwater levels were analysed over a wide range of years to estimate representative level data for use in evaluating model performance.

The scatter plot (see below) and the related Scaled RMS value of 8.1% indicates good model performance, within the 5-10% target criterion.

Figure 6-3 shows the steady state model ('long term average') pre-mining water table.



The water balance for the steady state model is given in Table 6.2, indicating that:

- the major inflow components are rainfall recharge (60%) and boundary inflow (30%), with stream leakage making up a small portion (10%)
- the major outflow components are boundary discharge (52%), and evapotranspiration (47%)

The steady state model was used to define the basic hydraulic conductivity parameter values and recharge distribution (refer Appendix F for details), as well as the initial groundwater level distribution for the transient history match model run, and the steady state configuration was also used as the basis for some sensitivity/uncertainty runs.

Table 6.2: SGCP Model Steady State Water Balance

	Inflow		Outflow	
	(m^3/day)	% of total	(m^3/day)	% of total
Wells	0	0	200	1
Recharge	11,808	60.4	0	0
Evapotranspiration	0	0	9141	46.8
River Leakage	2010	10.3	0	0
Head Dependent Boundaries	5734	29.3	10,211	52.2
TOTAL	**19,552**	**100%**	**19,552**	**100%**

6.4.3 Transient Calibration

A transient calibration model run has been conducted over the 40 year period between January 1st 1970 and January 1st 2011. The model has been calibrated against observed water level data in the region, and assumed variable recharge rates based on actual annual rainfalls. The time series plots in Appendix G show comparison hydrographs of model-predicted data against observed data. There are limited time series water level observations in the region, but there is evidence of groundwater level responses to wet periods in certain areas and at certain times.

Given recent project experience elsewhere, model sensitivity to episodic recharge may be tested by assuming high water levels in the main streams for short periods to explore whether high stream levels rather than diffuse rainfall recharge is the key dynamic influence. However, as there is no data on actually what the historic levels were in the streams across the model area, and as such events cannot be predicted, stream dynamics were not incorporated in the basic groundwater model. Even with this simplifying assumption, the results show that the general long term trend of the groundwater levels are predicted quite well by the model, although the short term dynamic responses to climatic variability may not be. This is considered to be appropriate for the model purpose of impact assessment for a project with a life of several decades.

Figure 6-4 shows the modelled pre-mining water table at the end of transient calibration, which is consistent with the steady state water table (Figure 6-3). Appendix G shows time series plots of measured and modelled levels during the transient calibration run. There is a reasonable agreement between the observed and predicted heads, demonstrating good overall calibration, and lack of any systematic error.

Table 6.3 presents the transient water balance at the end of the calibration run, which shows about double the recharge of the steady state case (which represents long term average rainfall - Table 6.2), due to very wet conditions in 2010 (rainfall of 1100 mm).

Table 6.3: SGCP Model Transient Water Balance (end of calibration run; Jan 2011)

	Inflow		**Outflow**	
	(m^3/day)	% of total	(m^3/day)	% of total
Change in aquifer storage	100	0.3%	10,300	32.8%
Wells	0	0	200	0.6%
Recharge	23,600	75.1%	0	0
Evapotranspiration	0	0	10,400	33.1%
River Leakage	2000	6.4%	0	0
Head Dependent Boundaries	5,700	18.2%	10,500	33.4%
TOTAL	**31,400**	**100%**	**31,400**	**99.9%**

Table 6.4 presents a summary of the calibrated aquifer parameters. Detailed zonation plots are presented in Appendix F. The values are consistent with the physically realistic range of values established in investigations in the region (refer to Section 4.2).

Table 6.4: SGCP calibrated aquifer parameters

Layer	**Horizontal Hydraulic Conductivity Kh (m/d)**	**Vertical Hydraulic Conductivity Kz (m/d)**	**Unconfined Specific Yield**	**Confined Specific Storage**
1	1e-5 to 1.8	1e-6 to 3e-2	0.01	1e-6
2	1e-5 to 3e-1	1e-6 to 3e-2	0.01 to 0.001	1e-6
3 (D1)	1e-4 to 3e-1	1e-6 to 3e-2	0.01	1e-7 to 5e-6
4	1e-4 to 3e-1	1e-4 to 3e-2	0.01	1e-7 to 5e-6
5 (D2)	1e-4 to 3e-1	1e-4 to 3e-2	0.01	1e-7 to 5e-6
6	1e-4 to 3e-1	1e-4 to 3e-2	0.01	1e-7
7	1e-4	1e-4	0.01	1e-7

6.5 CALIBRATION SENSITIVITY ANALYSIS

Table 6.5 summarises the range of sensitivity runs undertaken during the calibration process, with the Clematis Kz parameter taken forward into prediction uncertainty assessment. Appendix G presents some time series plots for selected sensitivity runs.

Table 6.5: Calibration Sensitivity

Run No.	Parameter change	Effect on model results
5	Extend low Kh/Kz zones laterally from Clematis (layer 2) to represent Moolayember and Rewan Formations (west and east).	Model sensitive. Steady State SRMS reduced from 18% to 13%. Justification is that these units occur in subcrop (i.e. in layer 2 horizon), whereas geological map shows shallow cover in this area. Retained as a feature in calibrated model.
6	Based on run 5, extend parameter change into layer 1.	Model not sensitive. Steady State SRMS reduced from 13% to 12%. No justification for these parameters in layer 1, as this should reflect the shallow cover. Not retained in calibrated model.
10	Increase Kh & Kz by factor of 5 in coal seams, interburden, Colinlea and Triassic to the east.	Model sensitive to this change. Steady State SRMS reduced from 13% to 9.7%. Retained as a feature in calibrated model.
17	17a:- Kz set to 3e-2m/d in layer 3 (D1 seam). 17b:- Tested variable recharge with time (i.e. % rate applied to annual rainfall).	17a:- Model sensitive. Steady State SRMS reduced to 7.7%. 17b:- Model not sensitive as long term trends not affected, and yet dynamic/seasonal model responses not apparent (possibly due to higher specific yield at this time of 0.10).
18	Implemented new zone under Clematis in layer 3 for Kz reduction to 3e-4 m/d to provide leakance values similar to Rewan units. Also increase Kh&Kz by factor of 10 in layer 1 (shallow GAB) west of and above Clematis. Extended northern boundary condition up from layer 3 to layers 1 and 2.	Model sensitive. Steady State SRMS increased to 9.7%. Water table contour pattern improved in SGCP area of model. Performance improved at outflow boundaries (north and west) in matches to nearby bores. Changes retained in calibrated model (but Kz parameter value adjusted further).
21	Kz in layer 3 under Clematis reduced to 1e-6 m/d.	Model sensitive. Steady State SRMS increased to 7.7%. Transient run showed good match to time series.
22	Recharge set constant with time (long term average); Alluvium: 1.88e-6m/d, Clematis: 3.77e-5m/d.	Model not sensitive. Steady State SRMS decreased to 7.6%. Transient run showed good match to time series.
23	Kz in layer 3 under Clematis reduced to 1e-6 m/d.	Model sensitive. Steady State SRMS increased to 9.4%. Reverted back to run 21 Kz value (1e-6 m/d). Final calibration was run 25, with some further parameter refinements.

6.6 MODEL LIMITATIONS AND FUTURE IMPROVEMENTS

Rather than make a long list of potential limitations (all models have a wide range of limitations as they are, by definition, a simplified representation of complex reality), the following points identify key aspects of the model that should be improved during subsequent investigation programs, as more data becomes available, and as hydrogeological understanding improves:

- Model layers: with the benefit of hindsight in the sense of the quite consistent calibrated parameter value distribution through layers 3, 4 and 5 (D1-seam, interburden and D2-seam), these three layers could be lumped into one model layer; this would then allow for layer 2 to be split into at 2 or 3 layers to better represent the upper Bandanna Formation, the Rewan Formation and Dunda Beds, and the Clematis Sandstone; this may also allow for better resolution of the longwall fracture zone parameter distribution in the overburden
- Model boundaries: it is difficult to identify a suitable location for the northern boundary, as there is a succession of mining projects proposed along the northern strike of the coal formations; it is currently set between the Galilee Coal Project and the Alpha Coal Project to attempt to use the principle of symmetry to simplify matters; the opportunity should be taken in future to review this approach, and consider improvements to this boundary condition, including the need for detailed representation of the other mining projects (there is an initiative in progress in NSW to develop more appropriate approaches for the incorporation of adequate detail in relation to other mining projects for assessing cumulative impacts, and the outcomes of that process may be insightful)

- Mine Plan: the SGCP mine plan could be resolved in more detail for the first 10 years of mining (rather than the first five), and then subsequently in 3-year blocks (rather than the current relatively coarse approach of 5-year blocks)
- Monitoring: once the survey and review of the vibrating wire and monitoring bore data at the SGCP site is completed, the data should be considered as a validation exercise for the SGCP model, which may involve some refinements to parameters and/or recharge
- Water table dynamics: some measured water levels show a dynamic response, which is attributed to rainfall through a CRD analysis; this could be extended by using the CRD to estimate recharge rates, and the model could be updated accordingly; this is only considered warranted if short term dynamics are considered to be important to model in detail, as the SGCP model is demonstrably capable of simulating the long term trends in water levels and groundwater flows

7. POTENTIAL GROUNDWATER IMPACTS – MINING AND POST-MINING

The predicted impacts of the SGCP on the environmental values of the groundwater resources are discussed in this section. The issues addressed include the following (as suggested in the ToR Table 2.1):

- potential impacts on the flow and the quality of groundwater from all phases of the SGCP, with reference to their suitability for the current and potential downstream uses and discharge licences
- potential impacts on groundwater depletion or recharge regimes
- the likely volume of groundwater to be dewatered during the operations, and its likely quality characteristics, including salinity
- potential impacts on groundwater resources in each aquifer of any take of groundwater or dewatering as a result of the mine's operation, including potential impacts on the Alpha township water supply
- response of the groundwater resource to the progression and cessation of SGCP
- cumulative impacts of existing/proposed mining projects in the region

7.1 REPRESENTATION OF MINING

This section provides information on how mining is represented in the groundwater model, and presents the results of the mine dewatering and post-mining recovery simulations, along with analysis and interpretations. The representation of mining as described below is consistent for the SGCP mine as well as the Galilee Coal project (which is located 47 km north of the SGCP and within the SGCP model domain). The more remote Alpha and Kevins Corner Coal projects (62 and 68 km north of the SGCP) are represented in the SGCP model with a boundary condition.

7.1.1 General Approach

The predictive models are based on the mine development schedule and track the progressive mining of open-pits and longwalls through to mine completion and post-mining recovery. Dewatering for the SGCP occurs in two stages associated with the D1 and D2 seams (layers 3 and 5, respectively). The mine plan/schedule is described in detail in Section 4 of the EIS document.

The model simulations include both open-cut and underground mining for the SGCP, as well as for the Galilee Coal Project (GCP) and the Alpha Coal Project (ACP) and Kevins Corner Coal Project (KCCP), along with subsequent post-mining groundwater recovery. For the purpose of the model simulation of cumulative impacts, it was assumed that the mining schedule for Galilee Coal Project (GCP) and the Alpha and Kevins Corner Coal Projects ('the other projects') match the start of the SGCP schedule. This means that all projects are assumed to start at the same time at mining year 1, which can be assumed to be 2015. The GCP is assumed to finish after 30 years of mining, while the ACP/KCCP extends to 33 years, along with the SGCP.

7.1.2 Open Cut Mining

Open cut mine dewatering was simulated by setting Modflow drain (DRN) cells at levels to represent the workings at each stage through the mine life simulation, and corresponding with the individual mining blocks associated with the mine plan. Recharge on the backfilled material was applied at the same rates as pre-mining values.

Drain cells are kept active in all active mining locations in the open pit, and progressively switched off as the mined out pit is backfilled with overburden. The drain conductance value reflects the resistance to flow between the surrounding material and the void and determines the simulated seepage inflow volumes into the workings. The drain cell conductance parameter used in the open-cut mine was 1 m^2/d, and sensitivity testing was undertaken on this parameter.

For the mine dewatering simulations, the in situ aquifer parameters were assumed to apply (i.e. parameters were not changed with time). This is referred to as the 'in situ' case (in combination with the underground 'in situ' case – see next section).

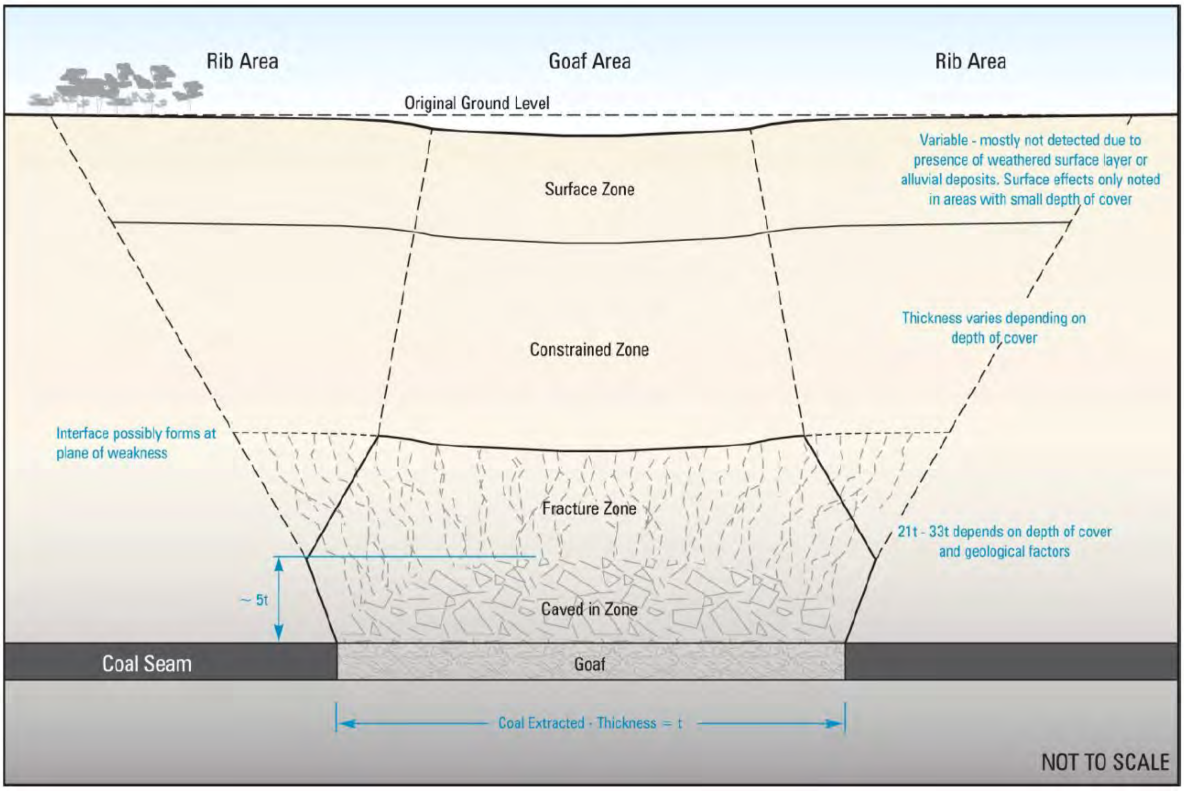
Sensitivity runs were also undertaken where the hydraulic parameters (Kh, and unconfined storage Sy) at each mine-block were increased to represent the nature of the open pit backfill material. In both cases, the parameters assumed apply from the start of mining, as an uncertainty assessment approach to identify the range of mining impacts.

For the backfilled parameter case, unconfined storage in the open pit backfill was increased to 0.1 (i.e. 10%). The horizontal conductivity (Kh) and vertical hydraulic conductivity (Kz) parameter values of the backfill material were increased to 1 m/d. The selection of appropriate permeability values was based on the results of hydraulic testing combined with model development experience which had the benefit of historical dewatering rates and observed groundwater level impacts.

7.1.3 Underground Mining

As for the open cut, modelled drains are progressively activated and de-activated with the progression of underground mining. For the mine dewatering simulations, the in situ aquifer parameters were assumed to apply to the underground and the overlying strata. This is referred to as the 'in situ' case (in combination with the open pit 'in situ' case – see previous section).

Sensitivity runs were also undertaken (in combination with the open pit 'backfilled' parameter assumptions), with aquifer parameters increased to represent the physical hydrogeological effects occur due to longwall mining, notably including subsidence-related fracturing caused by the caving and subsidence above panels, as illustrated below (source: Galilee Coal Project EIS documents).



The Review of Industry Subsidence Data in Relation to the Influence of Overburden Lithology on Subsidence and an Initial Assessment of a Sub-Surface Fracturing Model for Groundwater Analysis (ACARP, 2003) was considered as it contains assessments of the impact of various mining methods on overlying rock mass permeability, based on the depth of overburden above the mined seam and the degree of subsidence associated with the relevant mining method. In the SGCP case, fracture zones were implemented in the model to conservatively account for aquifer parameter changes above the SGCP longwall underground mining areas.

While the layer definition within the model allows mined coal seams to be represented individually, the regional extent of the model is large and thus the numerical model size is large, causing slow data processing and long run times. Under these constraints, the overburden (Bandanna Formation and Rewan Formation) could not resolved into multiple layers and thus various horizons of subsidence caving and fracturing effects above each seam could not be resolved. A much simpler and conservative approach was used to represent the impact of caving and fracturing associated with the mining, assuming it extends to the surface.

Several 'zones' of subsidence permeability change have been developed for the areas below, within and above the mined coal seam:

- the permeability of the model layer directly beneath underground mined areas (layer 6, Colinlea Sandstone) has been altered; here a uniform increase in vertical hydraulic conductivity (Kz) to three times the in situ parameters is applied, along with a uniform increase in horizontal hydraulic conductivity (Kh) of two times the in situ parameters
- a high permeability, caved zone within the mined coal seams (layers 3 and 5) following subsidence; here the vertical permeability has been assumed to increase to 10 m/d based on a log-linear monotonic (ramp) function, along with an increase in horizontal hydraulic conductivity to 10 m/d
- a zone of continuous cracking (as described above) immediately above the mined coal seam (i.e. within the Bandanna Formation represented by layer 2 and also the D1-D2 interburden of layer 4). Within this zone enhanced permeability occurs due to discrete vertical fractures that connect with horizontal layer separation features, allowing water to travel between and along layer boundaries
  - the fractured zone has been simulated with horizontal hydraulic conductivity enhanced by a factor of two, and with vertical hydraulic conductivity enhanced according to the ramp function, by a factor of 10 for the layer 4 interburden and the layer 2 overburden, to account for deep and shallow connections
  - in principle, the ramp function varies the vertical hydraulic conductivity field within the deformation zone overlying coal extraction areas and 'weights' the permeability changes based on layer thickness (where it is possible to use multiple layers; this is not the case for the SGCP model)
  - limits for the variability are governed by predicted fracture height and predetermined upper and lower bounds of hydraulic conductivity. The tortuous flow paths that are created along bed layers and down fractures result in a zone where the overall permeability is lower than the caved zone below
- finally a zone of discontinuous cracking near the surface. The fractured zone above the underground panels has been simulated with layer 1 horizontal hydraulic conductivity enhanced by a factor of two, and the vertical hydraulic conductivity increased by a factor of five
- as a conservative measure, it is assumed that the discontinuous shallow cracking would interact with the deep cracking, and thus enhanced aquifer parameters have been extended from the coal underburden (layer 6) up to the surface (layer 1) in the SGCP model

7.1.4 Summary of Model Parameter Changes to represent Mining

Table 7.1 summarises the parameter values applied to the model to represent mining effects (the post-mining model setup is discussed in Section 7.4).

Table 7.1: SGCP model parameter changes to represent mining

Layer	Mining Area	In situ or Calibrated Kh (m/d)	Fractured or Caved or Backfilled or Void Kh (m/d)	In situ or Calibrated Kz (m/d)	Fractured or Caved or Backfilled or Void Kz (m/d)
1	Underground Longwall Panels and overlying-underlying fractured and caved zones	0.1	0.2	0.01	0.05
2		0.1	0.2	0.0001	0.001
3 (D1)		0.3	10	0.03	10
4		0.3	0.6	0.03	0.3
5 (D2)		0.3	10	0.03	10
6		0.3	0.6	0.03	0.09
7		0.0001	no change	0.0001	no change
1 to 5	Open Pit backfilled areas	Calibrated values	1	Calibrated values	1
1 to 5	Open Pit Final Void	Calibrated values	1000	Calibrated values	1000

7.1.5 Alpha Coal Project (ACP)

The effect of mine dewatering at the ACP some 62 km to the north of the SGCP, and the cumulative impacts of the more distant Kevins Corner Coal Project was represented in the SGCP model by head-dependent flow boundaries at the northern model boundary (the southern extent of the ACP). For mining simulations, the level specified at this boundary is consistent with the base of mining in this area, which is the level to which dewatering would be required at ACP (whatever the influences of other mining in the region, including Kevins Corner). This approach removes the 'guesswork' involved in estimating what the pumping rates would be for this operation. It also accounts for cumulative impacts due to any potential influence of mine dewatering drawdown from any more remote projects (e.g. Kevins Corner, and/or others further north), as the ACP operation would adjust the pumping required to achieve the ACP target drawdown levels subject to the actual influence (if any) due to the other projects. Separate simulations were attempted with and without the ACP represented in this way, to allow for unpacking of the separate influences.

7.1.6 Galilee Coal Project (GCP)

The GCP falls entirely within the domain of the SGCP, and thus the effects of mining the open cut and longwall areas at the GCP were represented in a similar manner to that described above for the SGCP. One key difference is that the GCP also mines the B-seam, which occurs at a higher level than the D-seams at the SGCP. The B-seam lies within layer 2 of the SGCP model, and thus the drain elevations were set in layer 2 accordingly.

7.2 MINE DEWATERING VOLUMES

The predicted SGCP mine dewatering volumes under the cumulative impact simulation and for the in situ parameter case are presented in Figure 7-1.

These rates have been used by others (WRM) in the mine water balance assessments.

The sudden peak in dewatering rates at mine year 6 is due to the start of mining of the D2 seam at the SGCP, as well as the start of representing the mine plan in 5-year blocks from this time (i.e. the model applies drain cells to a much wider area that would actually occur during the mine progression). Subsequently, the start of the new 5-year plans do not result in such a large jump in dewatering rates (e.g. at years 11, 16, 21, 25 and 31), as the mine plan is more progressive through this period (less major changes). The peak in year 5 is an over-estimate of the mine dewatering rates, and gives an indication of the potential uncertainty in the prediction results.

Figure 7-1 also shows the cumulative volume extracted for mine dewatering is 147 GL over 33 years, which is understood to be broadly consistent with the other mining projects in the area. The model results could be analysed to indicate the dewatering rates for the GCP and the ACP, although the representation of the ACP with a boundary condition in the SGCP model is designed to be physically realistic in terms of dewatering levels, not in terms of volumes or rates.

The results of the sensitivity/uncertainty runs with 'backfilled/fractured zone' parameters indicate an increase of up to 1.5 to 2 times in the SGCP rates. This is a substantial over-estimate, as the parameters are assumed to apply from the start of mining (rather than changing progressively), and thus involve the removal from aquifer storage of a larger volume than is actually in situ, and higher inflow rates (due to the higher hydraulic conductivity parameter values). The predictions of the extent and magnitude of groundwater levels and drawdown for the sensitivity case showed very close similarity with the in situ case.

7.3 GROUNDWATER CHANGES DURING MINING

7.3.1 Water Balance Changes

Table 7.2 provides a summary of the water balance for the entire model at the end of mine year 30, when the GCP mine is still operating, along with the ACP/KCCP and the SGCP.

The head dependent boundaries term in the water balance includes the effect of the ACP/KCCP, in that inflow is simulated by setting the northern boundary level consistent with the base of the mine, while the adjacent boundary condition level remains at the pre-mining level (as described in Section 7.1.5). As a result, the northern boundary outflow increases (representing ACP/KCCP dewatering), and the adjacent boundary condition cells provide substantial inflow to match the outflow, as well as to provide some components of flow towards the GCP. With the cessation of the GCP at mine year 30, the water balance summary at mine year 33 (Table 7.3) shows that a large part of the inflow to the GCP was being drawn in across the northern boundary, and that inflow has reduced substantially.

Table 7.2: SGCP Model Water Balance Summary at year 30 of mining

	Inflow		Outflow	
	(m^3/day)	% of total	(m^3/day)	% of total
Change in aquifer storage	35,700	18.6%	3,200	1.6%
Wells	0	0	200	0.1%
Recharge	11,800	6.1%	0	0
Drains (SGCP & GCP dewatering)	0	0	123,500	64.4%
Evapotranspiration	0	0	8,600	4.5%
River Leakage	2000	1%	0	0
Head Dependent Boundaries (includes effects of ACP/KCCP dewatering)	142,400	74.2%	56,300	29.4%
TOTAL	**191,900**	**99.9%**	**191,800**	**100%**

Table 7.3: SGCP Model Water Balance Summary at end of mining (mine year 33)

	Inflow		Outflow	
	(m^3/day)	% of total	(m^3/day)	% of total
Change in aquifer storage	15,300	15.5%	26,500	26.8%
Wells	0	0	200	0.2%
Recharge	11,800	12%	0	0
Drains (SGCP dewatering only)	0	0	6400	6..5%
Evapotranspiration	0	0	8,600	8.7%
River Leakage	2000	2%	0	0
Head Dependent Boundaries (includes effects of ACP/KCCP dewatering)	69,600	70.5%	57,000	57.8%
TOTAL	**98,700**	**100%**	**98,700**	**100%**

The river leakage term in the water balance shows no change from the pre-mining condition (compare Tables 7.2 and 7.3 to Tables 6.2 and 6.3), which indicates that there is no induced leakage due to mining. This is essentially because the depth to water table is typically in excess of 10 m and the stream features are recharging the water table at maximum potential rate.

In terms of the other elements of the water balance, the results show that the evapotranspiration discharge has reduced only very slightly from a rate of 9 to 10 ML/day for the steady state and transient calibration (Tables 6.2 and 6.3) to 8.6 ML/day at both mine year 30 and 33. This indicates that the drawdown due to dewatering has no significant affect on the evapotranspiration feature in the model, which is a surrogate for discharge from groundwater-dependent vegetation. Similarly, the extraction for the Alpha town water supply also remains unchanged. Finally, the recharge to the system remains unchanged throughout these simulations, confirming that the GAB recharge is unaffected by mining.

7.3.2 Water Table changes during mining

Appendix G presents contour plans and time series plots of water table, piezometric level and/or drawdown in various layers of the model at various times through the simulation.

Figure 7-2 shows the predicted water table elevations at the end of mine year 33, when the cone of depression has reached its maximum extent, with depressed water levels extending mainly to the north (towards the GCP). Figure 7-2 shows that water levels have decreased by 10 to 100 m across the SGCP area, compared to the pre-mining existing condition shown in Figures 6-3 and 6-4. The cone of depression extends mainly to the north because it is limited by low permeability units outcropping to the west, east and south:

- the low permeability Rewan Formation and Dunda Beds limit the western (and southern) extent of water table drawdown, which results in the Clematis Sandstone being largely unaffected by drawdown (some minor effects of the order of 5 m)
- the low permeability Joe Joe Formation limits the eastern extent of water table drawdown, such that water table levels changes in the Alpha township area are predicted to be less than 1 m.

The results in terms of changes in groundwater level show maximum drawdowns of around 100 m at the SGCP (more at the GCP). This effect reduces to around 10-20 m within the SGCP MLA (i.e. west, east and south of SGCP). However, north of the SGCP MLA, towards and within the GCP area, the drawdown remains in excess of 100 m at the end of mining, due to cumulative impacts in combination with the GCP, ACP and KCCP. Sensitivity runs with backfilled/fractured zone parameters showed very similar results in terms of water levels and drawdowns to the in situ case.

7.3.3 D1 and D2 Seam potentiometric level changes during mining

Figures in Appendix G present plots of the predicted water levels and drawdowns in the coal seam layers at various times, showing impacts similar to those described above.

7.3.4 Great Artesian Basin water levels and recharge

The recharge to the system remains unchanged throughout these simulations (Tables 7.2 and 7.3), confirming that the GAB recharge is unaffected by mining.

The figures in Appendix G demonstrate that the maximum drawdown under the Clematis Sandstone is in the order of 5 m, and that is a conservative estimate due to the relatively high assumptions of hydraulic conductivity parameter values. Nevertheless, even with this minor drawdown, there would be no significant environmental effects, as there are no mapped springs in the area, no known GDEs, and the depth to water table in this area is in excess of 10 m.

7.3.5 Sensitivity/Uncertainty Analysis

Table 7.4 provides a summary of the uncertainty assessment runs completed during the dewatering prediction investigation. The objective of the simulations was to confirm that the drain conductance parameters had no substantive effect on the predicted mine dewatering rates, to evaluate the effect of changes to recharge, to evaluate the influence of hydraulic conductivity parameter values (horizontal Kh and vertical Kz) on the transmission of drawdown from the coal seams upwards into the Clematis Sandstone, and understand the effect of applying parameter values to represent open pit backfill and the fractured zone above the underground. It was established during the calibration sensitivity assessment that the parameters of the Clematis Sandstone had little influence on the model results, and specialist hydrogeological advice indicated that the low permeability Rewan Formation and Dunda Beds would limit the potential for drawdown to be transmitted to the Clematis Sandstone. The uncertainty analysis considered what parameter changes may be required to invoke such drawdown, and confirm that the selected calibrated model values were consistent with the physically realistic range.

Table 7.4: Prediction Uncertainty Simulation Summary

Run	Parameter change	Effect on model results
1	Drain cell conductance increased from $1m^2/d$ to $100m^2/d$ (in situ parameters case)	Model not sensitive. Little to no impact on drain outflow rates with time, minor increase in cumulative outflow volume
2	Drain cell conductance increased from $1m^2/d$ to $100m^2/d$ (failure zone and backfill mining parameters case)	Model not sensitive. Little to no impact on drain outflow rates with time, minor increase in cumulative outflow volume
3	Kz set to 3e-7m/d in layer 3 under the Clematis	Model sensitive to this change. Results in major effects on model water levels, and poor calibration performance
4	Kz set to 3e-6m/d in layer 3 under the Clematis	Model somewhat sensitive. Results in ~15 m drawdown in the Clematis (compared to less than 5 m for the calibration case)
5	Kz set to 3e-5m/d in layer 3 under the Clematis	Model somewhat sensitive. Results in ~15 m drawdown in the Clematis (compared to less than 5 m for the calibration case)
6	Kz set to 3e-4m/d in layer 3 under the Clematis. Kh and Kz increased by an order of magnitude to the west of the Clematis in layer 3	Model quite sensitive. Results in ~30m drawdown in Clematis (compared to less than 5 m for the calibration case)
7	Kz in Clematis (layer 2) set to 3e-2m/d	Model very sensitive. Results in ~40m drawdown in Clematis (compared to less than 5 m for the calibration case)
8	Replace in situ parameters with open pit backfill parameters and underground fractured zone parameters and re-run dewatering predictions.	Model sensitive to inflows but not levels. Mine dewatering rates increase to 1.5 to 2 times in situ case, and increase at faster rate due to drainage through fractured zone. Groundwater levels and drawdowns very similar to in situ case as final target drainage levels are the same and regional parameters are not changed.

The uncertainty assessment confirmed the following:

- the drain conductance is not an uncertain parameter
- the in situ parameter case provides the best estimate for mine inflows and groundwater level changes
- the model results are quite sensitive to the Kz parameter value that applies to the 250 m thick aquitard (Rewan Formation and Dunda Beds) underlying the Clematis Sandstone, and the adopted calibration value (Kz = 1e-6 m/d) is conservative in that it allows drawdown to impact on the Clematis Sandstone up to about 5 m.

7.4 GROUNDWATER CHANGES POST-MINING

7.4.1 Post-Mining Recovery

A 100 year post-mining recovery run simulates the groundwater level recovery after mining stresses are removed. The recovery simulation includes changes to the aquifer parameters within the open pit mined and backfilled areas to represent the different properties of backfill, as well as the underground areas to represent subsidence impacts.

The post-mining recovery simulation also adds an evaporation feature to the residual open void which is represented with hydraulic parameters consistent with 100% porosity (rather than a porous medium aquifer), and starts with the initial groundwater levels set to the final state from the dewatering prediction.

During the mining period, drain cells representing dewatering were progressively de-activated as the backfill operations to specific open pit void areas are completed, or as the underground mining progressed away from mined-out areas. The recovery simulation assumes no active mine drainage features (apart from the residual void evaporation).

The residual void area on the western margin of the open pit is represented in the post-mining model with a high horizontal and vertical permeability (1000 m/day), and an unconfined aquifer specific yield parameter value of 1.0 (the confined parameters are unchanged). The aquifer parameters in the failure zone within and above the longwall panels were set to the failure parameters indicated in Table 7.1. This applied to the SGCP as well as the Galilee Coal Project.

Evapotranspiration is applied to the residual open pit void with an assumed EVT surface (above which the maximum rate applies) as the base of the open cut void, and other parameters:

- EVT maximum rate at 500 mm per year
- extinction depth of 3 m.

The EVT maximum rate was set to the lower rate of 0.5 m per year to allow for less evaporation from the pit void lake (compared to the BoM rate). This was assumed because the water in the lake would be cold and there would be little wind, due to the pit void being narrow and oriented north-south. This means that it would receive little direct sunlight but a lot of shade would be cast from the side walls as the sun traverses overhead, and the water level would be well below the natural surface and thus less subject to strong winds that would otherwise increase evaporation.

7.4.2 Regional Groundwater Levels Post-Mining

Figure 7-3 shows the predicted water table level at the end of the 100-year post-mining run, while Figure 7-4 shows time series measured and modelled data for selected monitoring bore locations, showing the rate of recovery of groundwater levels post-mining.

The post-mining model run shows that the long term groundwater levels recovery to around 10-20 m below the pre-mining levels, with about 80% of that recovery occurring within about 30 years of cessation of mining, and water levels effectively re-equilibrated (to within a few metres of the long term level) within 50 years post-mining.

Groundwater levels in bores immediately adjacent to the SGCP will not recover completely to pre-mining levels (Figure 7-4, and other time series plots in Appendix G). However, the groundwater levels will rise substantially up to 10-20 m below pre-mining levels. The model results (Appendix G) show that bores located outside the MLA to the west, east and south have long term levels 1-2 m lower than pre-mining. However, those bores located to the north and outside the SGCP MLA show long term levels up to 20 m lower than pre-mining, due to the cumulative impacts of SGCP combined with the other mining projects.

7.4.3 Final Pit Void

Figure 7-3 shows that the final pit void remains a local groundwater sink, as groundwater inflows effectively find a new hydrological equilibrium with the evaporation from the final pit void lake. The final lake water level is predicted to stabilise at around to 313 mAHD, which is 7 to 12 metres below the pre-mining water levels. The final void extends over about 8 km south to north, and within a groundwater flow regime from south-west to north-east, and thus the final lake level is higher in the south than in the north (as are the original groundwater levels).

The predicted water balance for the final pit void lake (100 years post-mining) indicates that groundwater inflows are about 1.58 ML/day (0.58 GL/year).

The water balance and salinity of the final void is being addressed in detail by others (WRM).

7.5 IMPACTS ON SENSITIVE RECEPTORS

7.5.1 Water Table Systems, Groundwater Users and Registered Production Bores

The predicted changes in groundwater level range from maximum drawdowns of around 100 m at the northern end of the SGCP, reducing to around 10-20 m within the SGCP MLA (i.e. west, east and south of SGCP). However, the drawdown remains in excess of 100 m at the end of mining north of the SGCP MLA, towards and within the GCP area, due to cumulative impacts in combination with the GCP, ACP and KCCP.

On the north-eastern corner of the SGCP MLA (i.e. the closest point to the Alpha township), the drawdown effect is predicted be less than 1 m, due to the outcrop/subcrop in this area of the low permeability Joe Joe Formation.

7.5.2 Extraction Bores at Alpha township

The extraction bores at Alpha town not materially affected by the cumulative impacts of mining. The model results show that the assumed extraction continues throughout the simulation, and that the predicted drawdown effect is less than 1 m, which is within the natural seasonal range.

7.5.3 Streams and Groundwater Dependent Ecosystems (GDEs)

Ecological surveys have not identified any GDE fauna in the SGCP area (ALS, 2011), and there are no mapped springs nearby. The model results show that the evapotranspiration discharge has reduced only very slightly from a rate of 9 to 10 ML/day for the steady state and transient calibration (Tables 6.2 and 6.3) to 8.6 ML/day at both mine year 30 and 33. This indicates that the drawdown due to dewatering has no significant affect on the evapotranspiration feature in the model, which is a surrogate for discharge from groundwater-dependent vegetation. Similarly, the stream leakage component also remain unchanged, indicating that there is no induced flow effect due to mining.

The results in terms of changes in groundwater level show maximum drawdowns of around 100 m at the SGCP (more at the GCP). This effect reduces to around 10-20 m within the SGCP MLA (i.e. west, east and south of SGCP). However, north of the SGCP MLA, towards and within the GCP area, the drawdown remains in excess of 100 m at the end of mining. The rate of decrease in water level occurs at a fairly slow rate, as shown in the time series plots in Appendix G. Overall, this indicates that there would remain substantial saturated aquifer resources regionally that would support potential GDEs if they occur in the area.

8. POTENTIAL GROUNDWATER IMPACTS

8.1 APPROACH

Based on the results of the impact assessment modelling described in Section 7, Section 8 presents more discussion on the assessment of the impacts, including (as suggested in the ToR):

- a description of how extracted groundwater will be managed in the surface water management system to minimise the likelihood of discharging highly saline water
- measures to prevent, mitigate and remediate any impacts on existing users or groundwater dependent ecosystems
- potential environmental impact caused by the SGCP (and associated project components) to local groundwater resources
- potential impact on the local ground water regime caused by the altered porosity and permeability of any land disturbance
- potential for the SGCP to impact on groundwater dependent vegetation, including avoidance and mitigation measures.

Section 9 subsequently explores management options.

8.2 MINE DEWATERING AND POST-MINING RECOVERY

Dewatering must occur for the safe operation of the open-cut and underground mines. The impacts associated with the required mine dewatering and subsequent post-mining recovery are related to the changes in groundwater levels, which can affect surrounding users, including:

- dewatering of the coal seams
- drawdown of groundwater within overlying and underlying aquifers
- post-mining recovery in groundwater levels and related increases in bore yields
- potential reduction in baseflow to surface water systems including springs (although it is noted that there are no known springs in the area and the streams are all ephemeral and do not receive baseflow from groundwater), and subsequent recovery

The groundwater model design, calibration and prediction details presented Sections 6 and 7 included details on modelled effects relating to fractured zones above the underground, the open pit backfilling/rehabilitation and the residual pit void. Predictions at different stages of mining and post-closure recovery of effects on groundwater levels, drawdown and interactions with surface water and third party water sources are presented and discussed.

8.2.1 Open Pit Dewatering

Section 7 and Appendix G present plots and tables on the model predictions of the effects of open pit mine dewatering in combination with longwall panel dewatering. These predictions were undertaken on a cumulative impact approach, identifying the combined effect of all mining operations (SGCP, GCP, ACP and KCCP). In summary, maximum drawdowns of around 100 metres are predicted at SGCP, reducing to the order of 10-20 m regionally, and developing at a fairly slow rate over the life of mine of 33 years (see Appendix G for time series plots). This indicates that there would remain substantial saturated aquifer resources regionally that would support potential GDEs if they occur in the area, noting that GDE stygofauna have not been identified (ALS, 2011), there are no mapped springs, and the surface-groundwater interaction volumes due not change materially from pre-mining, through mining to post-mining.

The predicted drawdowns will have a substantial impact on any bores within the mine lease areas, and these bores may need to be deepened or replaced. Deepening of bores is a viable option as saturated aquifer conditions remain below the water table that is drawn down by mine dewatering (i.e. the Colinlea Sandstone underlying the D seams remains an effective aquifer). Outside the MLA, the drawdown impacts are much reduced, to less than 1 m at the Alpha township area, mainly due to the influence of the low permeability Joe Joe Formation outcrop limiting the eastern extent of drawdown.

In addition to the dewatering effects, the final open pit void was simulated in the groundwater model for the post-mining period (refer to Section 8.2.5 for more detail).

8.2.2 Longwall Mining Effects

Subsidence can create stress zones in overlying aquifers causing fracturing and increasing permeability and transmissivity, resulting in changes to hydraulic gradients independent of mine dewatering. Above the underground longwall panels, in areas referred to as 'fractured zones', changes will occur in fracture porosity and permeability, due to the opening up of existing joints, new fractures, and bed separation. The impact of mining on the groundwater regime and groundwater inflow to the underground workings is generally influenced by the height of fracturing above the longwall blocks that provide hydraulic connection between the overlying groundwater resources and the target coal seams.

The deep fracture mechanisms can extend upwards to a height of about 0.6 to 0.67 times the longwall width (which are 350 m at SGCP). This is a height of about 210 to 235 m, compared to the depth of cover of around 150 m at SGCP. This indicates potential for the connective cracking to extend from the longwall panel through deep fracture zone to overlap with the shallow fracture mechanisms near the ground surface, and this has been represented in the groundwater model. It is likely that the fractures would remain open until in-filled with sediment mobilised by intense rain events or flooding, which would tend to reduce the permeability of the fractured zone and thus reduce potential for related impacts. However, the groundwater model assumes (conservatively) that connective fracturing properties (e.g. higher hydraulic conductivity) are invoked during mining, but then do not change subsequently with time due to any sedimentation or infilling process.

The water table will be lowered in response to mining and dewatering in the immediate vicinity of the mine, and the shallow water table may drop substantially. Following cessation of mining, the water table will recover but to a different elevation than observed pre-mining due to the (assumed) permanence of the fractured zone above the longwall panels. The adjacent open pit final void will also receive groundwater inflows and be subject to evaporation, which will tend to result in a long term depression in the water table in the local mine area. This would be partly balanced by enhanced groundwater recharge to the fractured zone, although this has not been represented in the groundwater model as a conservative approach to not underestimate the impacts. The depression in the water table in the vicinity of the SGCP is up to 70 m below pre-mining levels.

Changes in hydraulic properties through the fractured zone can affect groundwater heads and flow patterns. For example, if the effects reach the surface, baseflow to streams can potentially be reduced, and/or stream leakage can increase. However, given the ephemeral nature of the local drainage features and substantial depth to water table in the region, there is no effective baseflow to streams. Hence, changes in aquifer hydraulic properties in the SGCP area are likely to affect only stream leakage, and even then only during the short periods when rainfall is sufficient to generate runoff and stream flow. These effects would be expected to actually reduce with time due to sedimentation effects infilling the connective cracking and reducing leakage rates.

8.2.3 Groundwater Recharge, Discharge and Induced Flow

Mining does not impact the Clematis Sandstone recharge to the GAB; it will remain unchanged with time, as demonstrated by comparing the water balance summaries at Table 6.2 (steady state) with Tables 7.2 and 7.3 (end of mining).

Recharge to the alluvium areas within the catchment also remains unchanged with time. Groundwater discharge to stream features is virtually zero, but leakage from stream systems is about 2 ML/day, and both of these components of the water balance do not change with time during the mining and post-mining simulations (i.e. there is no additional induced flow from surface water streams as the depth to water table is typically 10 m or more).

Previous sections describe the development of connective cracking in the sub-surface above the longwall panels, and the representation of that in the groundwater model through higher permeability values. The parameter values apply to represent mining and subsequently increase to represent the fracture zone effects above the longwall panels only for the post-mining period.

However, it is expected that the shallow fractures will seal with sediment after intense rain events or a flooding episode, limiting the ability of the fractures to quickly convey infiltration below the influence of evapotranspiration.

Modelling results (Appendix G) also confirm that the location of the groundwater divide along the Clematis Sandstone outcrop/recharge area remains unchanged relative to the pre-mining water table. This supports the mass balance flow analysis which indicates no change in recharge volumes to the GAB via the Clematis Sandstone as a result of mine operation.

Evapotranspiration in the model reduces very slightly during the mining period (from a range of 9 to 10 ML/day to a minimum of 8.6 ML/day), and then recovers back towards pre-mining levels during the post-mining period.

The major change to the water balance is thus demonstrated to be the discharge for dewatering purposes (Section 7), which is drawn from aquifer storage (and then subsequently replenished during post-mining recovery).

8.2.4 Groundwater Levels and Flow Patterns

The drawdown effects due to mining increase gradually with the development of mining and dewatering for the open pit and adjacent longwall mining areas (refer to a range of plots in Appendix G).

After 33 years of mining, the cone of depression has reached its maximum extent, and is evident in the water table across the mine lease area, with drawdown trends extending generally to the north. The cone of depression extends mainly to the north because it is limited by low permeability units outcropping to the west, east and south:

- the low permeability Rewan Formation and Dunda Beds limit the western (and southern) extent of water table drawdown, which results in the Clematis Sandstone being largely unaffected by drawdown (some minor effects of the order of 5 m or less)
- the low permeability Joe Joe Formation limits the eastern extent of water table drawdown, such that water table levels changes in the Alpha township area are predicted to be less than 1 m.

Although there is no change to the GAB recharge, there are predicted reductions in the confined aquifer piezometric levels in the western extent of the D1 and D2 seams at depth under the GAB aquifer systems (the Clematis Sandstone). This drawdown effect is due to drawdown within the Bandanna Formation coal seams extending outwards from the SGCP mine area to areas underneath the GAB, and this drawdown is then transmitted upwards into the overlying GAB formation in the eastern margin area of the GAB. However, the SGCP model has assumed a relatively high parameter value for the vertical hydraulic conductivity of the Rewan Formation and Dunda Bed units (1e-4 to 1e-6 m/day), which allows more transmission of this drawdown effect that would be expected for this very thick (250 m) and very low permeability unit. The resulting predicted drawdown of in the order of 5 m in the Clematis Sandstone is a conservative over-estimate, but would have little material impact, as there are no mapped springs in this area, no identified GDEs, the depth to water table is in excess of 10 m.

8.2.5 Post-Mining Recovery of Groundwater

Dewatering of mine workings will cease at the conclusion of mining operations, and groundwater levels previously drawn down will begin to recover. The rising groundwater post-mining levels will provide inflows to residual open pit mine voids, resulting in a lake and subsequent evaporation from the open water surface. Depending on the balance between inflows and evaporation, residual mine void lakes can become long term hydrological sinks (or discharge features, as expected in this case), or can develop as throughflow or recharge lakes.

Post-mining, the groundwater system begins to re-adjust to the new aquifer conditions surrounding the mined area, and water levels within the regional aquifers eventually attain a new equilibrium level (i.e. steady state condition). In the local mine area, the new equilibrium groundwater system will have a different potentiometric surface from that which was present pre-mining owing to:

- the presence of a final pit void in the west of the open-pit area
- backfilled open pit material having different hydraulic properties than the rock units that existed pre-mining
- the presence of fractures above the longwall panels

Groundwater levels in neighbouring bores immediately adjacent to the SGCP will not recover completely to pre-mining levels (refer to time series plots in Appendix G). However, the groundwater levels will rise substantially up to 10-20 m below pre-mining levels, and this would support the ability of the bores to provide long term water supplies for domestic or agricultural uses.

The model results (Appendix G) show that bores located outside the MLA to the west, east and south have long term levels 1-2 m lower than pre-mining. Those bores located to the north and outside the SGCP MLA show long term levels up to 20 m lower than pre-mining, due to the cumulative impacts of SGCP combined with the other mining projects.

The SGCP open pit and underground mine will result in the disturbance of the overlying strata and the localised dewatering of aquifers as mining progresses. The depth of the open pit and thus the residual final pit void will extend to the base of the deepest seam mined below surface level.

Mining activities and post-mining effects also have the potential to change the chemistry of groundwater via evaporation from any final pit void lake, and via subsequent groundwater mixing. Following cessation of mining at the SGCP and surrounding mines, dewatering will cease and groundwater will continue to seep into the final pit void. As the final pit void fills with groundwater seepage, and some direct rainfall and surface runoff, water levels will begin to recover. The final pit void is located at the western end of the open-cut excavation and will be protected from major flood inundation by an engineered levee wall (described in other reports).

A groundwater model simulation was performed where the final pit void was assigned a hydraulic conductivity value of 1,000 m/d, a specific yield of 1.0, and an assumed maximum evaporation rate of 0.5 m/year. The simulation results (presented and discussed in detail in Section 7) suggest that the final pit void water level should stabilise at levels around 10 m lower than the pre-mining water table, forming a permanent groundwater sink (receiving groundwater flow from all directions, including through the mined longwall area). The post-mining model run also shows that about 80% recovery of the groundwater flow system storage capacity occurs within about 30 years of cessation of mining. and levels have largely re-equilibrated within 50 years post-mining.

The predicted water balance for the final pit void lake (100 years post-mining) indicates that groundwater inflows are about 1.58 ML/day (0.58 GL/year). Although the salinity of water in the final pit void lake is expected to increase with time post mining due to evaporation (see separate assessment by WRM), this reduction in water quality is not expected to impact the surrounding aquifers because the final pit void lake remains as a long term groundwater sink (no outflow). Consequently, there will be no post-mining deleterious effect on the productive uses of existing groundwater sources, which all occur remote from the mine area and draw water from the shallow water table system (not the D1-D2 seams).

8.2.6 Groundwater Quality

The inflow water to the final pit void will be a mixture of the water qualities of the waters in source lithologies and the waste rock. Given higher rainfall infiltration rates through mine waste rock, there is potential for chemicals in the waste to be leached out and conveyed to the voids. Geochemical investigations undertaken found that the bulk of the overburden and interburden materials are expected to be non acid forming (NAF). Some materials sampled close to seam levels were found to be potentially acid forming (PAF).

As the PAF materials present a risk, EGI (2011) has recommended selective handling, blending and disposal by deep burial or encapsulation. The recommended mine waste segregation and handling practices will be sufficient to maintain adequate control over ARD risk on-site, so that there would be negligible impacts to groundwater quality (either directly or via final pit voids) as a result of PAF material.

Until mining is completed, water from the open-cut pits could flow down gradient along the coal seams to the underground workings, due to a strong hydraulic gradient in that direction. In the long-term, the groundwater levels above the underground workings will recover and the hydraulic gradient in the seams will flow towards the final pit void from all directions.

Over time, the salinity in the final pit void will increase through evaporative concentration. However, as long as the void remains a groundwater sink, there will be no deleterious effect on environmental values of any groundwater sources.

The mine water balance assessment being undertaken by WRM as part of this EIS considers the final void water balance and salinity effects in detail.

8.2.7 Existing Groundwater Users

Some groundwater bores identified in the DEHP database and during the bore survey are likely to be impacted by the SGCP. Groundwater level drawdown in existing groundwater bores has the potential to impact on the use of groundwater for agricultural purposes (stock watering) by causing material interference to bores (e.g. by limiting the available drawdown in the bore and hence reducing the yield, or by drawing the water level down below the existing pump inlet).

The material effect on these bores will depend on the reduction in the amount of available drawdown (depth between static water level and pump inlet) and whether the bores affected intersect the aquifers to be dewatered. As the dewatering impacts on groundwater levels are mainly manifest in close proximity to the mined areas, there is usually substantial residual aquifer thickness remaining at third party bores, and material effects can thus be managed by a range of actions including bore deepening and/or pump replacement.

The existing extraction bores in the vicinity of the Alpha township are predicted to be largely unaffected (drawdowns less than 1 m, which is within the seasonal range), so there should be no need for mitigation actions.

Those bores within the mine lease areas are predicted to be greatly affected by drawdown of around 100 m during mining, recovering post-mining to 10-20 m below the pre-mining level (i.e. groundwater levels may fall to near or below the bottom of the bore as a result of mining). These bores are likely to require deepening or replacement. Again, deepening of bores is a viable option as saturated aquifer conditions remain below the water table that is drawn down by mine dewatering (i.e. the Colinlea Sandstone underlying the D seams remains an effective aquifer).

8.2.8 Ecology (Groundwater Dependent Ecosystems)

There are no identified GDE stygofauna in the project area (ALS, 2011).

There are no identified springs in the area affected by drawdown related to SGCP mining.

There is the potential for impact on terrestrial vegetation, which may be groundwater-dependent to some degree. As the mine progresses, simulation results predict decreased evapotranspiration volumes as a result of lowered water table levels for mining. The evapotranspiration feature in the model is depth-dependent and is designed to represent shallow groundwater discharge in low-lying areas of the landscape (e.g. the near-stream zone). This zone could include groundwater-dependent terrestrial vegetation if it is present, although groundwater-dependent terrestrial vegetation is not identified as a key environmental feature in the SGCP area.

Predictions of reduced evapotranspiration can be interpreted as potentially reducing groundwater availability for use by plant communities. The predicted changes to evapotranspiration are relatively small, and given the substantial depth to the regional water table under natural conditions (typically more than 10 m), it is more likely that the terrestrial vegetation that is present is more reliant on shallow soil moisture and/or infiltration from stream flows, which would be largely unaffected across the catchment (i.e. apart from areas directly affected by mining).

8.2.9 Great Artesian Basin

The Clematis Sandstone, a GAB recharge bed, crosses the south-western corner of the mining lease, and dips to the west into the GAB. At its closest point, it lies about 2 km from the western limit of proposed underground mining and about 7 km west of the western limit of proposed open-cut mining. The low permeability Dunda Beds and Rewan Formation together form a 250 m thick aquitard underlying the Clematis Sandstone and intervening between it and the SGCP coal seams.

Analysis of model results indicates that there will be no change to the GAB groundwater recharge volumes to the Clematis Sandstone, and minor drawdown effects on the Clematis Sandstone due to SGCP mining (i.e. drawdown effects of in the order of 5 m).

As there is predicted to be no interception of any GAB recharge, no significant drawdown and thus no variation in natural stream leakage or induced flow, licences are not required from those water sources.

8.3 MINE WASTE AND WATER INFRASTRUCTURE

The following key infrastructure is considered to have the potential to impact on groundwater resources in the area, due to changes in recharge and aquifer character (due to backfilled open pits and fracture zone effects above longwall panels):

- coal waste (rejects and tailings) disposal areas
- ROM coal stockpiles
- CHPP
- raw water dams
- mine dams
- fuel and oil storage facilities
- water and wastewater treatment systems
- sewage systems
- workshops and storage areas.

Recharge impacts are considered to potentially occur below the major infrastructure facilities that will be constructed for the SGCP. These include the CHPP water and waste management system, mine and coal waste areas, fuel and chemical storage areas, sewage system, and environmental dams. Downward seepage has the potential to cause mounding if the recharge volumes are high enough, which in turn can cause alteration of groundwater patterns and possible waterlogged areas in extreme cases.

All water, waste, fuel and chemical storage facilities will be designed, constructed, and operated to prevent seepage (for example, to AS1940), thus the risk to groundwater resources is limited. Monitoring will be conducted to validate seepage control measures.

In general the potential for the SGCP to impact on regional groundwater quality is relatively low as groundwater flow will be toward the mine workings, and the potential for contaminants to migrate off-site via the groundwater system will be low. The greatest potential for groundwater quality impacts is considered to be poor quality infiltrating water, where downward seepage from storage facilities has the potential to result in off-site contaminant migration via shallow groundwater flow to the surface water system.

Seepage from water and waste facilities could result in downward leakage through surficial sediments until reaching lower permeability weathered sediments. Lateral migration on the lower permeable sediments could occur, which could migrate down gradient at shallow depth toward surface water drainages. It is envisaged that this seepage would not be controlled by regional groundwater drawdown, (which would limit the potential for impacted groundwater to leave site as flow is toward the mined voids) as this component of unsaturated flow occurs above the water table.

Thus shallow seepage monitoring will be required adjacent to the storage facilitates to enable identification and assessment of potential seepage. If monitoring detects a potential for off-site seepage then it is likely that active seepage controls (such as cut-off trenches) would be required.

The impacts of seepage into the deeper aquifers are, however, limited as:

- during mining and after closure (final pit void), groundwater flow will be towards the operating and final pit voids, and there is low potential for contaminants to move out via the groundwater system
- geochemical testing indicates that most materials disturbed and exposed during mining are NAF or have low potential for PAF

8.4 INFRASTRUCTURE CORRIDOR

There is a very low risk of potential groundwater impacts in the infrastructure corridor as the depth to water table is in generally excess of 10 metres, and the only interaction between surface water and groundwater resources is driven by leakage from surface streams. The model simulations show no change to stream leakage (‘induced flow’) due to mining, due to the depth to water table, and the streams already recharging the water table at maximum potential rate. The surface water section of the EIS should be consulted for discussion of these potential impacts.

8.5 CUMULATIVE IMPACTS

The cumulative groundwater-related impacts from the SGCP in addition to the Alpha Coal Project (ACP), Kevins Corner Coal Project (KCCP), and Galilee Coal Project (GCP) are all located in the Galilee Basin. The cumulative groundwater-related impacts of these projects have been assessed through groundwater model simulations in combination with the SGCP (see details in Section 7).

The effect of mine dewatering at the ACP some 62 km to the north of the SGCP, and the cumulative impacts of the more distant Kevins Corner Coal Project was represented in the SGCP model by head-dependent flow boundaries at the northern model boundary (the southern extent of the ACP). For mining simulations, the level specified at this boundary is consistent with the base of mining in this area, which is the level to which dewatering would be required at ACP (whatever the influences of other mining in the region, including Kevins Corner). This approach removes the ‘guesswork’ involved in estimating what the pumping rates would be for this operation. It also accounts for cumulative impacts due to any potential influence of mine dewatering drawdown from any more remote projects (e.g. KCCP, and/or others further north), as the ACP operation would adjust the pumping required to achieve the ACP target drawdown levels subject to the actual influence (if any) due to the other projects. Separate simulations have been completed with and without the ACP represented in this way, to allow for unpacking of the separate influences.

Drawdowns due to the ACP, KCCP and GCP (i.e. without the SGCP in operation) are predicted to extend southwards towards SGCP, and join with the cone of drawdown from the SGCP. These cumulative impacts on groundwater resources have been assessed with the SGCP model as documented in Section 7.

9. GROUNDWATER MANAGEMENT AND MITIGATION MEASURES

The SGCP has the potential to impact on groundwater resources. Mitigation and management measures to be implemented, to reduce or eliminate the risks identified, are required to:

- not detrimentally impact on the availability and suitability of groundwater for agricultural use (stock watering)
- prevent adverse changes to groundwater quality as a direct result of the mine project outside the mine footprint
- promptly address landholders concerns over impacts on their groundwater supplies
- evaluate the effects any final pit void post-mining, and outline how it will be managed and maintained and after mining ceases
- protect cultural heritage or spiritual values associated with surface water features that are maintained by groundwater (if any)
- no alteration of the diffuse recharge areas so as to ensure recharge during the life of the mine and after mining ceases

9.1 DEWATERING IMPACTS MITIGATION

Where detrimental impacts on landholder groundwater supplies may be detected, and be shown to be related to the SGCP operations, the Proponent will seek to reach mutually agreeable arrangements with affected neighbouring groundwater users for the provision of alternate supplies throughout the mine life, and after mine completion while the aquifer recovers.

Regular groundwater monitoring will be undertaken to enable groundwater level drawdown to be identified prior to any impacts being experienced in surrounding landholder bores. On the basis of monitoring trends, short-term alternative water supplies can be put in place before supplies from relevant existing landholder bores are adversely affected.

If predicted impacts differ from actual impacts, the numerical model developed as part of this hydrogeological assessment should be recalibrated with the benefit of a longer period of data and with data that should show a mining signature. Subsequently, the model should be used as a management tool for the prediction of groundwater impacts throughout the SGCP life.

The results of the groundwater monitoring program will inform progressive development of the numerical model. Revised outputs from the numerical model will be incorporated into ongoing mine planning and design over the life of the SGCP.

To maintain existing water usage rates, the following mitigation measures may be undertaken as required, in consultation with the landholders:

- inlet valves within bores may be lowered in order to maintain sufficient head of water above the pump; this may increase the cost of extracting groundwater from bores
- new pumps may be required if existing pumps are not powerful enough to lift groundwater from the increased depth beneath the surface
- in some situations, bores may need to be deepened or relocated in order to provide sufficient long-term water supply
- provision of piped water sourced from the mine may be available (i.e. surplus water from the dewatering program, depending on quality)

Deepening of bores is a viable option as saturated aquifer conditions remain below the water table that is drawn down by mine dewatering (i.e. the Colinlea Sandstone underlying the D seams remains an effective aquifer).

Under the Water Act 2000, DNRM has authority to direct a licensee to provide and maintain alternative water supplies for other holders of water entitlements who are materially impacted by the granting of a licence. The SGCP will develop alternate water supply agreements with landholders who will potentially be impacted by mine dewatering.

Landholders who have groundwater supplies that are materially impacted by the operation, to a degree where groundwater is not able to be used for its pre-mining beneficial use (in terms of quality and/or quantity) will be provided with an alternate water supply of comparable yield and quality. The Proponent has made a commitment to make-good affected groundwater supplies.

The specific arrangements for affected properties will be discussed with relevant landholders if they occur, with a view to reaching a mutually acceptable agreement.

9.2 SUBSIDENCE MITIGATION

The impacts associated with longwall mining include the alteration of aquifers and the potential for increased dewatering impacts. These impacts are as a result of the mining method to be employed and, thus, cannot be altered.

Predictive groundwater modelling has provided predictions regarding:

- groundwater ingress
- optimum dewatering strategies
- assessing drawdown impacts adjacent to the mine

These model predictions will enable the compilation of detailed dewatering scheme(s) required to ensure the safe mining conditions and the effective removal of excess groundwater. Groundwater monitoring will be conducted to assess any alteration in groundwater level (compared to model predictions) and hydrochemistry (mixing of groundwater). This monitoring data will aid in the regular model assessment and refinement.

9.3 MITIGATION OF REGIONAL GROUNDWATER IMPACTS

This investigation has shown that the Alpha township bores and nearby production bores are not materially affected by the proposed SGCP mine (i.e. drawdown is predicted to be less than 1 m in this area, mainly due to the very low permeability Joe Joe Formation in outcrop/subcrop on the eastern margins near Alpha, limiting the regional extent of drawdown).

All water, waste, fuel and chemical storage facilities will be designed, constructed, and operated to prevent seepage, thus the risk to the groundwater resources is limited. Monitoring will be conducted to validate seepage control measures.

Modelling does not predict long term detrimental impacts to neighbouring bores or surface water, as a result of post-mining groundwater recovery. The long term local scale groundwater sink that is formed by evaporation from the residual open pit void exceeding groundwater inflow results in no potential groundwater migration off-lease, and no material drawdown effect on nearby bores.

9.4 MINE WASTE AND WATER INFRASTRUCTURE MITIGATION

The risk associated with seepage will be reduced through the correct design and construction of mine waste, water, fuel, and chemical storage facilities. The effectiveness of these seepage controls will be validated through monitoring. The risk of this impact can thus be reduced and managed.

Controls will be implemented to prevent seepage and to manage seepage should it occur. Potential seepage from water and waste storage facilities will be monitored using down-gradient groundwater monitoring bores.

In the event of groundwater impacts being identified, mitigation measures will include:

- investigation of the integrity of the containment systems and potential areas/sources of seepage
- removal of the source of contamination and/or repair to the containment system, as required
- installation of systems to intercept seepage (e.g. interception trenches or bores)

9.5 INFRASTRUCTURE CORRIDOR IMPACT MITIGATION

The pre-mining depth to water table across the infrastructure corridor is generally greater than 10 m, and further drawdown due to mine dewatering would not impact on surface water and groundwater interaction processes. Subsequent post-mining groundwater recovery would effectively restore the groundwater levels and flow system, and thus is anticipated that mitigation measures will not be required for this area for either groundwater quantity or quality.

9.6 ECOLOGICAL IMPACT MITIGATION

There are no sensitive groundwater dependent ecosystems that have been identified in the study area that may be impacted due to mine dewatering, and no specific groundwater monitoring program is proposed for ecological impact assessment. However, the general monitoring program will provide information that can be used to validate groundwater model predictions during mining and thus be used to update environmental management plans accordingly.

9.7 GREAT ARTESIAN BASIN IMPACTS MITIGATION

There is no predicted reduction in groundwater recharge to the GAB through the Clematis Sandstone recharge/intake beds as a result of mining, therefore no specific mitigation measures are proposed. However, groundwater monitoring will be implemented to monitor the potential impacts of the SGCP. The model predictions under a conservative worst case setup (i.e. tending to over-estimate impacts) indicate drawdowns within the Clematis Sandstone of the order of 5 m during mining, which subsequently recovers post mining. The maximum drawdown in GAB units further west within the model domain is predicted to be in the order of 5 m, which is within a dynamic range that the available monitoring indicates would be reasonable to expect over the long term. Compared to a depth to water table that is generally well in excess of 10 m, such dynamic variations do not warrant specific mitigation/management.

9.8 FINAL PIT VOID GROUNDWATER INTERACTION MITIGATION

As the pre-mining depth to water table in the SGCP MLA is typically 30 to 60 m below ground, there is no groundwater interaction with the surface. There would be some low volumes of leakage from the ephemeral surface streams during the short periods of time when rainfall is sufficient to generate runoff and flow. Given the depth to water table, this leakage rate is already occurring at the maximum potential rate, and further drops in the water table level would not affect the leakage (i.e. there would be no induced flow due to predicted groundwater level changes). Thus there is no need for mitigation in relation to these processes.

The post-mining model run shows that the long term groundwater levels recovery to around 10-20 m below the pre-mining levels, with about 80% of that recovery occurring within about 30 years of cessation of mining, and water levels effectively re-equilibrated (to within a few metres of the long term level) within 50 years post-mining.

9.9 GROUNDWATER MANAGEMENT AND MONITORING PROGRAMS

9.9.1 Groundwater Management Program

A Groundwater Management Program (GMP) will be prepared and submitted for review in accordance with project approval conditions and any groundwater-related licences. The plan will be designed to monitor groundwater levels and quality to confirm the extent and magnitude of impacts from mine dewatering, including consideration of any triggering of the application of management responses (e.g. mitigation measures), which will also be detailed in the GMP.

Monitoring of groundwater levels and quality will be undertaken during all stages of mining (continuing the pre-construction monitoring program, and extending through construction, operation and rehabilitation periods). The monitoring frequency will range from weekly to monthly during early stages of active dewatering, and may increase to quarterly to annually during later mining and post mining stages. The groundwater monitoring will also be used to validate the numerical model, and to help support other mining and environmental management activities.

The information will be used for environmental compliance reporting. In particular, the groundwater quality monitoring will include analysis of the following parameters: pH, dissolved oxygen, EC, TDS, iron, aluminium, arsenic, magnesium, molybdenum, selenium, calcium, sodium, chloride and sulfate. Analysis will be undertaken at an accredited laboratory. Water quality data will be evaluated as part of the annual reporting process and will aim to identify any potential mining related impacts.

Groundwater monitoring bores have been established within the mine lease area (refer Section 4.2), and further work will progress on the bores listed in Table 9.1. These bores are currently open exploration holes that will be converted into groundwater bores by installing casings with screened intervals positioned against the major fractured zones in the Bandanna Formation, coal seams and the Colinlea Formation. Some locations will have nested multilevel bores. The locations were selected to monitor groundwater levels and quality along the SGCP boundaries and down gradient of the final pit void.

Table 9.1: Proposed SGCP Monitoring Program Bore Locations

Hole Name	Easting (MGA)	Northing (MGA)	Comments
BH06	444010	7374020	Located on southern boundary of MLA and will remain undisturbed for 10 years, so this will also provide useful background information, including monitoring the impact on groundwater from waste rock dumps.
BH21	446111	7378014	To monitor dewatering of southern operations and baseline for future mining. Located at eastern boundary and will remain undisturbed for 25 years.
BH33	441533	7382067	Will remain undisturbed for at least 25 years.
BH42	445067	7384006	To monitor dewatering of the northern operations. Located on the northern boundary and may remain undisturbed throughout the mine life.
BH85	445501	7381000	To monitor dewatering of the northern operations. Will also provide background data prior to expansion and will likely remain undisturbed throughout the mine life.
BH34	444148	7382453	Located near northern proposed “dirty water” dam, and will likely remain undisturbed through the mine life.
SP142	445299	7374183	Located near southern proposed “dirty water” dam, and will likely remain undisturbed. Will also be useful to monitor the impact on groundwater from waste rock dump.
BH27	442900	7379447	Located in the middle of the model domain and possibly will remain undisturbed for 20 years.
CK110	446300	7380050	Located on eastern side of operation and will be useful to monitor groundwater impact from waste rock dump. May remain undisturbed for 10-15 years.
BH05	442094	7374161	Located at south western corner and will remain undisturbed for 10 years.
BH18	440058	7378132	Located at western side and may remain undisturbed for 15 years or more.
CK177	439044	7380762	Located at western side and may remain undisturbed for 25 years or more.
BH39	438973	7383544	Located at north western corner and will remain undisturbed for 25 years or more
CK226	442113	7378175	Located at the middle of the mining domain and will remain undisturbed for about 15 years.

Monitoring of groundwater levels and quality should be undertaken from the existing local farm bores (assuming negotiation with landholders is successful). The groundwater monitoring bore network may be expanded in due course to areas surrounding MLA if triggered by the GWMP.

9.9.2 Operations Monitoring

During mining, dewatering volumes will be measured and recorded regularly and the volumetric rates compared to the model-predicted rates to confirm the modelling predictions. In areas particularly where drawdowns are predicted in third party bores, detailed and regular monitoring will be conducted.

Multi-level piezometers will be installed to the west of the mine site to measure groundwater levels and monitor mining influences. Shallow piezometers will be installed in the fractured zone above the longwall panels to monitor changes in water table elevations. Additionally, if available, groundwater levels will be obtained from neighbouring mine monitoring networks so that widely distributed water levels will be available for regional evaluation.

In summary, the groundwater monitoring program will monitor groundwater conditions for changes as a result of mining and should include consideration of aquifer definition and interactions, strata hydraulic properties, pore pressure distributions and groundwater quality.

The monitoring data will be used to:

- assess drawdown predictions from the groundwater model on an annual basis, provide data for model updates as required. This process will support validation of the model and its predictions of potential impacts
- confirm the impacts of groundwater drawdown on existing groundwater users and other identified environmental values, and develop specific mitigation/management plans through consultation with landholders and/or negotiation of alternative water supply agreements
- review the performance of the groundwater monitoring network, and guide appropriate optimisation of the monitoring network during the life of the mine
- assess compliance with Water Licence and EA conditions
- where issues of non-conformance are identified, the monitoring will allow for an assessment of mitigation and remediation measures

To further assess groundwater resources in the context of cumulative/potential mining impacts, and develop the optimum management strategies, the following commitments regarding groundwater monitoring and compliance reporting are made:

- groundwater monitoring and sampling will be conducted by suitably qualified and experienced professionals in accordance with the current edition of the DEHP Water Quality Sampling Manual, or subsequent updated versions; and the AS/NZS 5667.11:1998 Australian/New Zealand Standard for water quality – sampling Part 11; guidance on sampling groundwater
- an annual review of the monitoring data will be conducted by suitably qualified and experienced hydrogeologists, and will include assessment of groundwater level and quality data, and the performance of the monitoring network
- all groundwater-based complaints will be investigated and a register kept of the nature of the complaint, the results of assessment, and any actions taken, and the register will be made available to the regulating authority upon request

9.9.3 Monitoring Frequency

Groundwater bore levels will be measured quarterly during the pre-mining and mining operation period. Following cessation of mining, groundwater levels will be measured quarterly for the first two years and annually during the rehabilitation period. During these periods, water levels from surrounding domestic bores will also be collected at least annually (at times corresponding to the quarterly groundwater measurement periods). If possible, the SGCP water levels will be supplemented with groundwater levels collected at nearby coal mines.

9.9.4 Post Mining Monitoring

After mining has ceased and decommissioning and rehabilitation works are complete, the Proponent will relinquish the SGCP mining lease. Prior to relinquishment, the nature, scope and resourcing of an ongoing groundwater monitoring program will be discussed with the parties with whom it has had alternate water supply agreements. This program may be a continuation of that outlined for operational mining, or an agreed variation, depending on the circumstances at the time.

Post-mining groundwater monitoring would be undertaken within monitoring bores that were installed during the operational phase of the SGCP.

9.9.5 Investigation Program

Consideration should be given to developing and implementing a hydrogeological investigation program progressively over the life of the SGCP to manage the potential for unexpected groundwater related effects as a result of geological structures such as faults, dykes and joint systems). Improved knowledge of geological structures should inform the development of Extraction Plans, and such features can be added to the model to refine prediction of effects on the groundwater system.

Since best practice suggests that a groundwater model should be dynamic and not static (Middlemis et al, 2001; Barnett et al 2012), the results of the groundwater monitoring program and hydrogeological investigation program should inform progressive development of the model. Revised outputs from the numerical model should be incorporated into ongoing mine planning and environmental management over the life of the SGCP.

This data, in combination with surface exploration and underground mapping data, could be used to build robust and accurate geological models upon which detailed mine plans can be developed, including consideration of potential groundwater related effects, and to form the basis for decommissioning and rehabilitation plans.

10. References

ACARP, 2003. *Review of Industry Subsidence Data in Relation to the Influence of Overburden Lithology on Subsidence and an Initial Assessment of a Sub-Surface Fracturing Model for Groundwater Analysis*. ACARP Research Project No. C10023, September 2003.

ALS Water Sciences Group. (2011). Aquatic Ecology Assessment for the South Galilee Coal Project EIS. Report to AMCI. December 2011. ALS document number 212652-EE2011-119.

Audibert, M. (1976). Progress Report on the Great Artesian Basin Hydrogeological Study 1972–1974. Bureau of Mineral Resources, Geology and Geophysics, Record 1976/5.

Barnett, B, Townley, L.R., Post, V., Evans, R.E., Hunt, R.J., Peeters, L., Richardson, S., Werner, A.D., Knapton, A. and Boronkay, A. (2012). Australian Groundwater Modelling Guidelines. Waterlines report 82, National Water Commission, Canberra.
URL: http://www.nwc.gov.au/publications/waterlines/82

Chaffey, B., ed., (1992). Principles of Sustainable Agriculture - Dryland Salinity. Department of Agriculture, Victoria.

Collective Experience, (2012). Geological Model for SGCP. Unpublished.

DEHP (2012). Digital extract from the Groundwater Database. © The State of Queensland (Department of Environment and Heritage Planning).

Environmental Geochemistry International Pty Ltd (EGI). (2011). ARD Assessment of Overburden and coal from the South Galilee Coal Project. Report No. 6702/952 prepared for AMCI (ALPHA) Pty Ltd, February 2011.

Environmental Simulations Inc. (2011). Groundwater Vistas (Version 6.11) software. Developed by J.O. Rumbaugh and D. B. Rumbaugh for Environmental Simulations Inc., Pennsylvania USA.
URL: http://www.groundwatermodels.com

Harbaugh, A.W., Banta, E.R., Hill, M.C. and McDonald, M.G. (2000). MODFLOW-2000, the US Geological Survey modular ground-water model—user guide to modularization concepts and the ground-water flow process, US Geological Survey Open-File Report 00–92.

van Heeswijck, A. (2006). The Structure, Sedimentary, Sequence Stratigraphy and Tectonics of the Northern Drummond and Galilee Basins, Central Queensland, Australia. Unpublished PhD Thesis, Department of Earth Sciences, James Cook University, Qld. Aust.

Hillier, J.R. (2003). Groundwater Recharge in the Great Artesian Basin Intake Beds, Queensland Department of Natural Resources and Mine Technical Report.

HydroGeoLogic Inc. Modflow-Surfact software URL: www.hglsoftware.com/Modflow.cfm

JBT Consulting (2011). Alpha Coal Project Environmental Impact Statement: Groundwater. JBT Consulting Brisbane, Queensland, Australia.

Matrixplus (2009). Landholder Bore Census - Creek Farm. Report prepared for Alpha Coal Project. June 2009.

McDonald, M.C. and Harbaugh, A.W. (1988). MODFLOW, A Modular Three-Dimensional Finite Difference Groundwater Flow Model. U.S. Geological Survey, Open File Report 91-536, Denver.

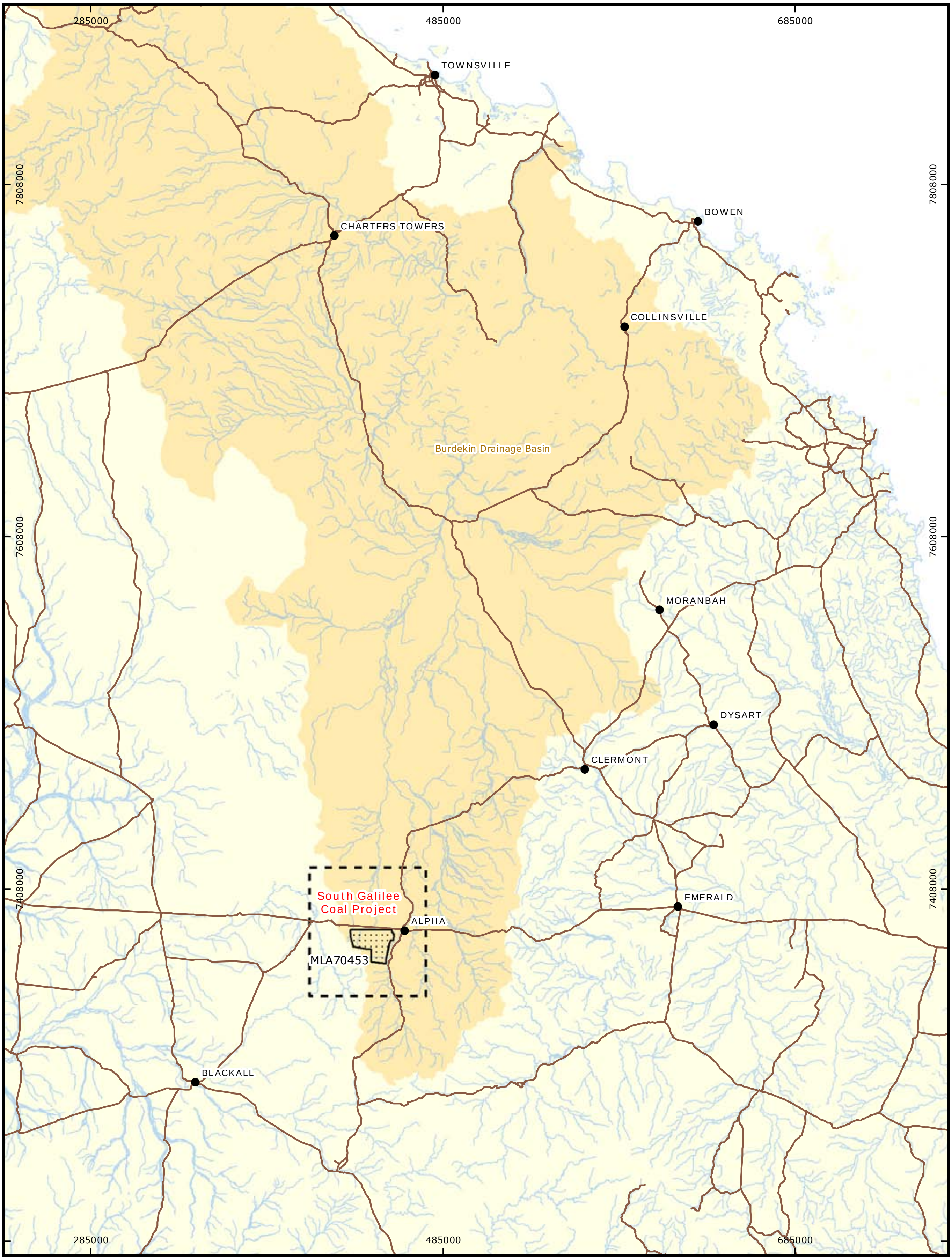
Middlemis, H., Merrick, N., Ross J. and Rozlapa, K. (2001). Groundwater Flow Modelling Guideline. Report prepared for Murray–Darling Basin Commission by Aquaterra, January 2001.
URL: http://publications.mdbc.gov.au/view.php?view=243

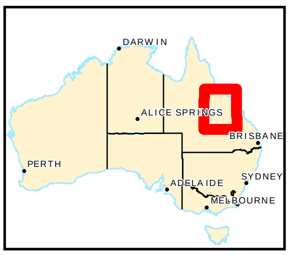
NASA (2012). URL: http://www2.jpl.nasa.gov/srtm/.

Ransley, T., Plazinska, A., Nation, E., Hostetler, S., Sundarum, B., Brodie, R.S. (2010). Cumulative Rainfall Collector – a Low-Cost Tool for Assessing Groundwater Recharge. Groundwater 2010 Australian National Conference of the International Association of Hydrogeologists, October 30 to November 4, 2010, Canberra. www.groundwater2010.com/documents/SundaramBaskaran.pdf.

URS (2012). Groundwater Modelling Report – Alpha Coal Project. Prepared for Hancock Coal.

FIGURES





N

25 0 25 50

Kilometres

APPROX SCALE 1:3,000,000 @ A4

GDA 1994 MGA Zone 55

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES
Client
Geoscience Australia
DEEDI

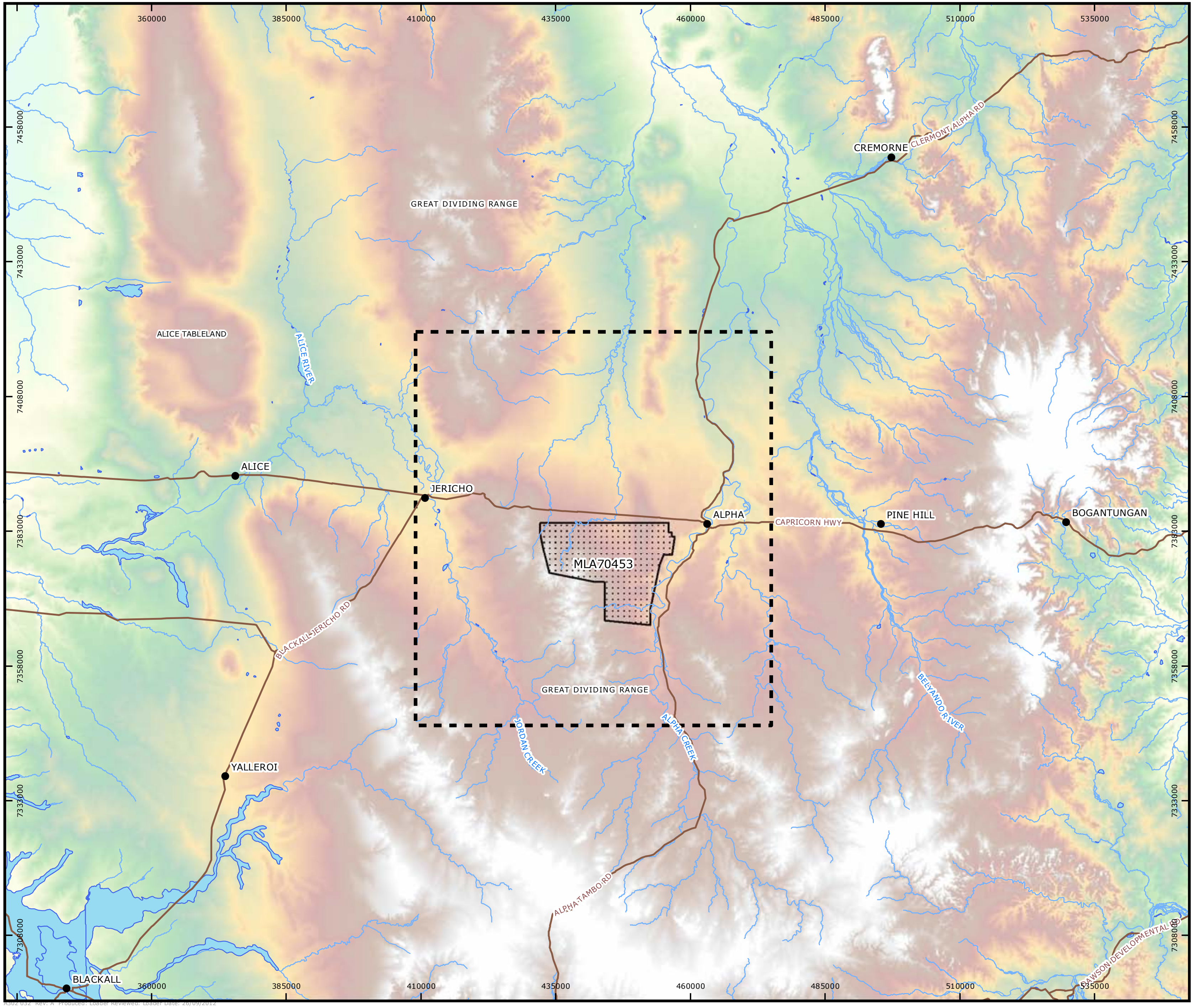
LEGEND

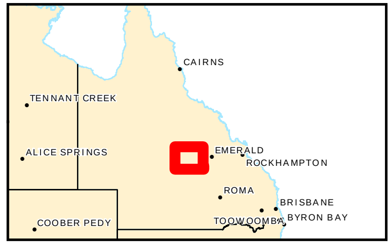
- Locality
- Rivers
- Mining Lease Application Boundary
- Model Extent
- Burdekin Drainage Basin

RPS Aquaterra

FIGURE 1-1
Locality Map

A302_036 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

N

10 0 10 20
Kilometres

APPROX SCALE 1:1,000,000 @ A4

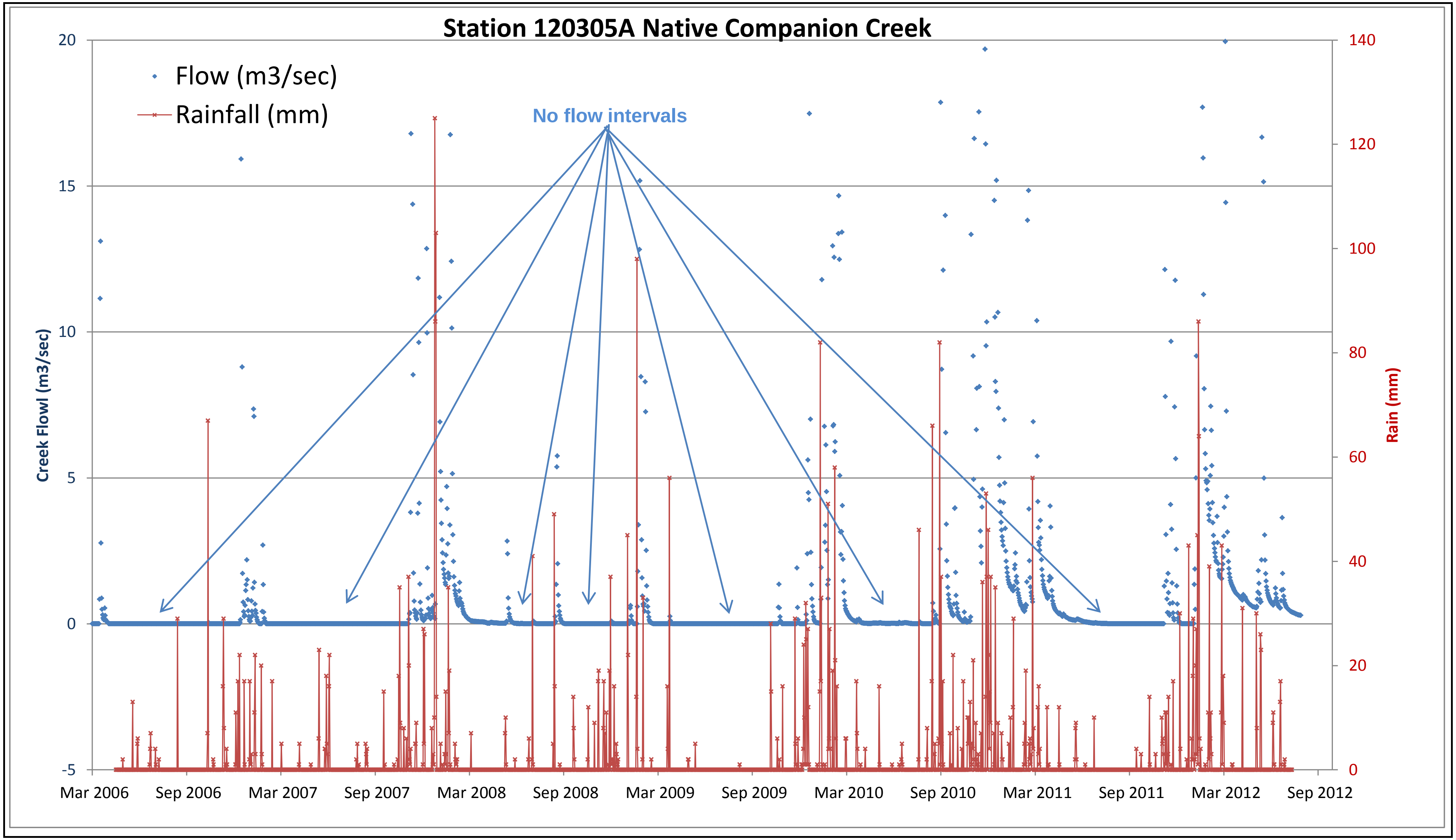
GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
Client

RPS Aquaterra

FIGURE 3-1

Physiographic Features & SGCP Site



RPS Aquaterra

Gauging Station Water Flow and Rain Graph FIGURE 3-2

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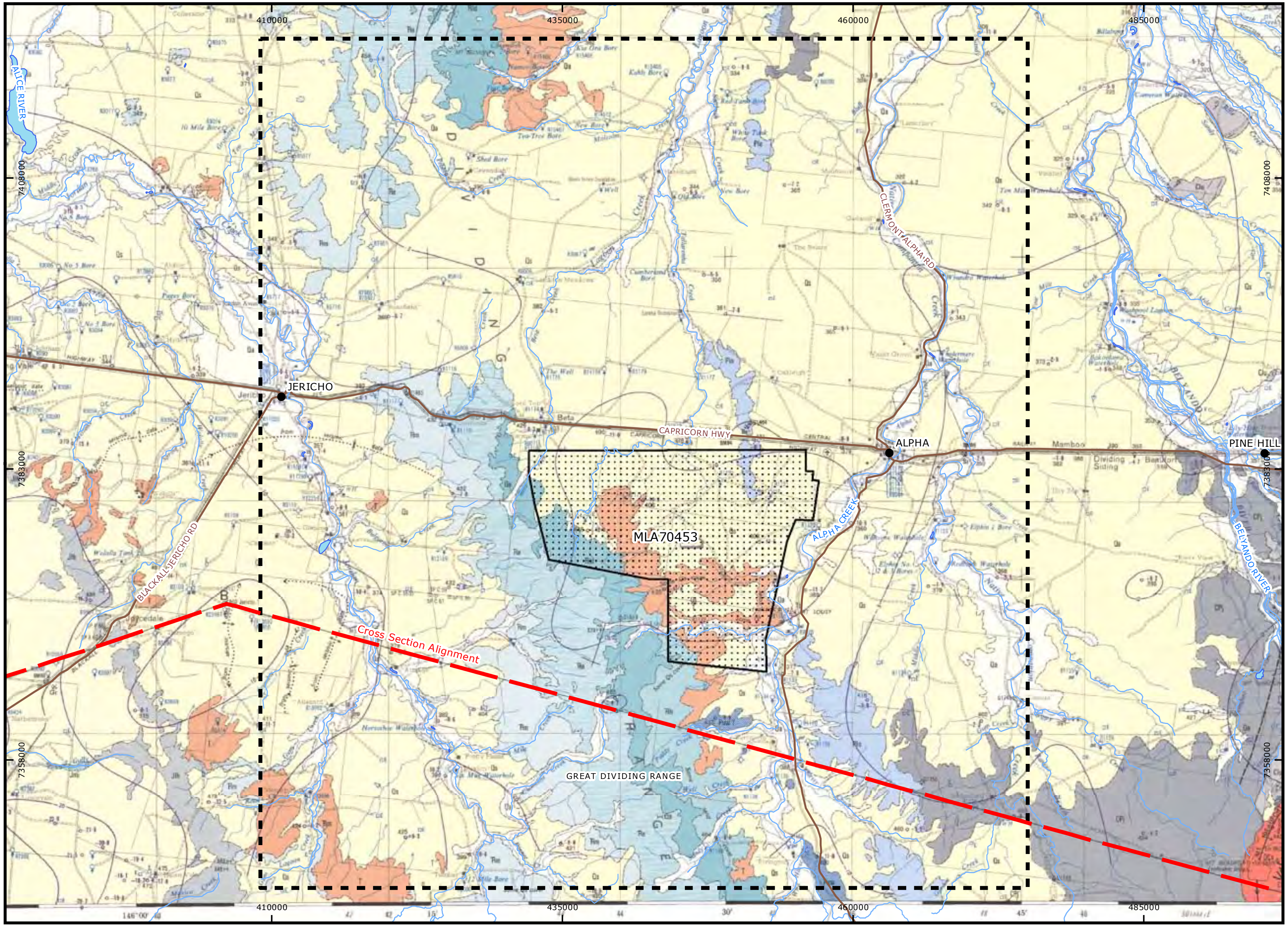
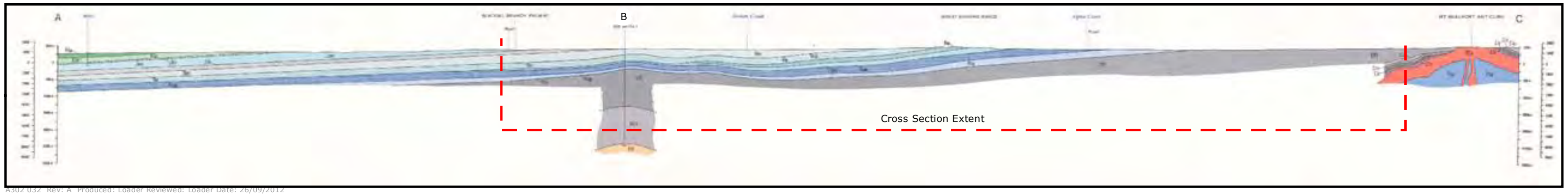
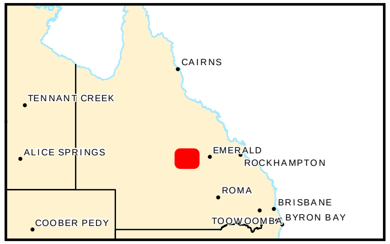






LEGEND

Model Extent

Mining Lease Application Boundary

Geology

- Qa — Alluvium, some gravel
- Qs — Sand, gravel, rubble
- T — Argillaceous sandstane, sand mudstone
- Tb — Basalt
- Kia — Mudstone, siltstone, minor labile sandstone
- Klu — Mudstone, siltstone, limestone
- Kld — Mudstone, glauconitic mudstone and siltstone
- JKr — Quartz and labile sandstone, mudstone
- Jmi — Labile sandstone, mudstone
- Jlh — Quartz sandstone
- Rm — Mudstone, sandstone, siltstone, shale
- Re — Quartz sandstone, minor siltstone & mudstone
- Rld — Labile sandstone, siltstone, mudstone
- Rlr — Mudstone, siltstone, labile sandstone
- Pow — Labile siltstone, carbonaceous sandstone
- Plo — Labile & quartz sandstone, minor siltstone & coal
- CPj — Mudstone, labile sandstone, siltstone, shale
- Clu — Interbedded feldspathic sandstone, green & brown mudstone minor limestone and tuff
- Cls — Quartz sandstone. minor pebbly sandstone, conglomerate, lithic, sandstone, oolitic limestone
- Clr — Quartz sandstone. minor siltstone
- Clt — Tuff, agglomerate, basalt, conglomerate, algal limestone, feldspathic sandstone, mudstone
- DCs — Flow-banded and spherulitic rhyolite
- DCb — Pink feldspathic sandstone, siltstone, mudstone, varicoloured in part,: minor conglomerate
- Pzl — Partially welded acid vitric crystal tuff
- Pza — Schist. slate, fine grained sandstone, shale

Please see Jericho 1:250k Geology map for more detail

N

5 0 5 10

Kilometres

APPROX SCALE 1:500,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES

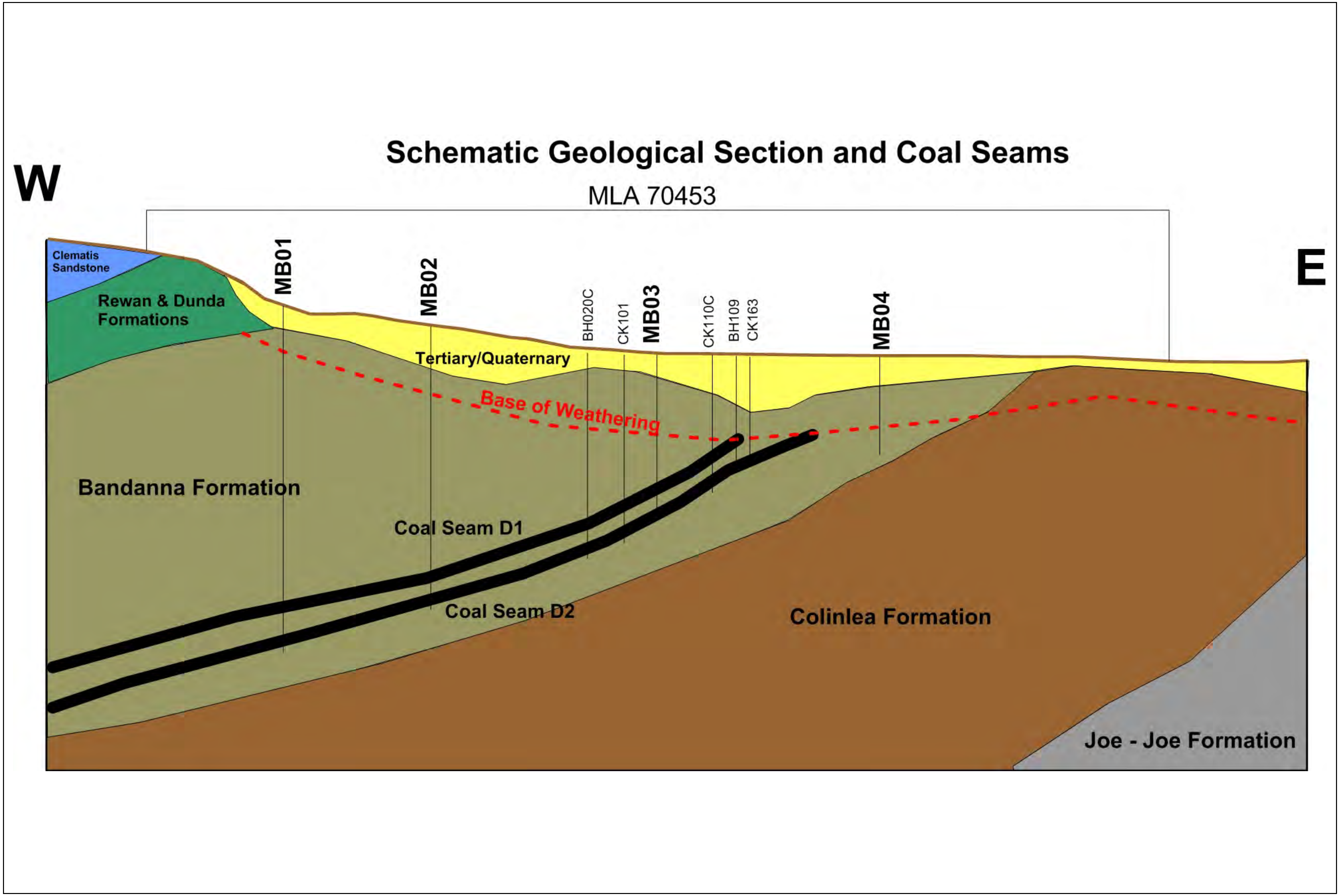
SRTM
Geoscience
Client

RPS Aquaterra

FIGURE 3-3

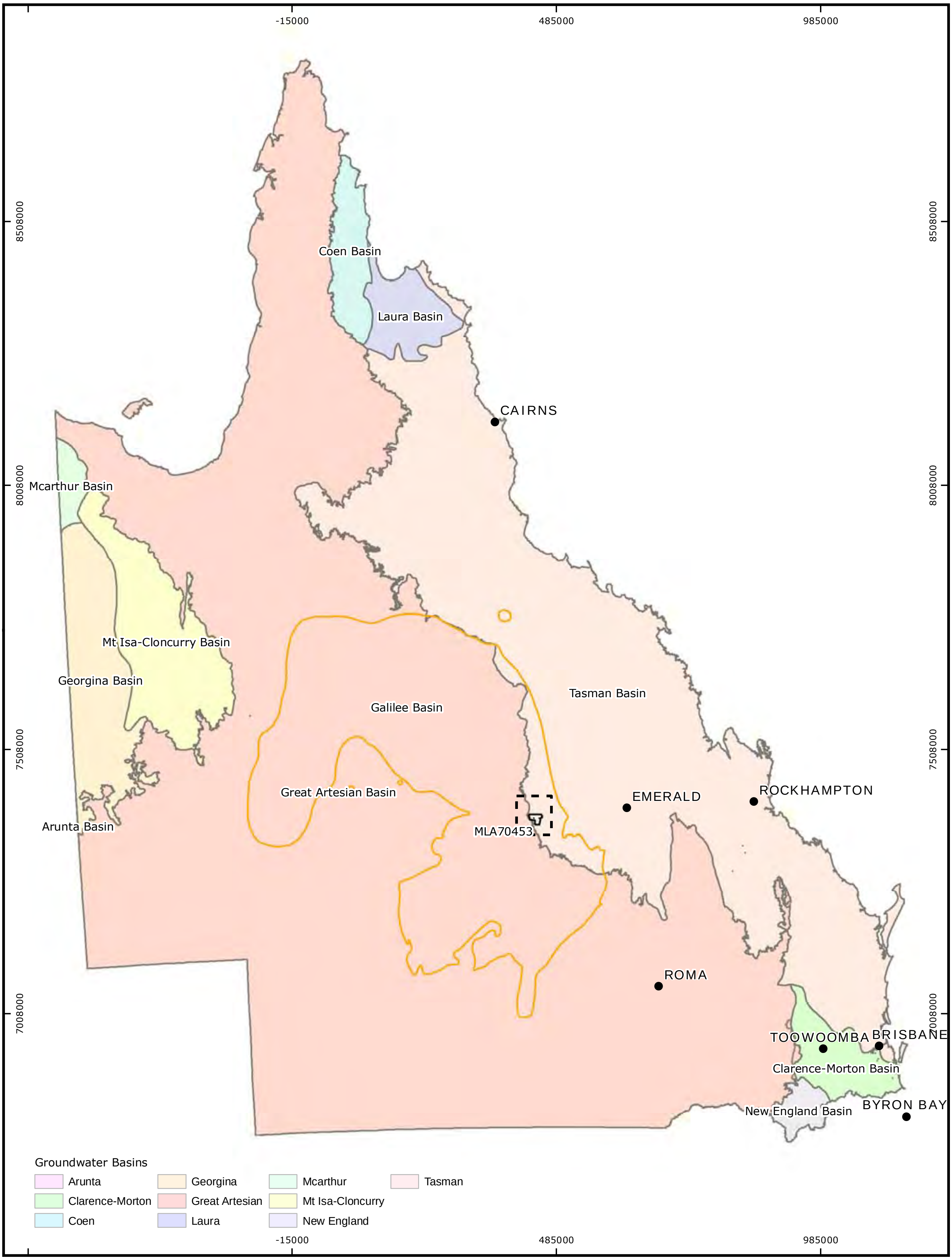
Geological Map and Cross Section

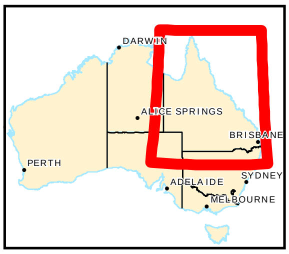
A302 032 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012

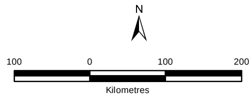


RPS Aquaterra

SCHEMATIC GEOLOGICAL CROSS SECTION FIGURE 3-4







APPROX SCALE 1:10,000,000 @ A4

GDA 1994 MGA Zone 55

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

DATA SOURCES
Client
Geoscience Australia
DEEDI

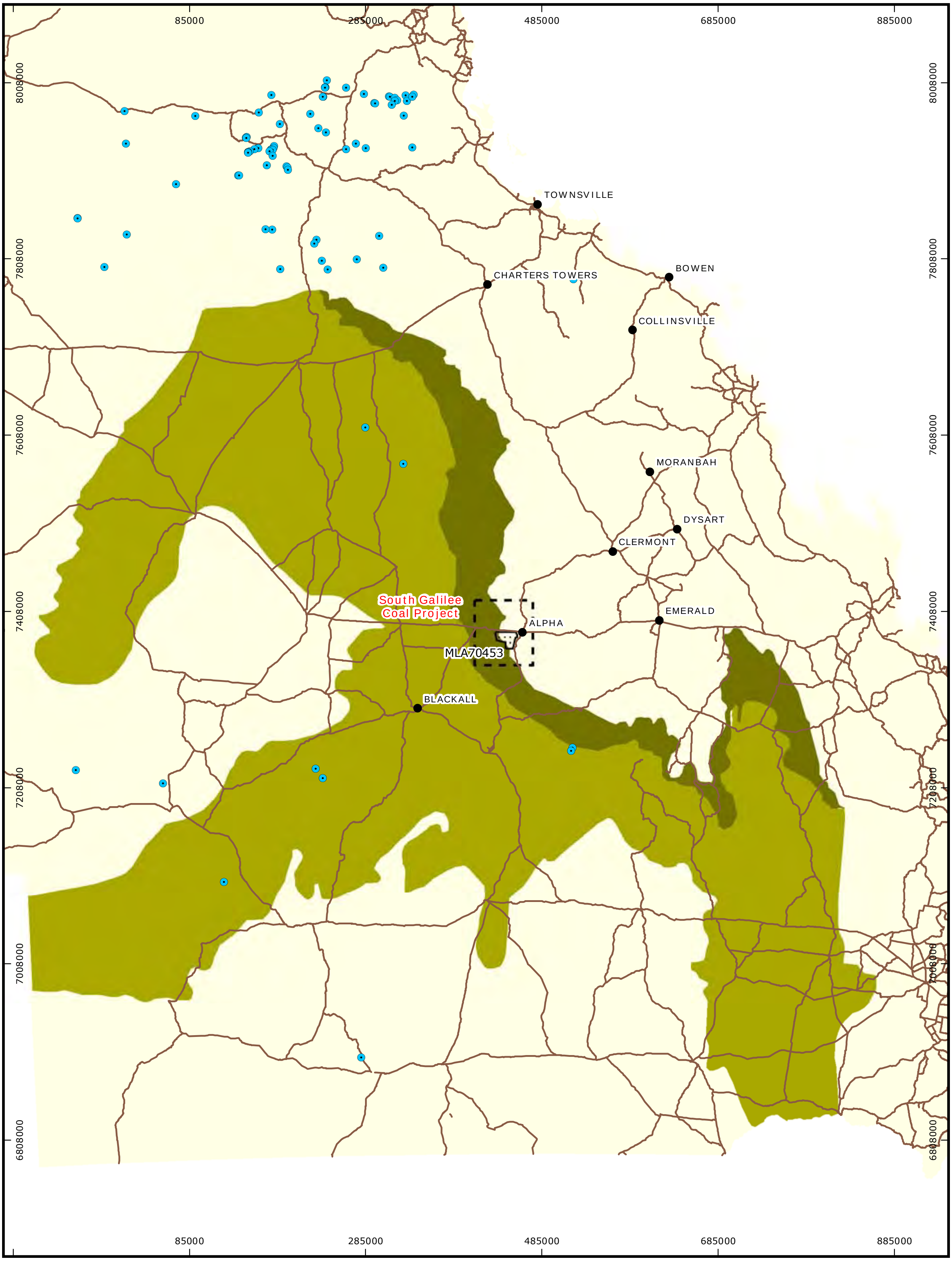
LEGEND

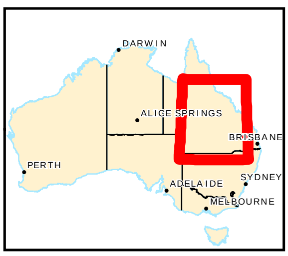
- Locality
- Mining Lease Application Boundary
- Galilee Basin
- Model Extent

RPS Aquaterra

FIGURE 3-5
Queensland GAB Extent and Underlain Basins

A302_036 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





N

50 0 50 100
Kilometres

APPROX SCALE 1:6,000,000 @ A4
GDA 1994 MGA Zone 55

DATA SOURCES
Client
Geoscience Australia
DEEDI

LEGEND
- Spring
- Locality
- Mining Lease Application Boundary
- Model Extent
- Rivers
- Approximate Outcrop Area
- Approximate Triassic Sequence Area

RPS Aquaterra

FIGURE 3-6
GAB Extent of Triassic Sequence

A302_036 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012

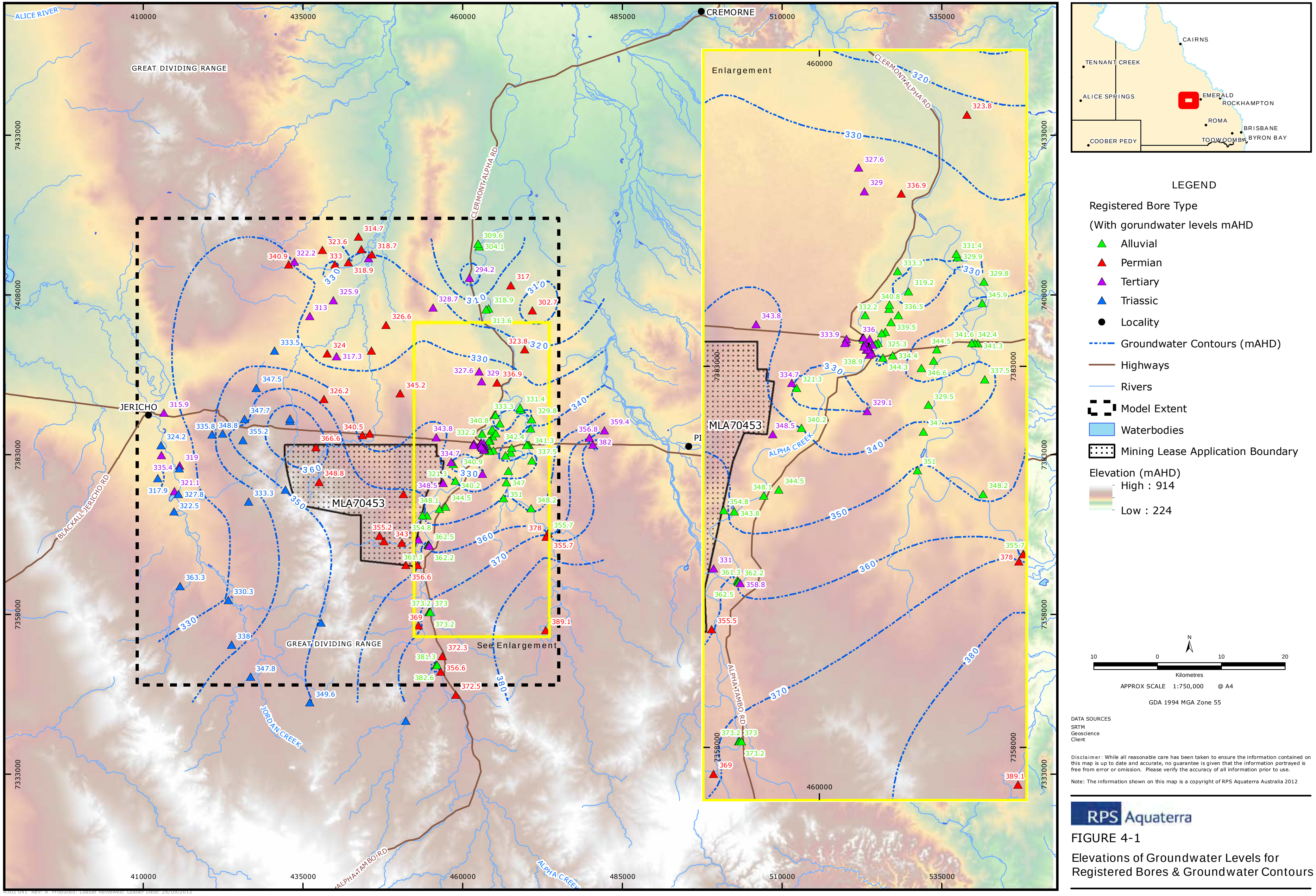
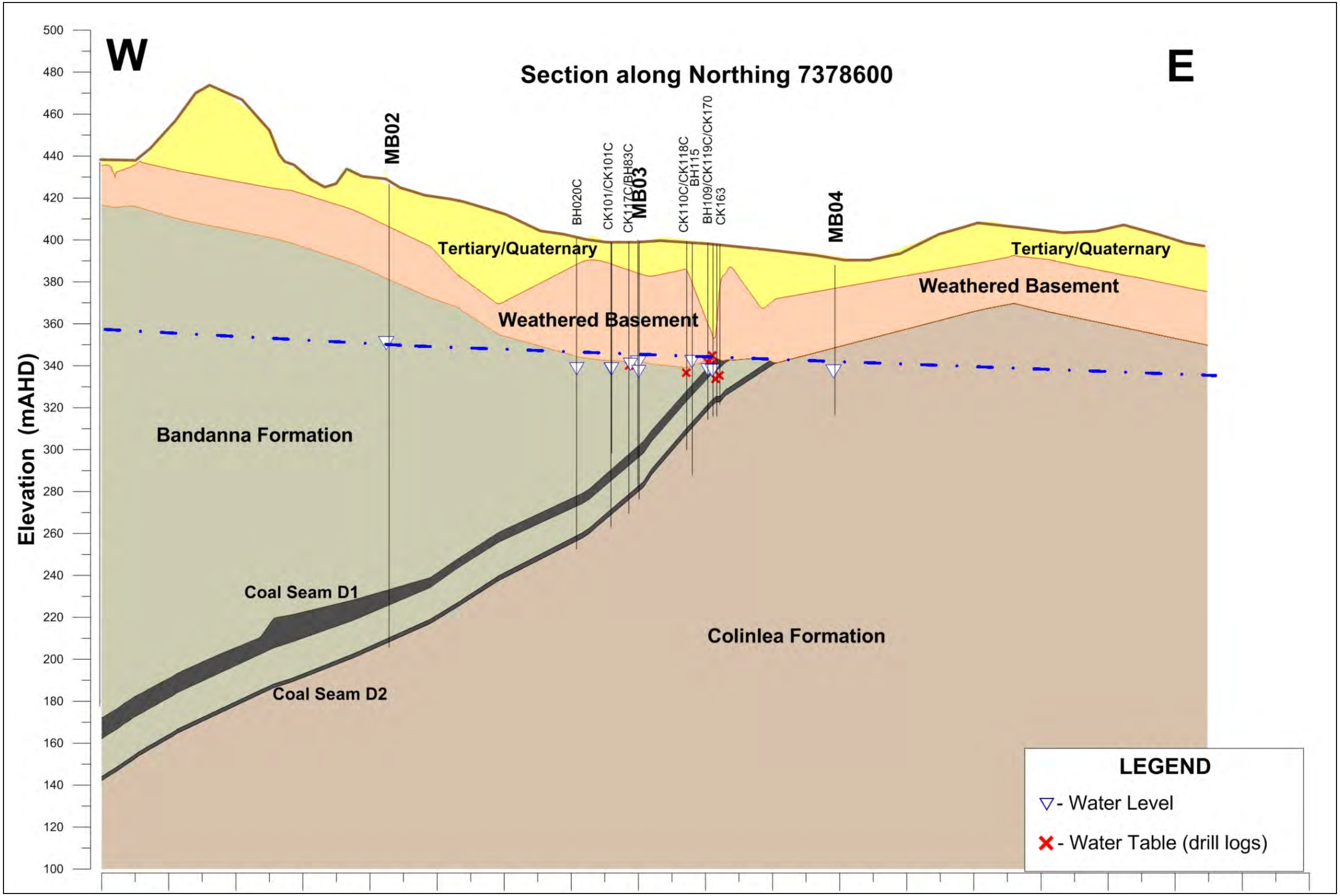
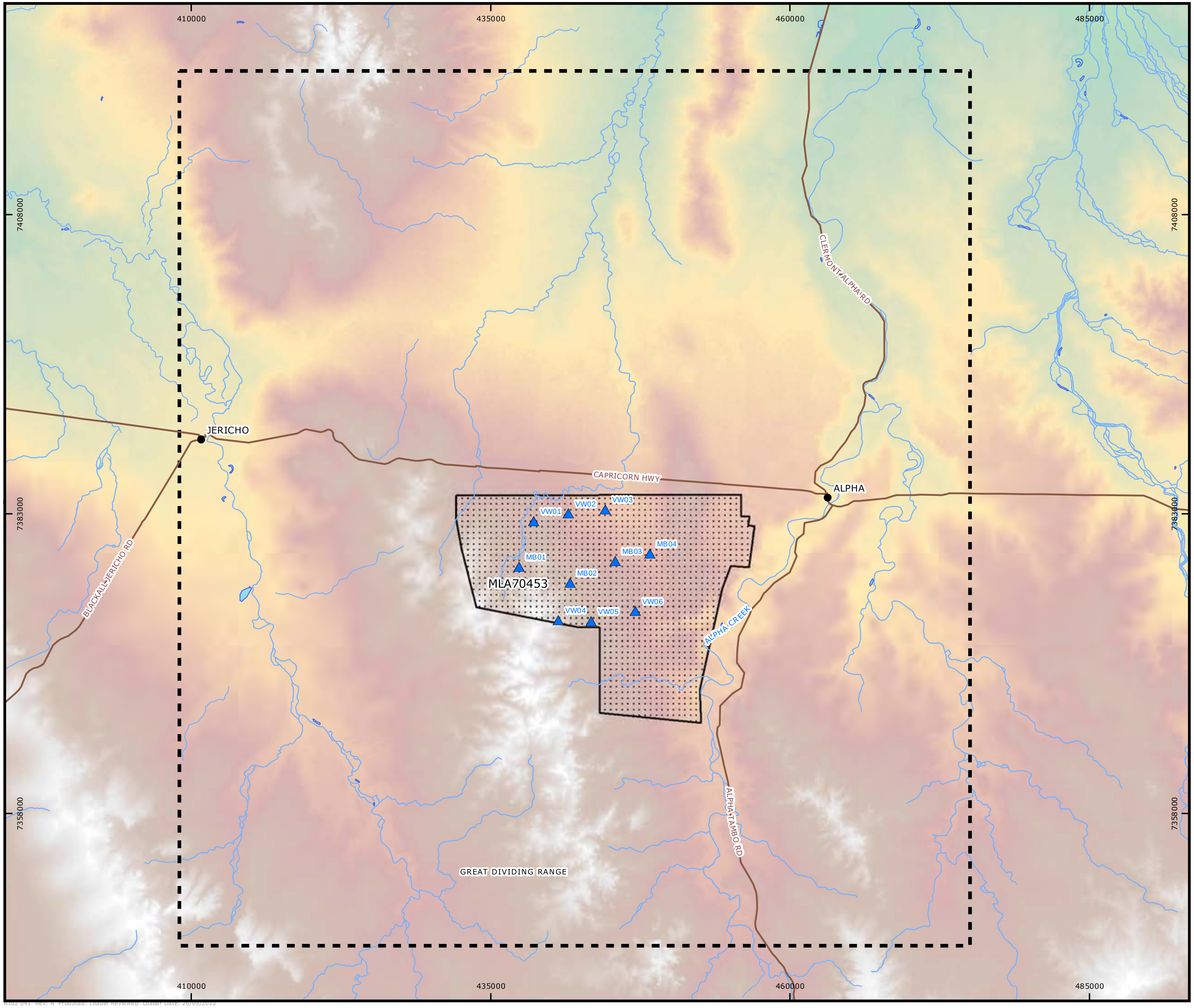


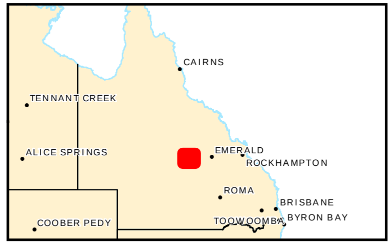
FIGURE 4-1

Elevations of Groundwater Levels for Registered Bores & Groundwater Contours



SCHEMATIC HYDROGEOLOGICAL CROSS SECTION FIGURE 4-2





LEGEND

- Monitoring Bore
- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

5 0 5 10
Kilometres

APPROX SCALE 1:450,000 @ A4

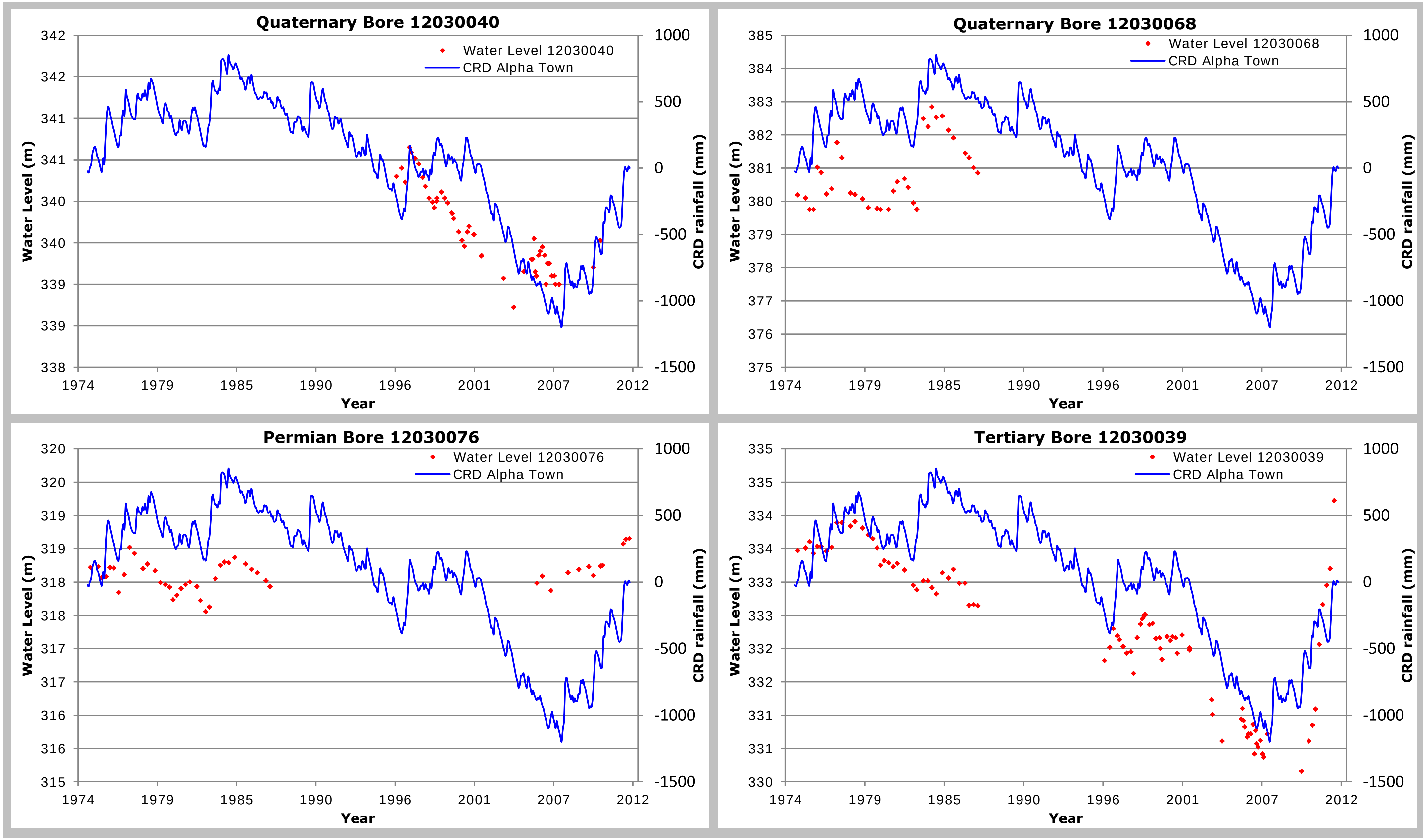
GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
Client

RPS Aquaterra

FIGURE 4-3

SGCP Monitoring Bores



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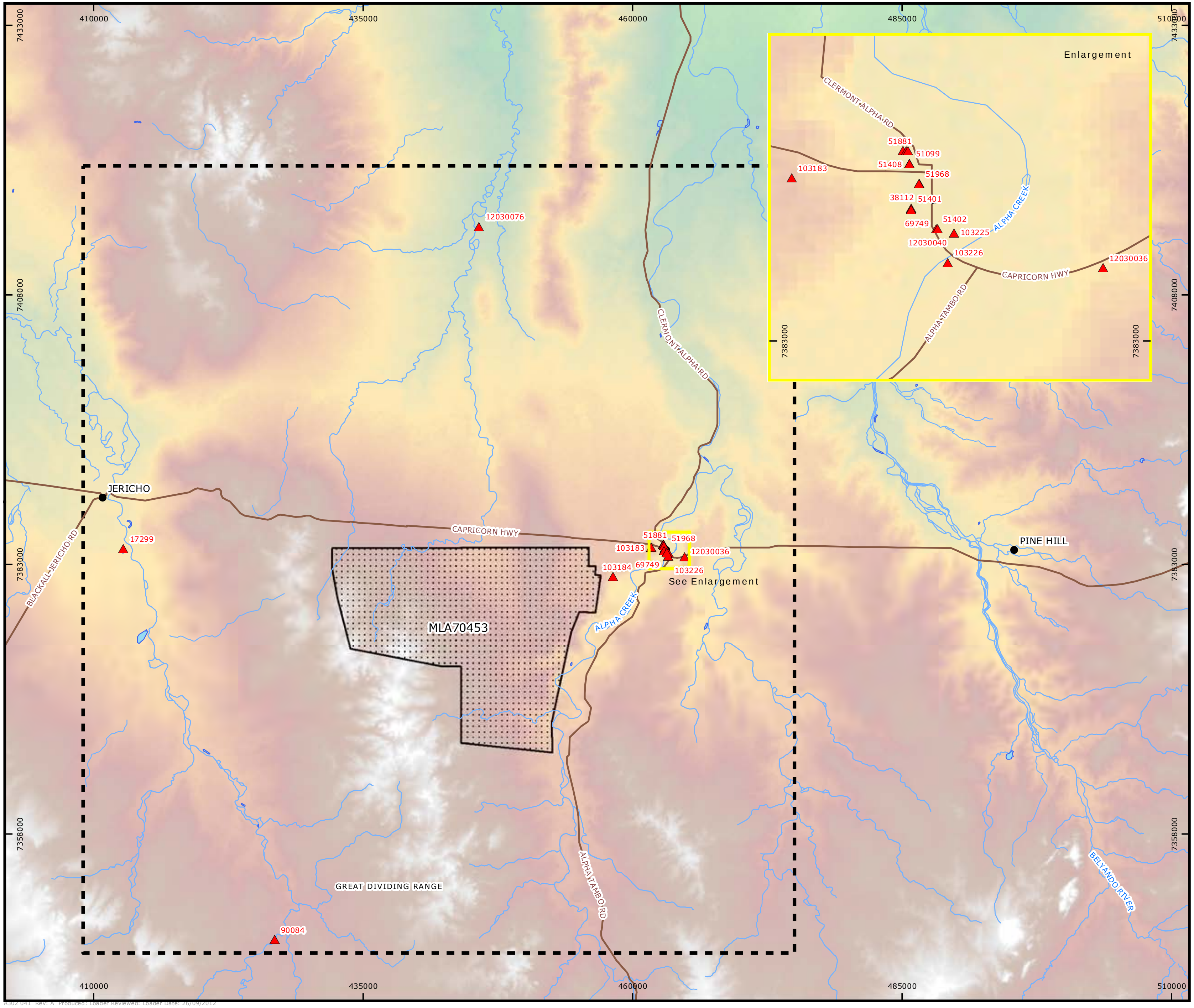
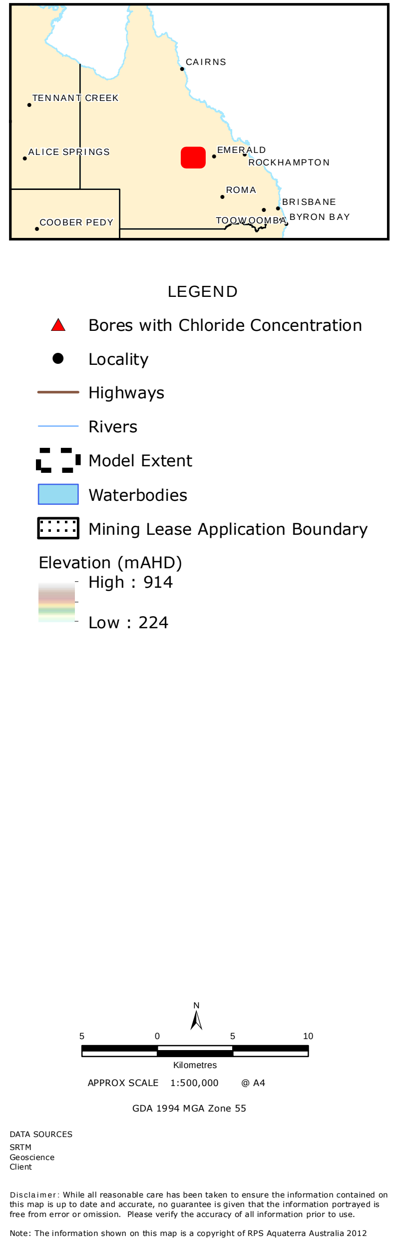
CRD and groundwater Levels in the Permian, Tertiary and Quaternary Sediments - FIGURE 4-4

F:\Jobs\A302C\600\R001\Figures\[CRD Analysis.xls]Figure_01





RPS Aquaterra

FIGURE 4-5

Location of Bores with Chloride Concentrations

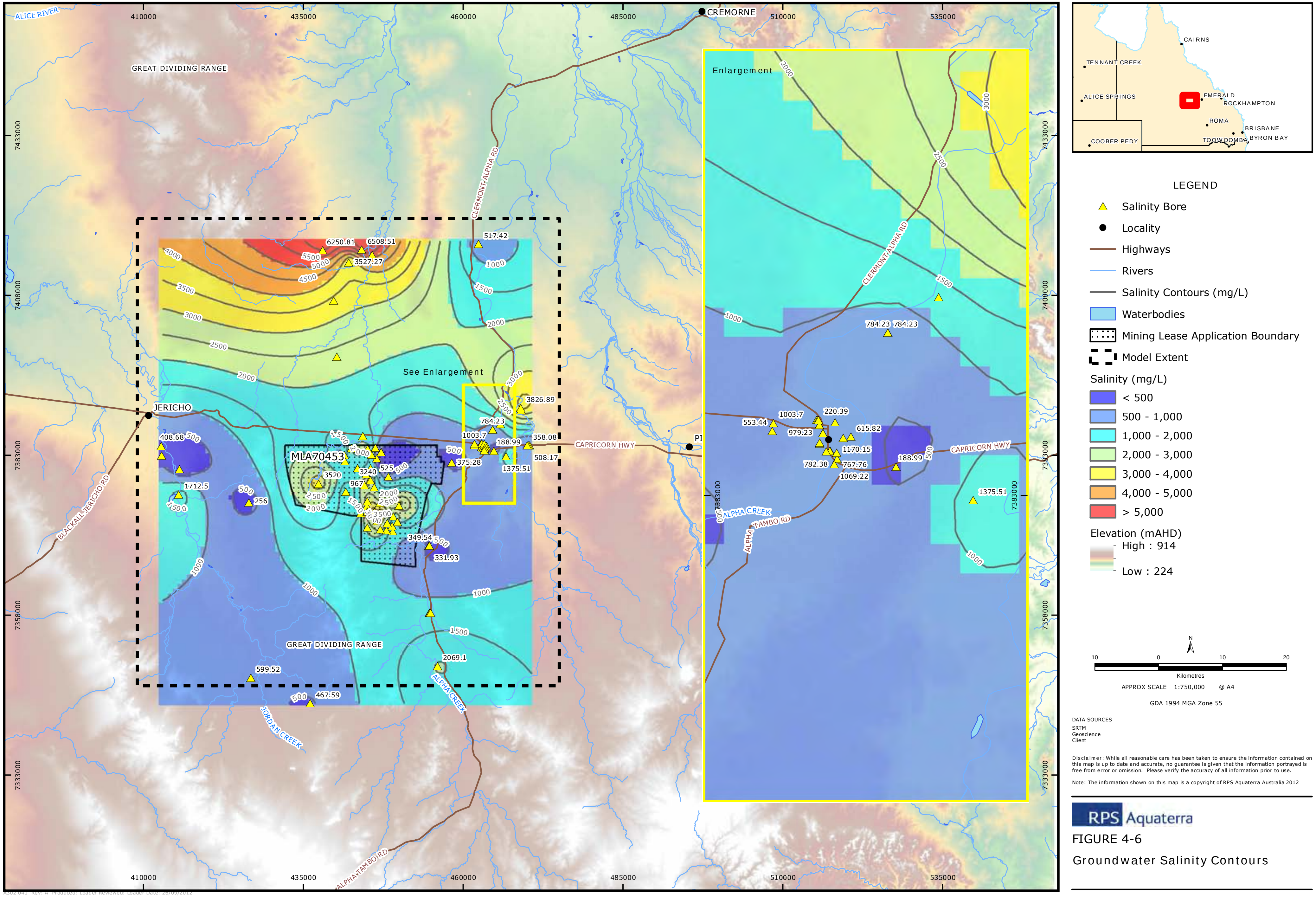
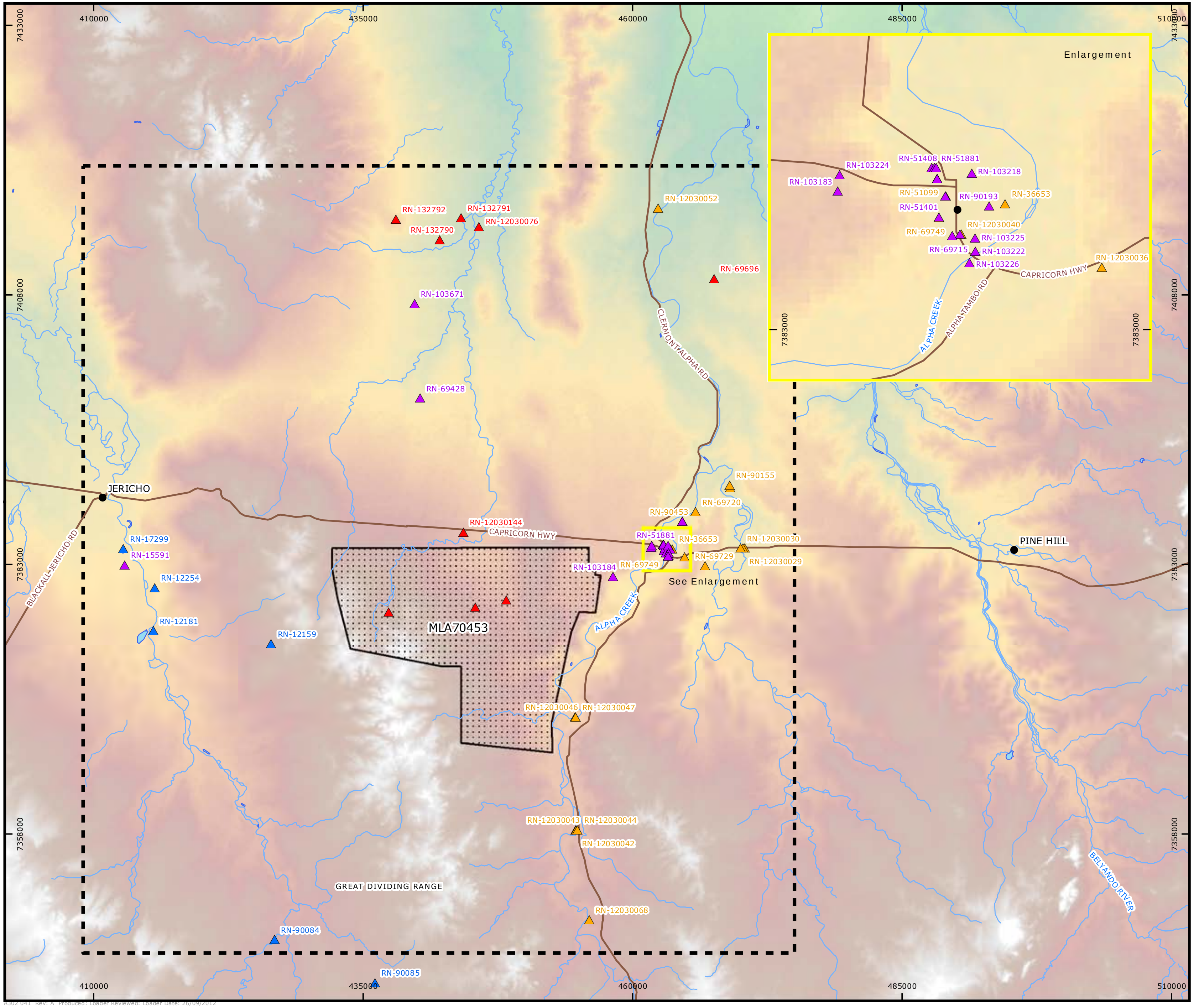
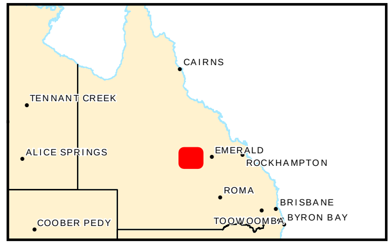


FIGURE 4-6

Groundwater Salinity Contours





LEGEND

Ion Tested Bore
- Quaternary
- Permian
- Tertiary
- Triassic

- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

5 0 5 10
Kilometres

APPROX SCALE 1:500,000 @ A4

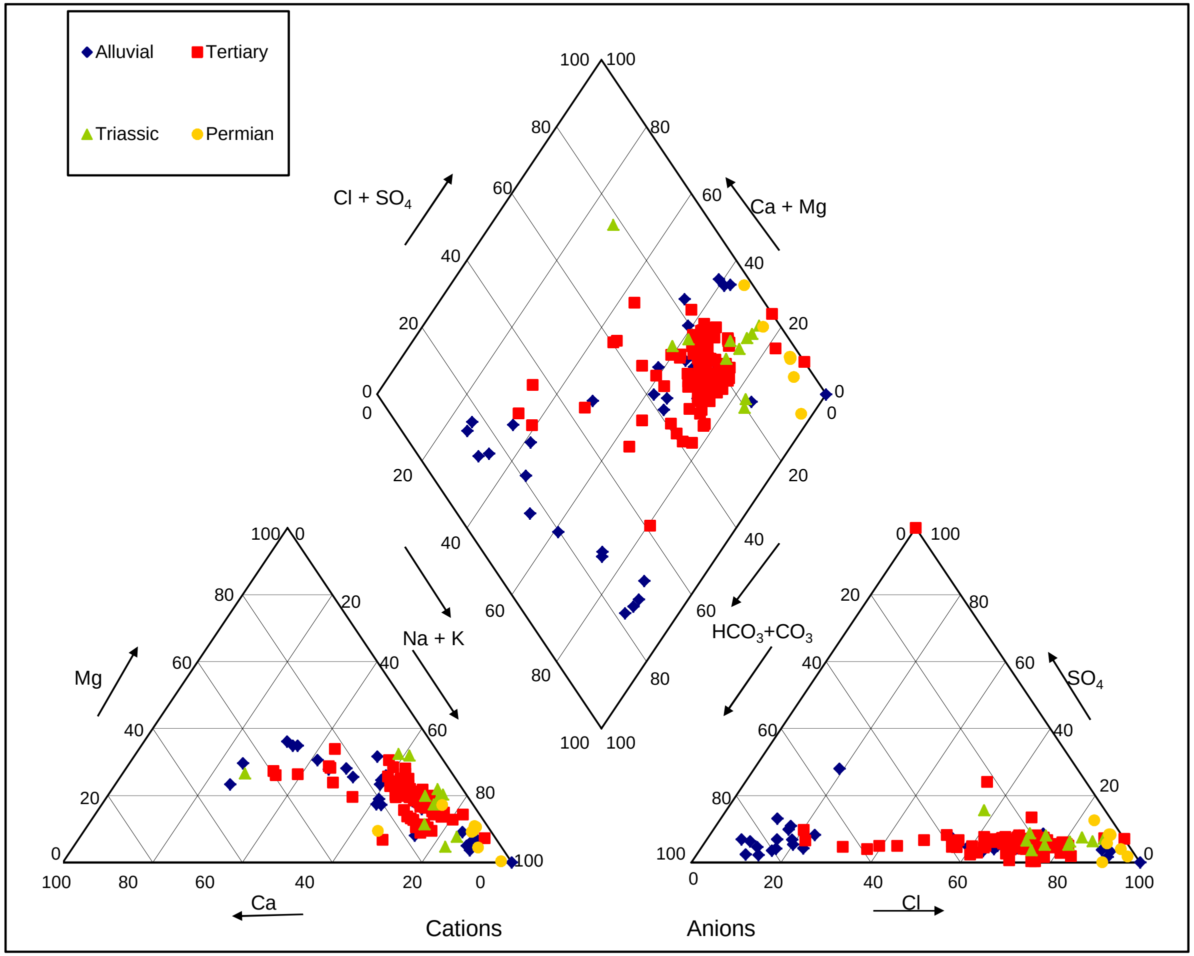
GDA 1994 MGA Zone 55

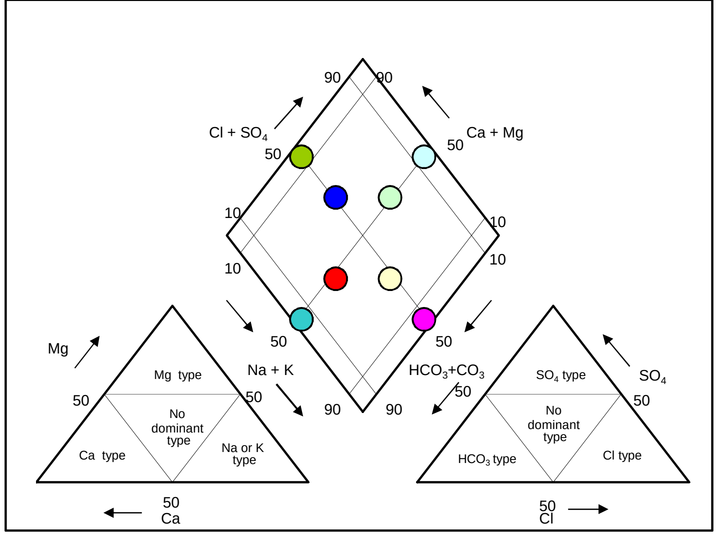
DATA SOURCES
SRTM
Geoscience
Client

RPS Aquaterra

FIGURE 4-7

Location of Bores Tested for Major Ions





WATER TYPE SUB-FIELDS

- Ca + Mg, Na + K type
- Ca + Mg type
- HCO_3, Cl + SO_4 type
- HCO_3 + CO_3 type
- Na + K, Ca + Mg type
- Na + K type
- Cl + SO_4, HCO_3 type
- Cl + SO_4 type

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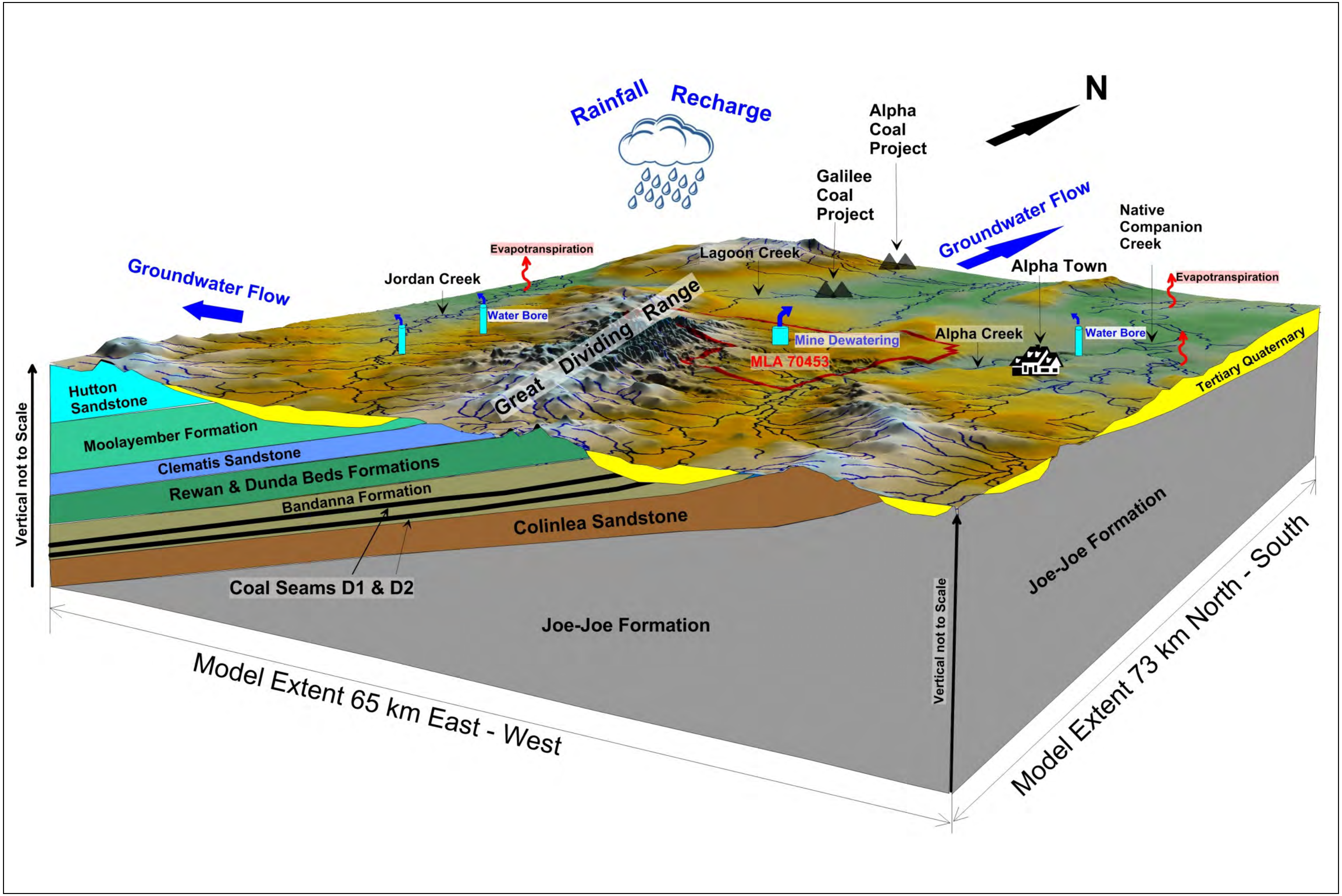
Piper Diagram

Figure 4-8

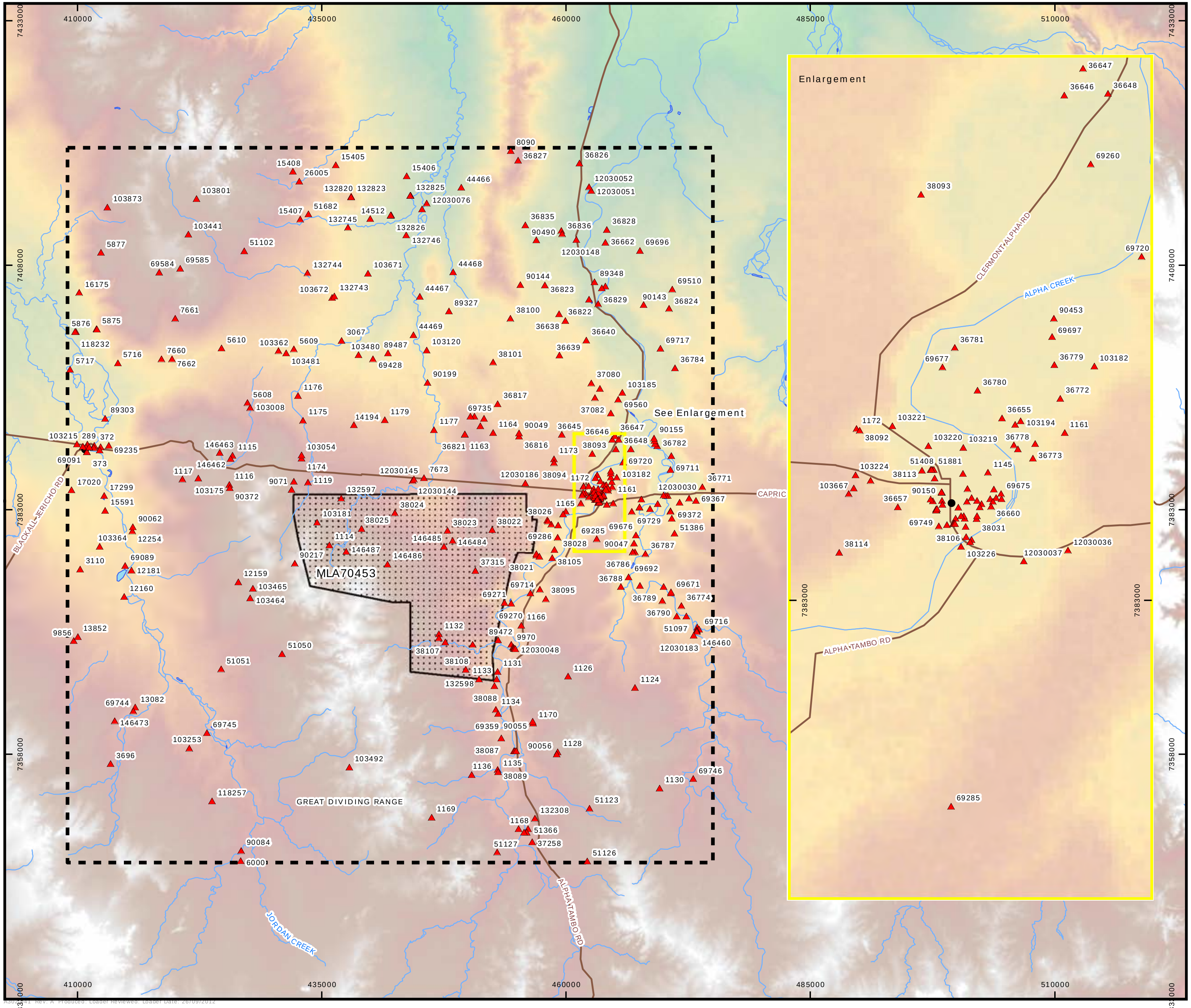
Date: 18/09/12	Project: South Galilee Coal Project	Description: Hydrogeological Assessment and Modelling	HydroCHEM 2.0
F:\Jobs\A302C\300\360 Analysis\Hydrochemistry analysis\[HydroCHEM2.0_SGCP.xls]Project Information	Project No: A302C	Client: Mining and Energy Technical Services Pty Ltd	

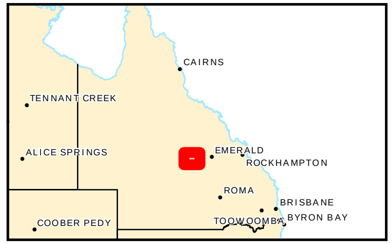


RPS Aquaterra

SGCP HYDROGEOLOGICAL CONCEPTUAL MODEL FIGURE 4-9

f:\jobs\a302c\600\r001\figures\fig 4-9 conceptual groundwater model.docx





LEGEND

- Registered Bore (DNRM Data)
- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

Kilometres
APPROX SCALE 1:550,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
DNRM

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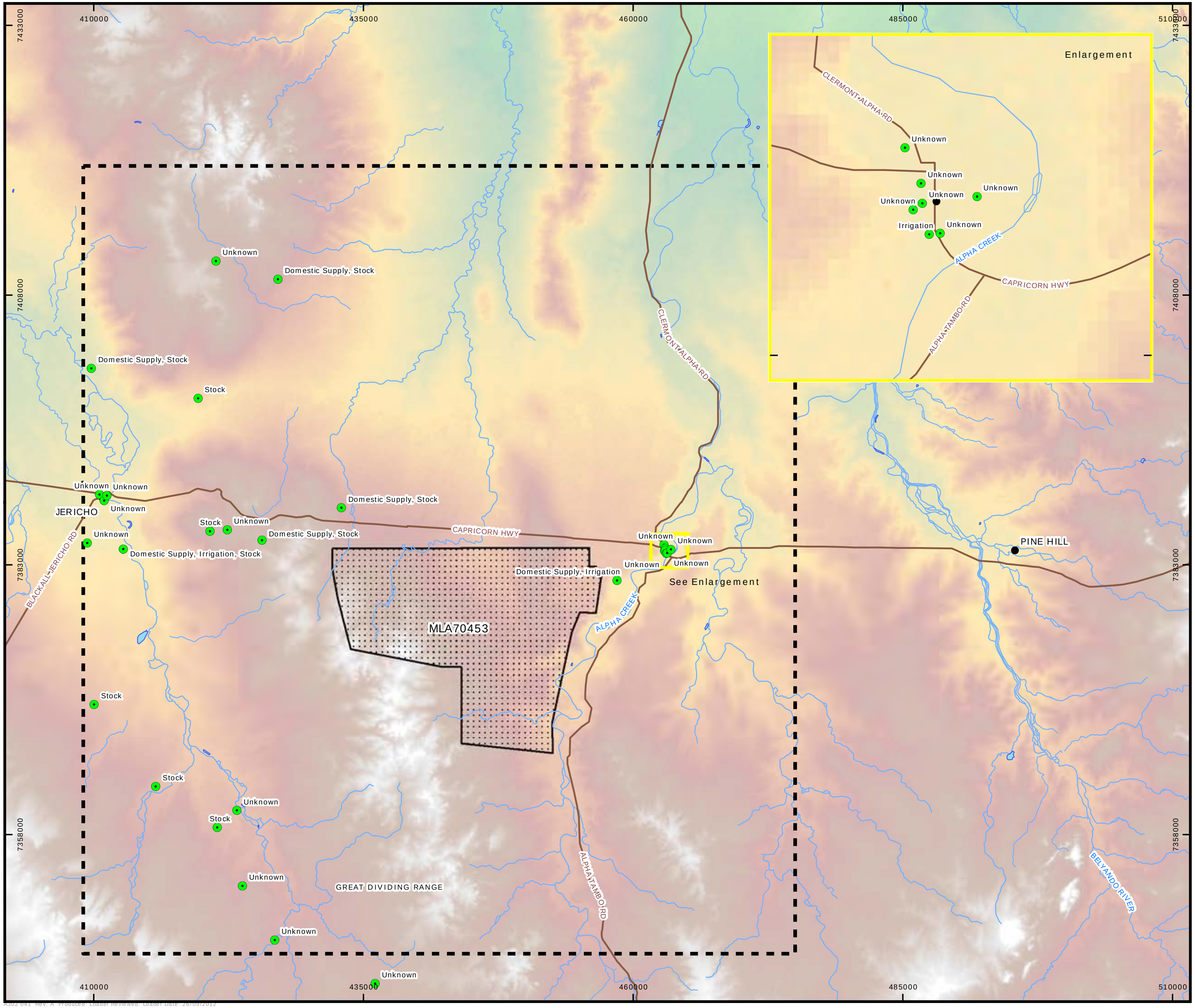
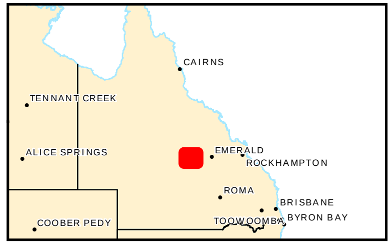
FIGURE 5.1

Location of Registered Bores (DNRM Data)





LEGEND

- Licensed Bore
- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

5 0 5 10
Kilometres

APPROX SCALE 1:500,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
Client

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Note: The information shown on this map is a copyright of RPS Aquaterra Australia 2012

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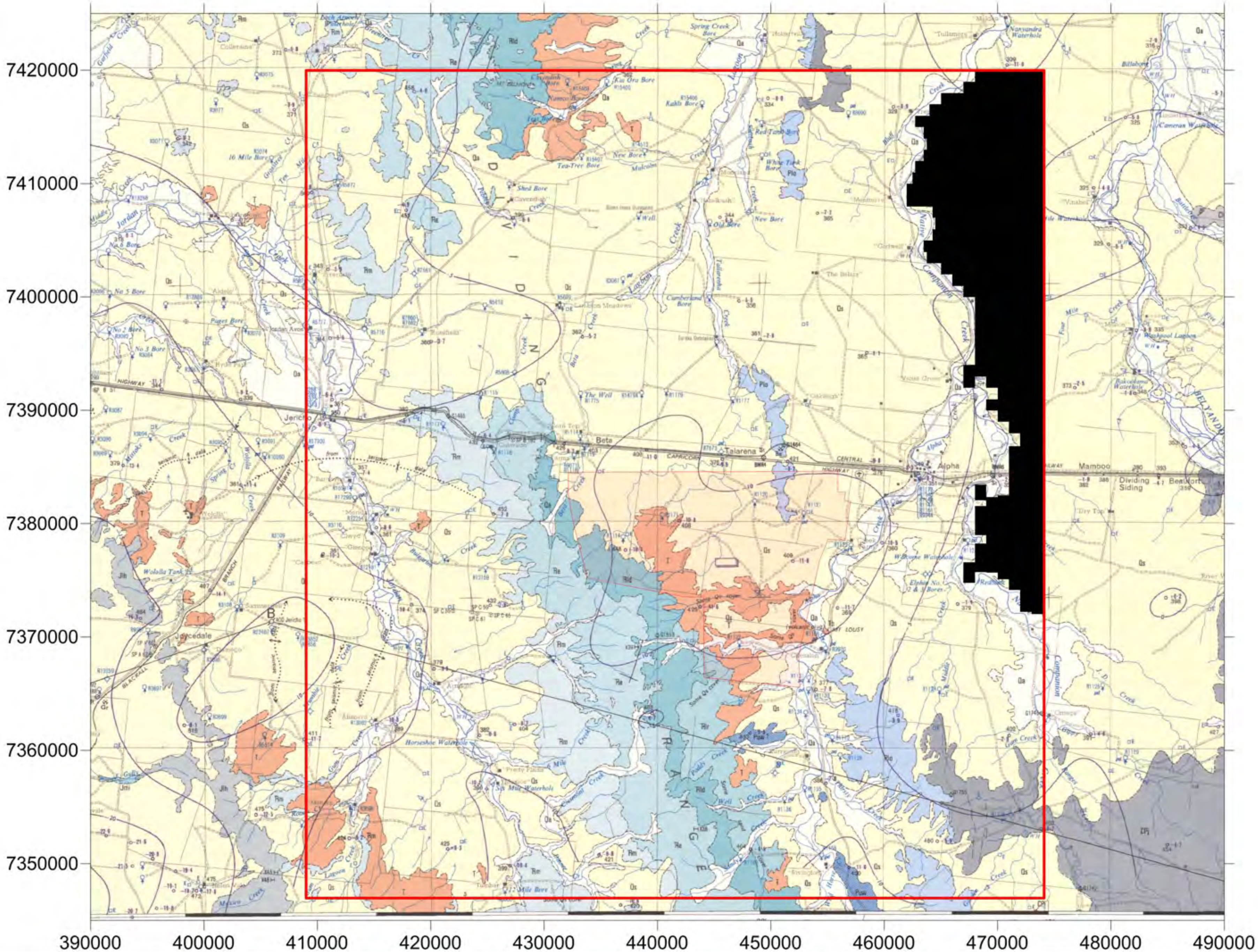
FIGURE 5.2

Location of Licensed Bores and Groundwater Use



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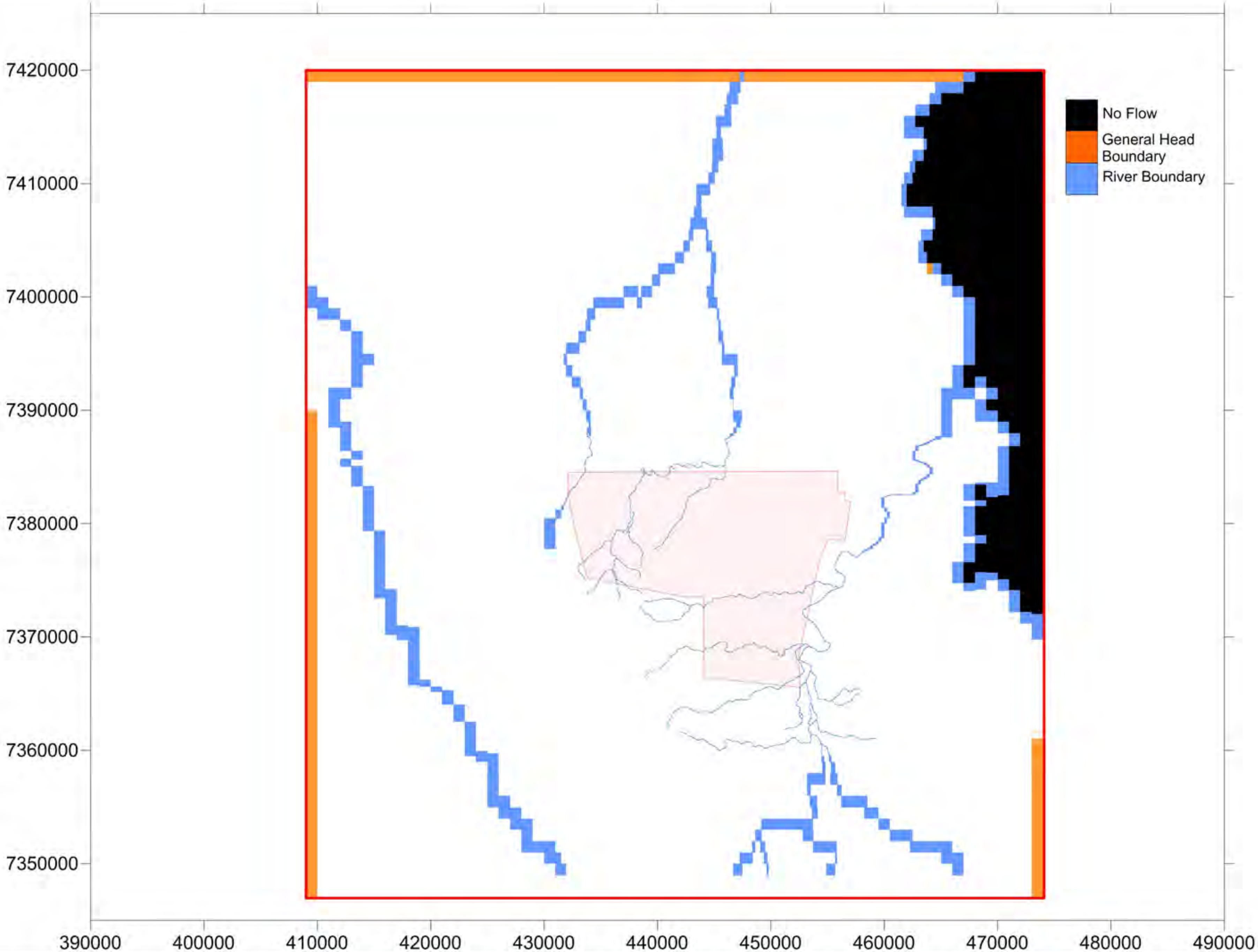
SOUTH GALILEE - MODEL DOMAIN FIGURE 6.1

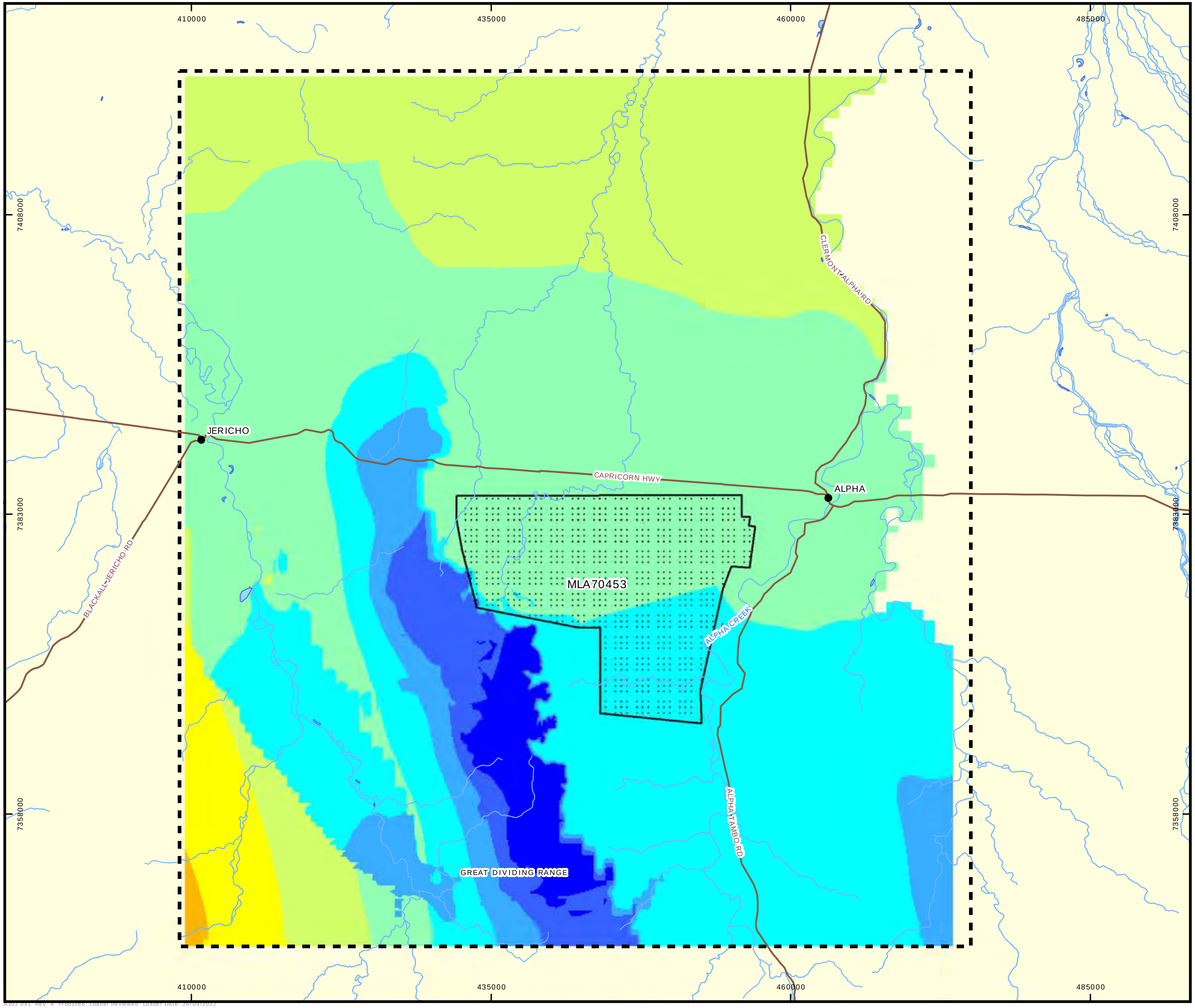
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf

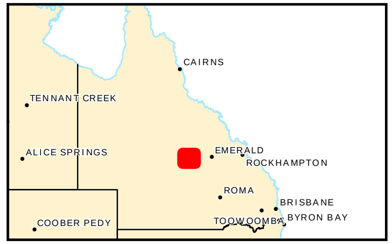


RPS Aquaterra

SOUTH GALILEE - BOUNDARY CONDITIONS FIGURE 6.2

F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

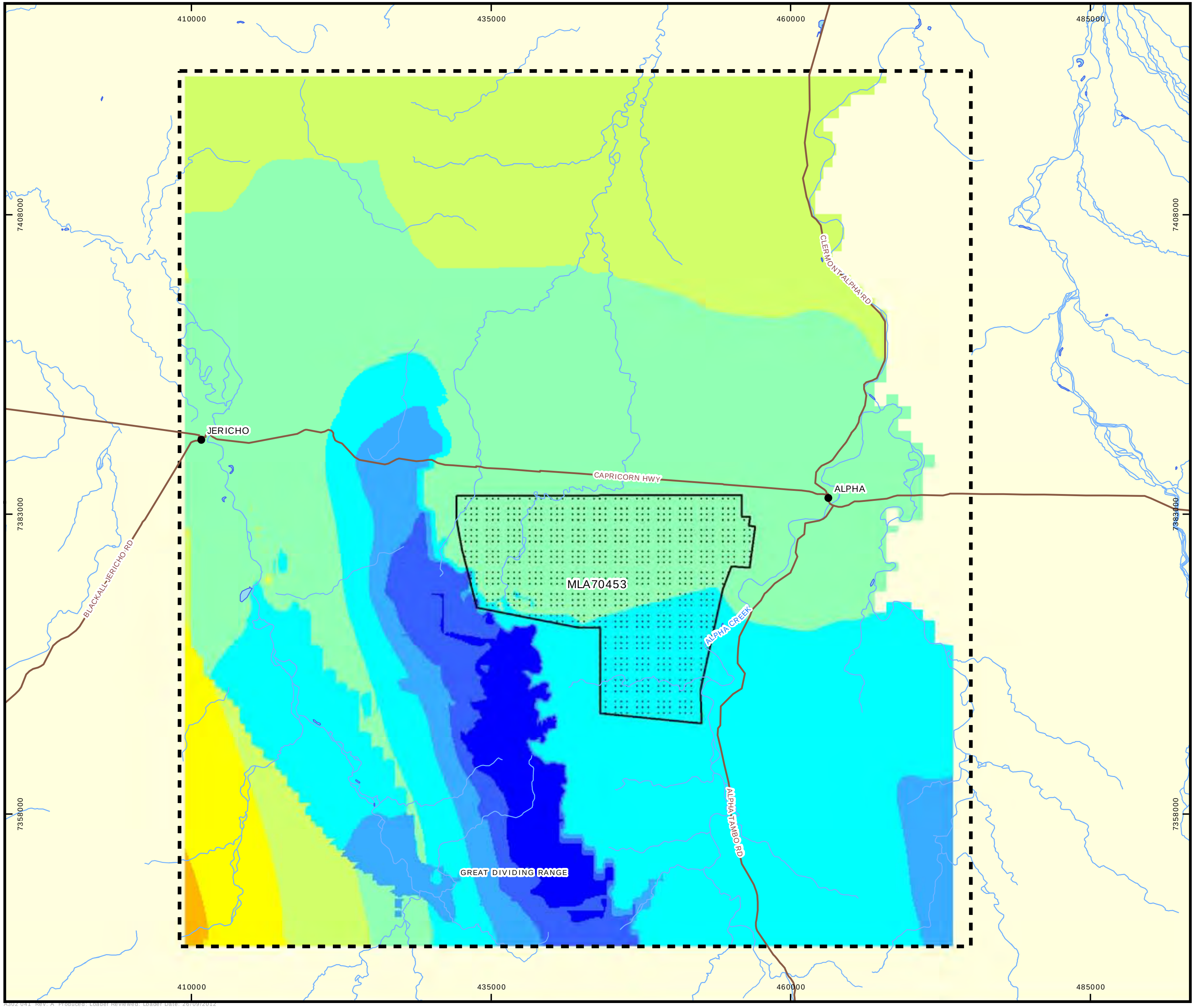
GDA 1994 MGA Zone 55

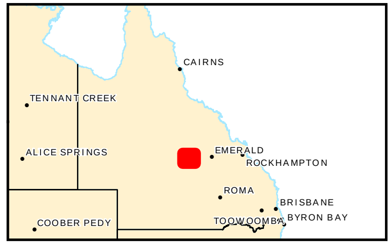
DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

FIGURE 6.3

Groundwater Existing Environment
- Calibrated Steady State Water Table





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

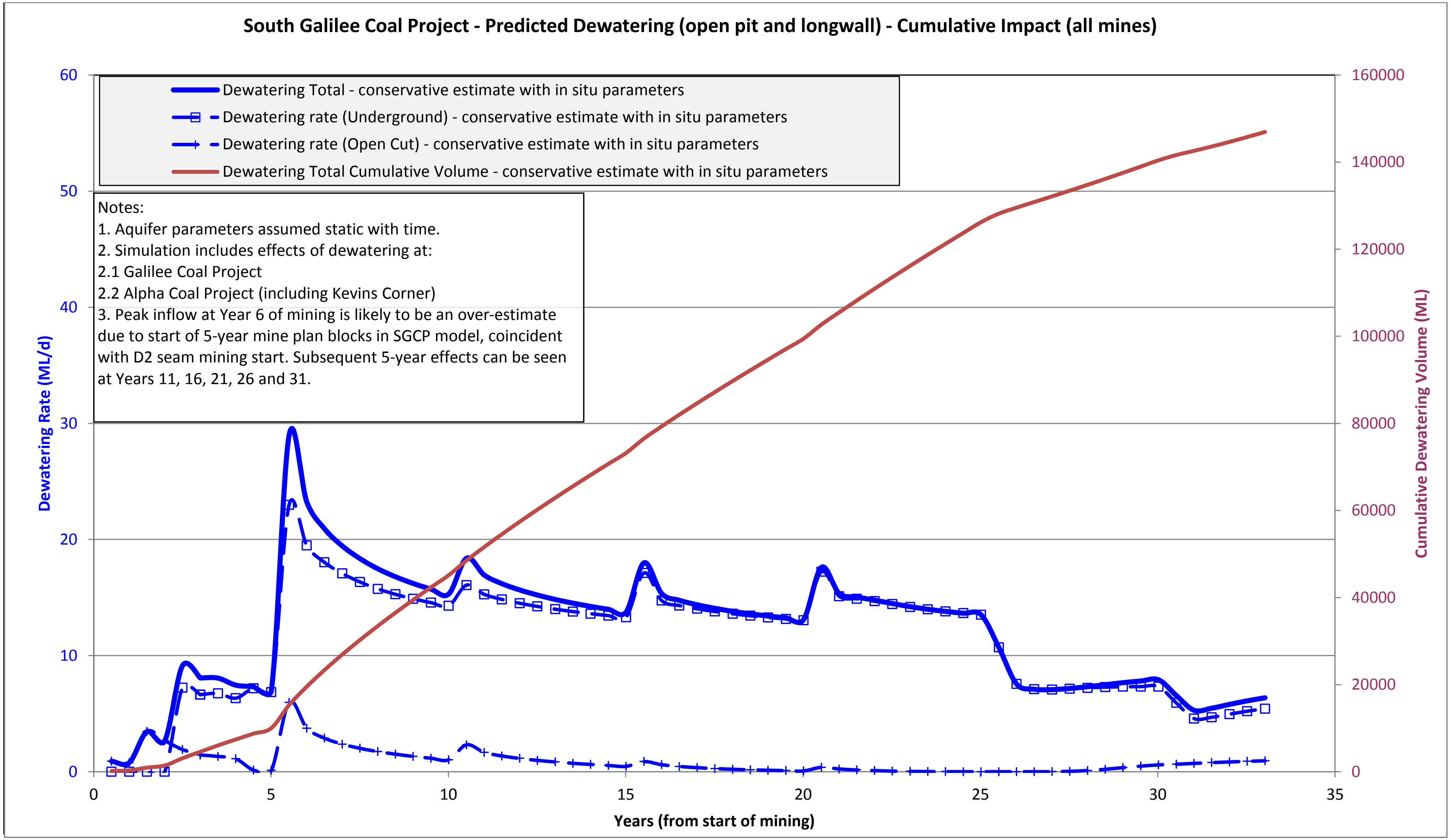
GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

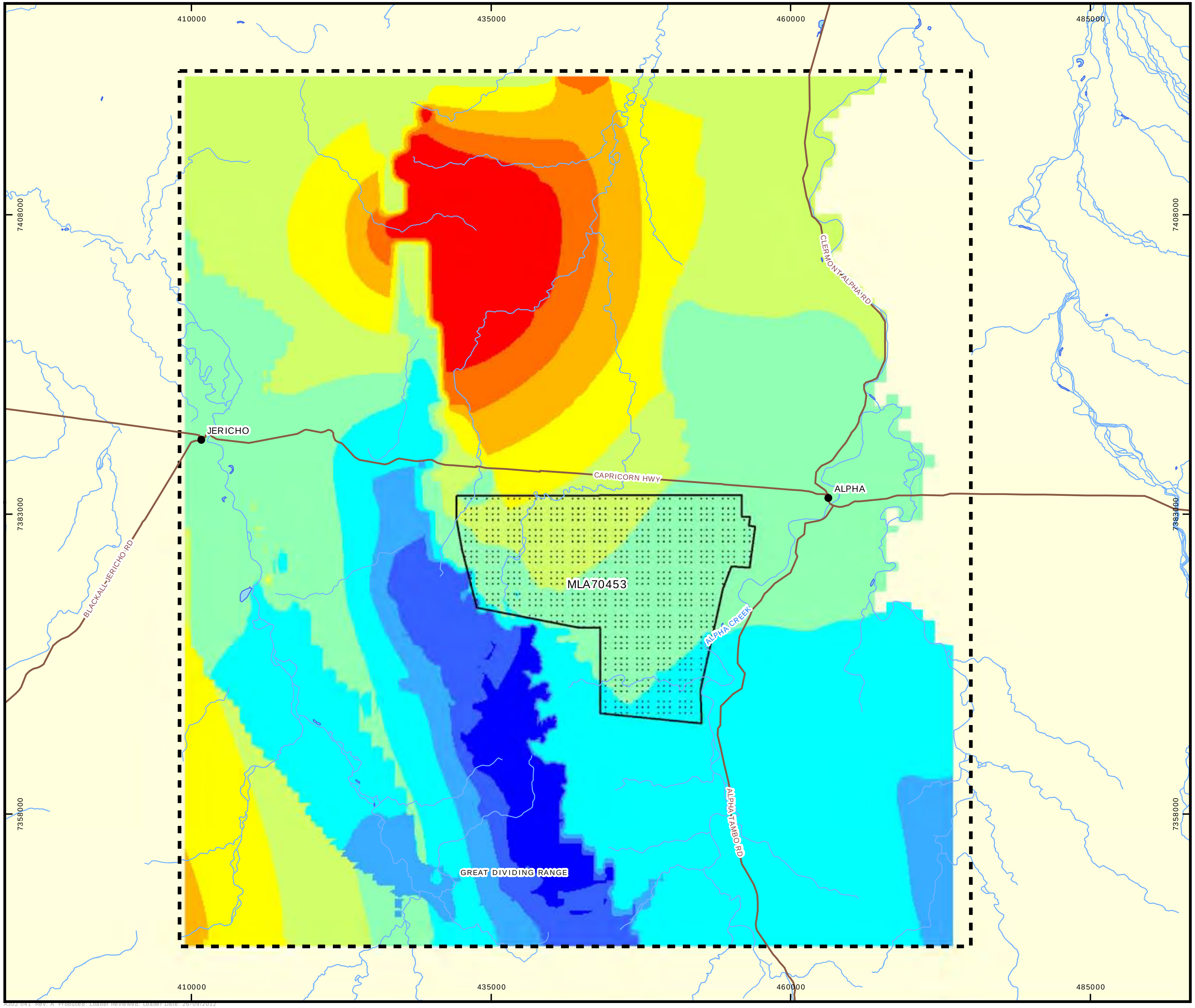
FIGURE 6.4

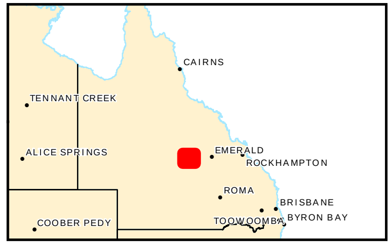
SGCP Model Water Table at end of transient calibration (Jan. 2011)



Predicted SGCP mine dewatering (cumulative impact, in situ parameters) FIGURE 7-1

F:\Jobs\A302C\300\Model_Output\[Dewatering_rates_insitu_parameters_Run25.xlsx]Report Fig7-1





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

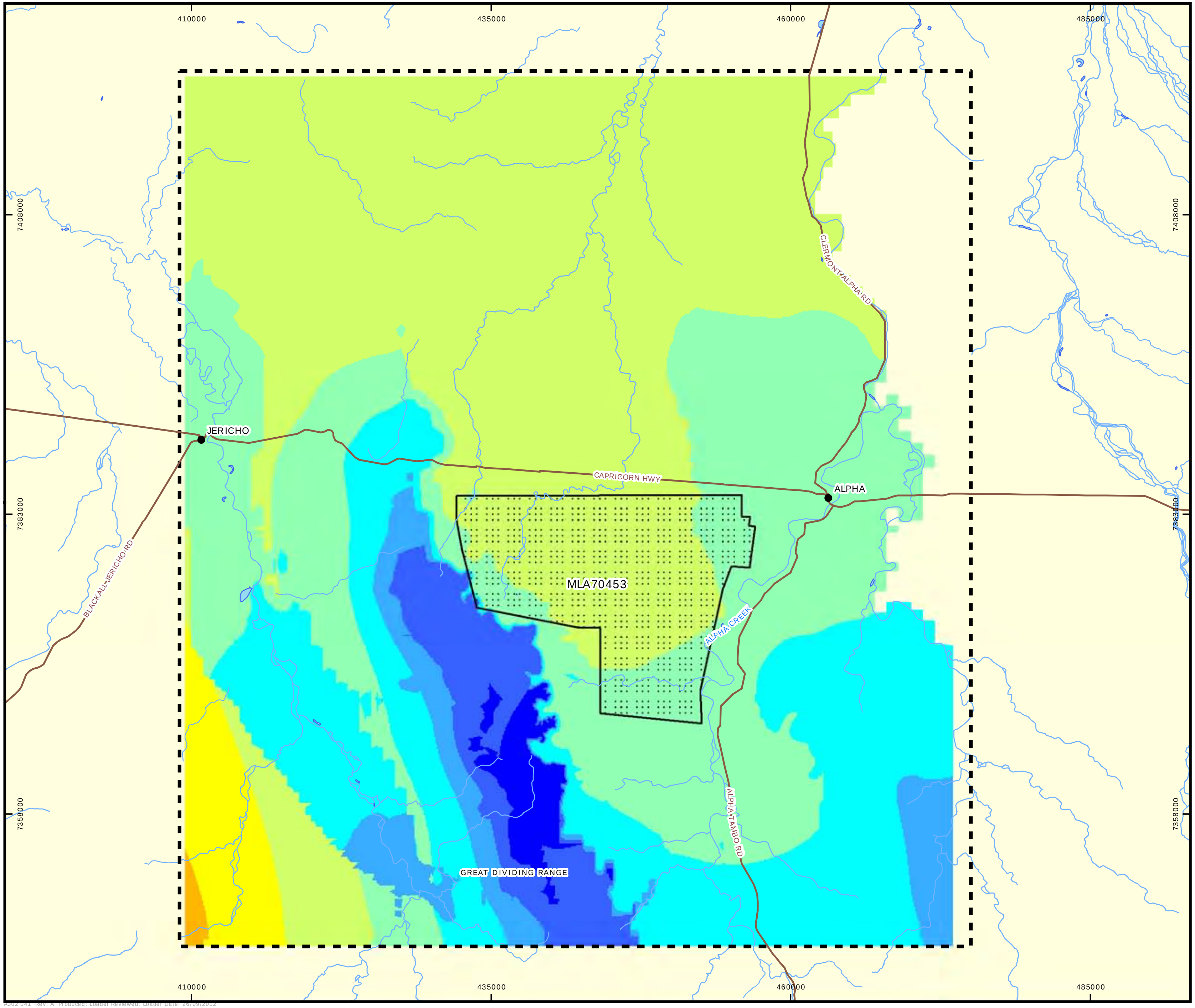
DATA SOURCES
SRTM
Geoscience
RPS

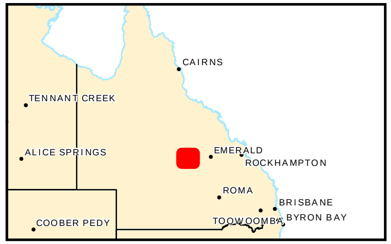
RPS Aquaterra

FIGURE 7.2

SGCP Water Table level after 33 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

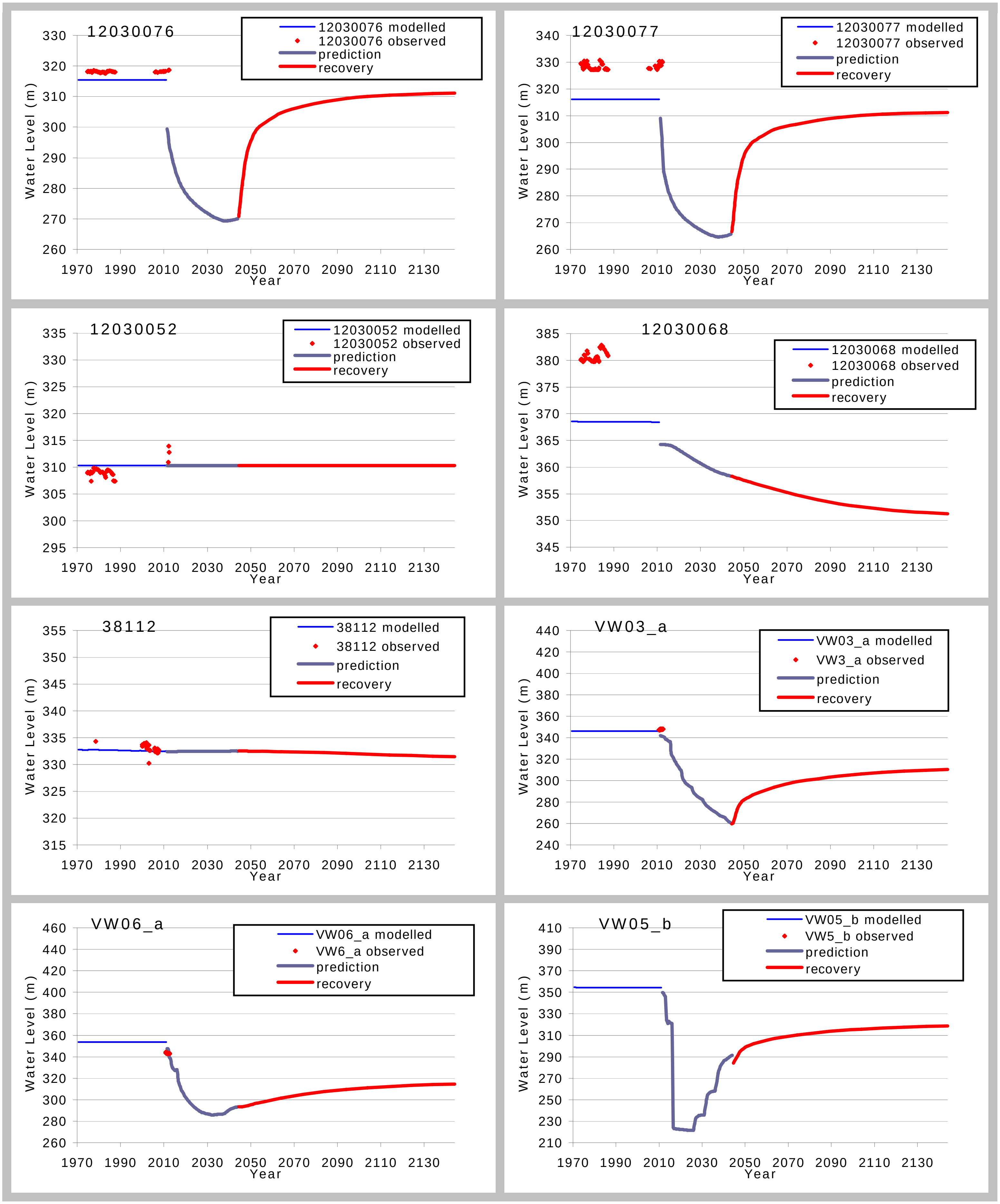
APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

FIGURE 7.3
SGCP Water Table 100 years after cessation of mining (post mining recovery, in-situ parameters)



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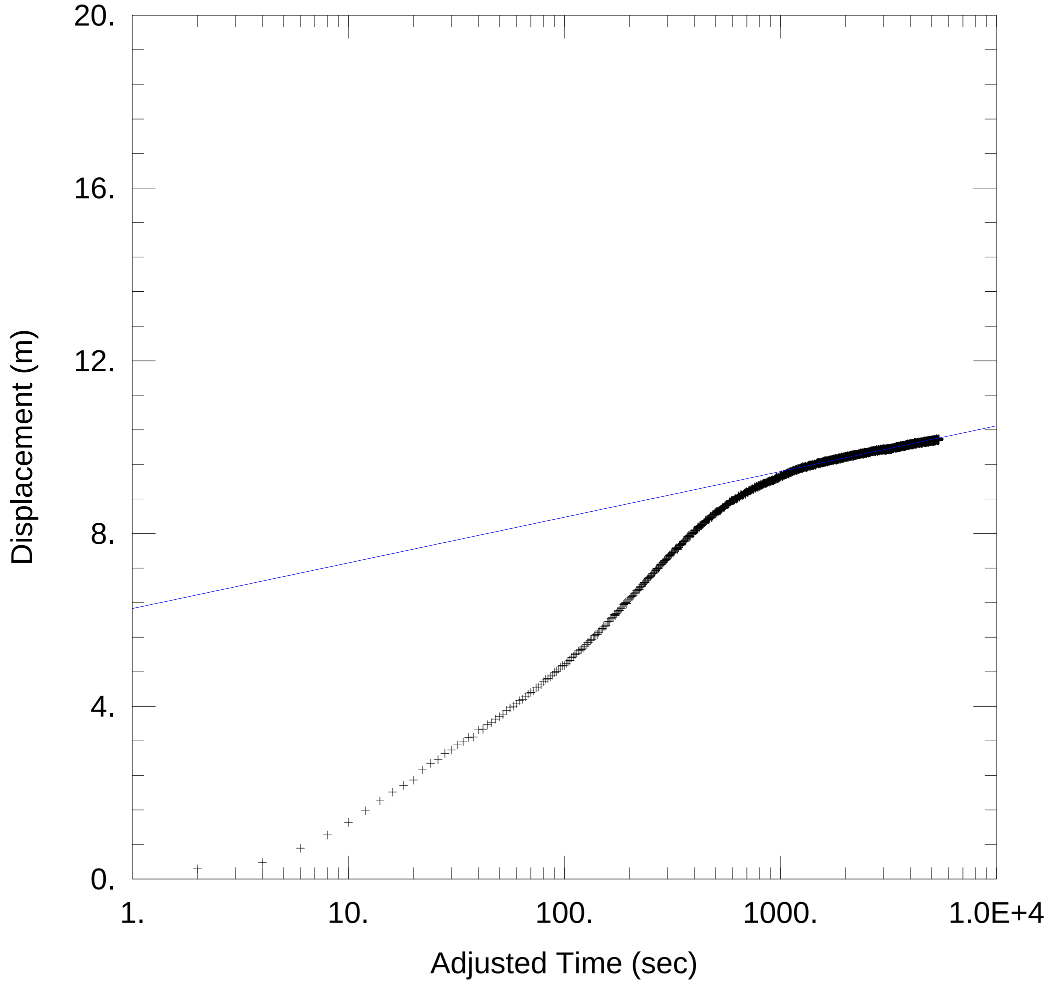
SOUTH GALILEE MODELLED HYDROGRAPHS FIGURE 7.4

F:\Jobs\A302C\600\R001\Figures\Fig7_4.xls

APPENDIX A:
AQUIFER TEST RESULTS



MB03_PUMPING TEST

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB3_CH01_AS Jacob.aqt
Date: 09/24/12 Time: 08:54:12

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Well: MB03
Test Date: 10/09/2011

AQUIFER DATA

Saturated Thickness: 70. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MB03	445383	7379099

Observation Wells

Well Name	X (m)	Y (m)
+ MB03	445383	7379099

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 14.97 m^2/day S = 4.658E-8

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB3_CH01_AS Jacob.aqt
Title: MB03_Pumping Test
Date: 09/24/12
Time: 08:53:37

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Date: 10/09/2011
Test Well: MB03

AQUIFER DATA

Saturated Thickness: 70. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: MB03

X Location: 445383. m
Y Location: 7379099. m

Casing Radius: 0.05 m
Well Radius: 0.1 m

Partially Penetrating Well
Depth to Top of Screen: 49.63 m
Depth to Bottom of Screen: 60.63 m

No. of pumping periods: 2

Pumping Period Data

Time (sec)	Rate (cu. m/sec)	Time (sec)	Rate (cu. m/sec)
0.	0.001	5424.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: MB03

X Location: 445383. m
Y Location: 7379099. m

Radial distance from MB03: 0. m

Partially Penetrating Well
Depth to Top of Screen: 49.63 m
Depth to Bottom of Screen: 60.63 m

No. of Observations: 3020

Observation Data

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2.	0.2367	3022.	9.948
4.	0.3833	3024.	9.955
6.	0.7122	3026.	9.948
8.	1.021	3028.	9.933
10.	1.312	3030.	9.942
12.	1.581	3032.	9.94
14.	1.808	3034.	9.928
16.	2.012	3036.	9.927

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
18.	2.168	3038.	9.934
20.	2.29	3040.	9.954
22.	2.528	3042.	9.95
24.	2.678	3044.	9.964
26.	2.766	3046.	9.945
28.	2.911	3048.	9.94
30.	2.986	3050.	9.948
32.	3.105	3052.	9.955
34.	3.176	3054.	9.958
36.	3.278	3056.	9.956
38.	3.286	3058.	9.939
40.	3.454	3060.	9.933
42.	3.469	3062.	9.93
44.	3.577	3064.	9.949
46.	3.621	3066.	9.963
48.	3.703	3068.	9.957
50.	3.761	3070.	9.943
52.	3.802	3072.	9.944
54.	3.906	3074.	9.942
56.	3.966	3076.	9.928
58.	4.003	3078.	9.949
60.	4.058	3080.	9.97
62.	4.13	3082.	9.947
64.	4.162	3084.	9.953
66.	4.219	3086.	9.927
68.	4.287	3088.	9.935
70.	4.319	3090.	9.931
72.	4.352	3092.	9.943
74.	4.426	3094.	9.96
76.	4.447	3096.	9.965
78.	4.493	3098.	9.952
80.	4.569	3100.	9.944
82.	4.629	3102.	9.928
84.	4.643	3104.	9.944
86.	4.678	3106.	9.944
88.	4.719	3108.	9.963
90.	4.788	3110.	9.96
92.	4.81	3112.	9.967
94.	4.86	3114.	9.968
96.	4.914	3116.	9.944
98.	4.946	3118.	9.938
100.	4.94	3120.	9.976
102.	4.996	3122.	9.974
104.	5.047	3124.	9.95
106.	5.062	3126.	9.958
108.	5.13	3128.	9.945
110.	5.16	3130.	9.94
112.	5.202	3132.	9.943
114.	5.226	3134.	9.952
116.	5.282	3136.	9.947
118.	5.299	3138.	9.953
120.	5.315	3140.	9.941
122.	5.345	3142.	9.941
124.	5.39	3144.	9.949
126.	5.429	3146.	9.982
128.	5.473	3148.	9.958
130.	5.485	3150.	9.963
132.	5.521	3152.	9.956
134.	5.55	3154.	9.944
136.	5.605	3156.	9.937
138.	5.636	3158.	9.945
140.	5.665	3160.	9.957
142.	5.665	3162.	9.971
144.	5.712	3164.	9.97
146.	5.743	3166.	9.963
148.	5.77	3168.	9.964

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
150.	5.801	3170.	9.954
152.	5.859	3172.	9.935
154.	5.842	3174.	9.941
156.	5.866	3176.	9.939
158.	5.952	3178.	9.945
160.	5.962	3180.	9.955
162.	5.953	3182.	9.947
164.	6.027	3184.	9.945
166.	6.059	3186.	9.964
168.	6.048	3188.	9.962
170.	6.125	3190.	9.976
172.	6.103	3192.	9.967
174.	6.149	3194.	9.973
176.	6.202	3196.	9.969
178.	6.214	3198.	9.966
180.	6.216	3200.	9.936
182.	6.254	3202.	9.955
184.	6.268	3204.	9.978
186.	6.3	3206.	9.962
188.	6.359	3208.	9.973
190.	6.38	3210.	9.957
192.	6.401	3212.	9.95
194.	6.38	3214.	9.949
196.	6.435	3216.	9.969
198.	6.463	3218.	9.982
200.	6.487	3220.	9.969
202.	6.514	3222.	9.951
204.	6.534	3224.	9.943
206.	6.546	3226.	9.952
208.	6.56	3228.	9.94
210.	6.607	3230.	9.946
212.	6.624	3232.	9.976
214.	6.641	3234.	9.96
216.	6.683	3236.	9.959
218.	6.694	3238.	9.974
220.	6.694	3240.	9.97
222.	6.707	3242.	9.943
224.	6.747	3244.	9.951
226.	6.767	3246.	9.953
228.	6.781	3248.	9.947
230.	6.815	3250.	9.951
232.	6.85	3252.	9.951
234.	6.866	3254.	9.954
236.	6.865	3256.	9.962
238.	6.876	3258.	9.97
240.	6.904	3260.	9.968
242.	6.925	3262.	9.958
244.	6.957	3264.	9.954
246.	6.981	3266.	9.94
248.	6.989	3268.	9.942
250.	7.	3270.	9.945
252.	7.024	3272.	9.959
254.	7.066	3274.	9.952
256.	7.067	3276.	9.947
258.	7.07	3278.	9.969
260.	7.091	3280.	9.989
262.	7.111	3282.	9.975
264.	7.141	3284.	9.985
266.	7.163	3286.	9.979
268.	7.191	3288.	9.966
270.	7.188	3290.	9.961
272.	7.187	3292.	9.957
274.	7.206	3294.	9.957
276.	7.224	3296.	9.96
278.	7.265	3298.	9.983
280.	7.282	3300.	9.98

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
282.	7.3	3302.	9.982
284.	7.322	3304.	9.973
286.	7.327	3306.	9.958
288.	7.345	3308.	9.97
290.	7.374	3310.	9.974
292.	7.369	3312.	9.99
294.	7.37	3314.	9.995
296.	7.398	3316.	9.985
298.	7.409	3318.	9.988
300.	7.428	3320.	9.973
302.	7.462	3322.	9.989
304.	7.477	3324.	9.976
306.	7.491	3326.	9.97
308.	7.508	3328.	9.962
310.	7.509	3330.	9.967
312.	7.546	3332.	9.963
314.	7.532	3334.	9.957
316.	7.566	3336.	9.964
318.	7.571	3338.	9.97
320.	7.564	3340.	9.96
322.	7.571	3342.	9.982
324.	7.617	3344.	9.977
326.	7.648	3346.	9.976
328.	7.65	3348.	9.996
330.	7.671	3350.	9.986
332.	7.656	3352.	9.98
334.	7.631	3354.	9.981
336.	7.664	3356.	9.986
338.	7.677	3358.	10.
340.	7.72	3360.	10.
342.	7.724	3362.	9.995
344.	7.717	3364.	9.989
346.	7.735	3366.	9.995
348.	7.745	3368.	9.985
350.	7.768	3370.	9.994
352.	7.78	3372.	10.
354.	7.803	3374.	10.
356.	7.813	3376.	9.995
358.	7.831	3378.	9.994
360.	7.825	3380.	9.989
362.	7.822	3382.	10.
364.	7.846	3384.	9.99
366.	7.873	3386.	9.995
368.	7.89	3388.	9.979
370.	7.896	3390.	9.988
372.	7.933	3392.	9.98
374.	7.926	3394.	9.975
376.	7.961	3396.	9.996
378.	7.957	3398.	10.
380.	7.933	3400.	10.
382.	7.99	3402.	10.01
384.	7.938	3404.	10.01
386.	7.989	3406.	10.
388.	8.01	3408.	10.
390.	7.999	3410.	9.991
392.	7.999	3412.	9.992
394.	7.988	3414.	9.984
396.	8.005	3416.	9.98
398.	8.025	3418.	9.989
400.	8.06	3420.	9.974
402.	8.067	3422.	9.98
404.	8.069	3424.	10.
406.	8.063	3426.	10.
408.	8.079	3428.	10.02
410.	8.083	3430.	10.02
412.	8.111	3432.	9.99

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
414.	8.138	3434.	9.994
416.	8.162	3436.	9.986
418.	8.145	3438.	9.978
420.	8.139	3440.	10.01
422.	8.147	3442.	10.01
424.	8.185	3444.	10.01
426.	8.194	3446.	9.987
428.	8.182	3448.	9.971
430.	8.176	3450.	9.99
432.	8.185	3452.	9.987
434.	8.205	3454.	10.01
436.	8.222	3456.	10.02
438.	8.213	3458.	10.
440.	8.219	3460.	9.983
442.	8.251	3462.	9.978
444.	8.255	3464.	9.982
446.	8.258	3466.	9.986
448.	8.274	3468.	10.01
450.	8.304	3470.	10.02
452.	8.308	3472.	10.02
454.	8.294	3474.	10.
456.	8.313	3476.	9.992
458.	8.318	3478.	9.983
460.	8.322	3480.	9.982
462.	8.326	3482.	9.982
464.	8.326	3484.	9.979
466.	8.328	3486.	9.998
468.	8.33	3488.	10.
470.	8.351	3490.	10.01
472.	8.381	3492.	10.
474.	8.408	3494.	10.01
476.	8.409	3496.	10.01
478.	8.378	3498.	10.03
480.	8.376	3500.	10.01
482.	8.374	3502.	10.01
484.	8.403	3504.	10.
486.	8.442	3506.	10.
488.	8.431	3508.	9.993
490.	8.446	3510.	10.02
492.	8.453	3512.	10.01
494.	8.444	3514.	10.01
496.	8.472	3516.	10.02
498.	8.484	3518.	10.02
500.	8.47	3520.	10.02
502.	8.498	3522.	9.994
504.	8.485	3524.	9.994
506.	8.508	3526.	9.985
508.	8.51	3528.	10.02
510.	8.519	3530.	10.02
512.	8.521	3532.	10.01
514.	8.496	3534.	10.
516.	8.511	3536.	9.991
518.	8.525	3538.	9.992
520.	8.524	3540.	9.986
522.	8.535	3542.	10.
524.	8.533	3544.	9.992
526.	8.535	3546.	10.01
528.	8.568	3548.	10.
530.	8.538	3550.	10.02
532.	8.557	3552.	10.03
534.	8.568	3554.	10.02
536.	8.58	3556.	10.
538.	8.592	3558.	9.982
540.	8.615	3560.	9.991
542.	8.618	3562.	9.991
544.	8.611	3564.	9.997

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
546.	8.602	3566.	9.997
548.	8.616	3568.	9.995
550.	8.607	3570.	10.
552.	8.636	3572.	10.01
554.	8.646	3574.	10.
556.	8.645	3576.	10.01
558.	8.643	3578.	10.01
560.	8.66	3580.	10.02
562.	8.671	3582.	10.02
564.	8.671	3584.	10.04
566.	8.676	3586.	10.04
568.	8.673	3588.	10.02
570.	8.674	3590.	10.01
572.	8.679	3592.	9.996
574.	8.681	3594.	9.998
576.	8.69	3596.	10.
578.	8.691	3598.	10.01
580.	8.726	3600.	10.03
582.	8.735	3602.	10.02
584.	8.757	3604.	10.01
586.	8.729	3606.	10.
588.	8.732	3608.	10.03
590.	8.731	3610.	10.04
592.	8.761	3612.	10.03
594.	8.761	3614.	10.02
596.	8.769	3616.	10.01
598.	8.762	3618.	10.01
600.	8.774	3620.	10.
602.	8.765	3622.	10.02
604.	8.773	3624.	10.03
606.	8.765	3626.	10.02
608.	8.772	3628.	10.
610.	8.773	3630.	10.
612.	8.786	3632.	10.
614.	8.779	3634.	10.01
616.	8.791	3636.	10.01
618.	8.803	3638.	10.01
620.	8.816	3640.	10.03
622.	8.814	3642.	10.03
624.	8.796	3644.	10.04
626.	8.803	3646.	10.04
628.	8.809	3648.	10.04
630.	8.813	3650.	10.02
632.	8.819	3652.	10.04
634.	8.817	3654.	10.03
636.	8.833	3656.	10.02
638.	8.869	3658.	10.01
640.	8.876	3660.	10.01
642.	8.846	3662.	10.02
644.	8.855	3664.	10.02
646.	8.838	3666.	10.02
648.	8.848	3668.	10.03
650.	8.87	3670.	10.04
652.	8.872	3672.	10.03
654.	8.887	3674.	10.05
656.	8.906	3676.	10.04
658.	8.914	3678.	10.04
660.	8.895	3680.	10.04
662.	8.886	3682.	10.03
664.	8.892	3684.	10.04
666.	8.894	3686.	10.02
668.	8.876	3688.	10.03
670.	8.871	3690.	10.03
672.	8.893	3692.	10.02
674.	8.907	3694.	10.01
676.	8.907	3696.	10.02

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
678.	8.922	3698.	10.03
680.	8.932	3700.	10.
682.	8.939	3702.	10.01
684.	8.938	3704.	10.01
686.	8.948	3706.	10.01
688.	8.929	3708.	10.02
690.	8.897	3710.	10.01
692.	8.95	3712.	10.04
694.	8.961	3714.	10.05
696.	8.964	3716.	10.05
698.	8.972	3718.	10.04
700.	8.96	3720.	10.05
702.	8.957	3722.	10.04
704.	8.955	3724.	10.03
706.	8.961	3726.	10.03
708.	8.952	3728.	10.04
710.	8.962	3730.	10.04
712.	8.987	3732.	10.04
714.	8.998	3734.	10.02
716.	8.986	3736.	10.03
718.	9.005	3738.	10.02
720.	8.999	3740.	10.03
722.	8.982	3742.	10.02
724.	8.992	3744.	10.01
726.	8.982	3746.	10.03
728.	8.992	3748.	10.03
730.	9.02	3750.	10.01
732.	9.036	3752.	10.02
734.	9.005	3754.	10.04
736.	9.014	3756.	10.05
738.	9.008	3758.	10.05
740.	9.034	3760.	10.03
742.	9.04	3762.	10.03
744.	9.034	3764.	10.01
746.	9.02	3766.	10.04
748.	9.015	3768.	10.06
750.	9.026	3770.	10.05
752.	9.024	3772.	10.05
754.	9.039	3774.	10.05
756.	9.057	3776.	10.03
758.	9.065	3778.	10.03
760.	9.083	3780.	10.02
762.	9.079	3782.	10.04
764.	9.074	3784.	10.05
766.	9.048	3786.	10.05
768.	9.052	3788.	10.06
770.	9.06	3790.	10.06
772.	9.07	3792.	10.04
774.	9.091	3794.	10.04
776.	9.081	3796.	10.04
778.	9.098	3798.	10.04
780.	9.106	3800.	10.01
782.	9.08	3802.	10.02
784.	9.072	3804.	10.04
786.	9.08	3806.	10.03
788.	9.07	3808.	10.03
790.	9.096	3810.	10.04
792.	9.111	3812.	10.05
794.	9.118	3814.	10.06
796.	9.099	3816.	10.05
798.	9.114	3818.	10.03
800.	9.124	3820.	10.03
802.	9.092	3822.	10.03
804.	9.096	3824.	10.05
806.	9.106	3826.	10.05
808.	9.113	3828.	10.06

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
810.	9.136	3830.	10.05
812.	9.148	3832.	10.07
814.	9.137	3834.	10.06
816.	9.125	3836.	10.05
818.	9.113	3838.	10.04
820.	9.12	3840.	10.04
822.	9.152	3842.	10.03
824.	9.155	3844.	10.04
826.	9.135	3846.	10.04
828.	9.129	3848.	10.03
830.	9.132	3850.	10.04
832.	9.139	3852.	10.04
834.	9.159	3854.	10.06
836.	9.163	3856.	10.07
838.	9.163	3858.	10.05
840.	9.172	3860.	10.03
842.	9.164	3862.	10.04
844.	9.164	3864.	10.05
846.	9.176	3866.	10.07
848.	9.16	3868.	10.07
850.	9.176	3870.	10.07
852.	9.152	3872.	10.08
854.	9.167	3874.	10.07
856.	9.162	3876.	10.07
858.	9.158	3878.	10.07
860.	9.168	3880.	10.08
862.	9.168	3882.	10.07
864.	9.188	3884.	10.07
866.	9.198	3886.	10.06
868.	9.203	3888.	10.05
870.	9.188	3890.	10.07
872.	9.173	3892.	10.05
874.	9.181	3894.	10.04
876.	9.195	3896.	10.04
878.	9.205	3898.	10.03
880.	9.221	3900.	10.05
882.	9.195	3902.	10.06
884.	9.193	3904.	10.06
886.	9.204	3906.	10.07
888.	9.188	3908.	10.07
890.	9.196	3910.	10.06
892.	9.216	3912.	10.05
894.	9.236	3914.	10.04
896.	9.223	3916.	10.04
898.	9.218	3918.	10.03
900.	9.202	3920.	10.05
902.	9.207	3922.	10.06
904.	9.196	3924.	10.06
906.	9.218	3926.	10.07
908.	9.226	3928.	10.08
910.	9.236	3930.	10.08
912.	9.238	3932.	10.06
914.	9.229	3934.	10.06
916.	9.248	3936.	10.03
918.	9.228	3938.	10.05
920.	9.225	3940.	10.05
922.	9.229	3942.	10.07
924.	9.243	3944.	10.07
926.	9.223	3946.	10.08
928.	9.237	3948.	10.05
930.	9.225	3950.	10.05
932.	9.239	3952.	10.04
934.	9.219	3954.	10.05
936.	9.249	3956.	10.07
938.	9.25	3958.	10.07
940.	9.247	3960.	10.07

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
942.	9.254	3962.	10.06
944.	9.244	3964.	10.08
946.	9.284	3966.	10.08
948.	9.289	3968.	10.08
950.	9.272	3970.	10.07
952.	9.253	3972.	10.08
954.	9.251	3974.	10.07
956.	9.269	3976.	10.06
958.	9.3	3978.	10.06
960.	9.296	3980.	10.06
962.	9.279	3982.	10.05
964.	9.286	3984.	10.06
966.	9.268	3986.	10.05
968.	9.268	3988.	10.05
970.	9.281	3990.	10.06
972.	9.269	3992.	10.09
974.	9.3	3994.	10.09
976.	9.293	3996.	10.09
978.	9.298	3998.	10.08
980.	9.298	4000.	10.08
982.	9.269	4002.	10.08
984.	9.289	4004.	10.07
986.	9.286	4006.	10.07
988.	9.286	4008.	10.08
990.	9.292	4010.	10.08
992.	9.314	4012.	10.07
994.	9.316	4014.	10.07
996.	9.335	4016.	10.05
998.	9.345	4018.	10.05
1000.	9.325	4020.	10.05
1002.	9.314	4022.	10.05
1004.	9.319	4024.	10.06
1006.	9.306	4026.	10.07
1008.	9.341	4028.	10.07
1010.	9.349	4030.	10.07
1012.	9.359	4032.	10.09
1014.	9.366	4034.	10.07
1016.	9.338	4036.	10.09
1018.	9.333	4038.	10.07
1020.	9.328	4040.	10.07
1022.	9.318	4042.	10.07
1024.	9.324	4044.	10.05
1026.	9.328	4046.	10.05
1028.	9.354	4048.	10.05
1030.	9.373	4050.	10.06
1032.	9.372	4052.	10.07
1034.	9.344	4054.	10.06
1036.	9.353	4056.	10.06
1038.	9.359	4058.	10.07
1040.	9.36	4060.	10.05
1042.	9.368	4062.	10.07
1044.	9.375	4064.	10.06
1046.	9.348	4066.	10.06
1048.	9.346	4068.	10.08
1050.	9.367	4070.	10.1
1052.	9.383	4072.	10.08
1054.	9.369	4074.	10.08
1056.	9.356	4076.	10.07
1058.	9.363	4078.	10.07
1060.	9.357	4080.	10.06
1062.	9.39	4082.	10.07
1064.	9.398	4084.	10.05
1066.	9.401	4086.	10.05
1068.	9.387	4088.	10.08
1070.	9.368	4090.	10.09
1072.	9.366	4092.	10.07

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1074.	9.385	4094.	10.08
1076.	9.391	4096.	10.07
1078.	9.394	4098.	10.05
1080.	9.409	4100.	10.05
1082.	9.419	4102.	10.06
1084.	9.39	4104.	10.06
1086.	9.389	4106.	10.06
1088.	9.392	4108.	10.07
1090.	9.395	4110.	10.06
1092.	9.417	4112.	10.07
1094.	9.393	4114.	10.09
1096.	9.372	4116.	10.08
1098.	9.416	4118.	10.09
1100.	9.427	4120.	10.1
1102.	9.434	4122.	10.1
1104.	9.402	4124.	10.09
1106.	9.408	4126.	10.09
1108.	9.409	4128.	10.09
1110.	9.414	4130.	10.08
1112.	9.418	4132.	10.09
1114.	9.444	4134.	10.07
1116.	9.441	4136.	10.07
1118.	9.412	4138.	10.06
1120.	9.414	4140.	10.08
1122.	9.416	4142.	10.06
1124.	9.427	4144.	10.06
1126.	9.439	4146.	10.07
1128.	9.446	4148.	10.08
1130.	9.446	4150.	10.07
1132.	9.42	4152.	10.08
1134.	9.428	4154.	10.07
1136.	9.445	4156.	10.08
1138.	9.46	4158.	10.09
1140.	9.44	4160.	10.1
1142.	9.443	4162.	10.1
1144.	9.442	4164.	10.09
1146.	9.452	4166.	10.11
1148.	9.451	4168.	10.1
1150.	9.475	4170.	10.09
1152.	9.471	4172.	10.1
1154.	9.463	4174.	10.09
1156.	9.442	4176.	10.09
1158.	9.454	4178.	10.08
1160.	9.45	4180.	10.06
1162.	9.445	4182.	10.08
1164.	9.46	4184.	10.1
1166.	9.473	4186.	10.11
1168.	9.482	4188.	10.1
1170.	9.47	4190.	10.11
1172.	9.48	4192.	10.1
1174.	9.466	4194.	10.11
1176.	9.467	4196.	10.1
1178.	9.455	4198.	10.1
1180.	9.489	4200.	10.08
1182.	9.49	4202.	10.09
1184.	9.483	4204.	10.08
1186.	9.451	4206.	10.08
1188.	9.458	4208.	10.08
1190.	9.482	4210.	10.07
1192.	9.481	4212.	10.08
1194.	9.476	4214.	10.09
1196.	9.473	4216.	10.11
1198.	9.468	4218.	10.1
1200.	9.469	4220.	10.1
1202.	9.495	4222.	10.08
1204.	9.516	4224.	10.09

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1206.	9.516	4226.	10.06
1208.	9.482	4228.	10.06
1210.	9.484	4230.	10.1
1212.	9.486	4232.	10.1
1214.	9.479	4234.	10.11
1216.	9.508	4236.	10.09
1218.	9.515	4238.	10.1
1220.	9.493	4240.	10.09
1222.	9.483	4242.	10.09
1224.	9.493	4244.	10.1
1226.	9.505	4246.	10.1
1228.	9.518	4248.	10.08
1230.	9.505	4250.	10.08
1232.	9.502	4252.	10.08
1234.	9.502	4254.	10.06
1236.	9.507	4256.	10.07
1238.	9.511	4258.	10.07
1240.	9.513	4260.	10.08
1242.	9.513	4262.	10.07
1244.	9.532	4264.	10.08
1246.	9.513	4266.	10.08
1248.	9.527	4268.	10.08
1250.	9.51	4270.	10.09
1252.	9.531	4272.	10.09
1254.	9.526	4274.	10.1
1256.	9.516	4276.	10.09
1258.	9.503	4278.	10.11
1260.	9.504	4280.	10.12
1262.	9.508	4282.	10.11
1264.	9.535	4284.	10.11
1266.	9.553	4286.	10.11
1268.	9.513	4288.	10.09
1270.	9.512	4290.	10.09
1272.	9.522	4292.	10.1
1274.	9.531	4294.	10.1
1276.	9.532	4296.	10.11
1278.	9.522	4298.	10.11
1280.	9.531	4300.	10.11
1282.	9.532	4302.	10.09
1284.	9.527	4304.	10.09
1286.	9.553	4306.	10.09
1288.	9.562	4308.	10.09
1290.	9.549	4310.	10.1
1292.	9.539	4312.	10.11
1294.	9.532	4314.	10.12
1296.	9.535	4316.	10.11
1298.	9.528	4318.	10.1
1300.	9.525	4320.	10.11
1302.	9.529	4322.	10.11
1304.	9.557	4324.	10.11
1306.	9.55	4326.	10.11
1308.	9.566	4328.	10.11
1310.	9.539	4330.	10.12
1312.	9.542	4332.	10.11
1314.	9.534	4334.	10.12
1316.	9.544	4336.	10.1
1318.	9.529	4338.	10.11
1320.	9.533	4340.	10.1
1322.	9.536	4342.	10.11
1324.	9.538	4344.	10.11
1326.	9.56	4346.	10.12
1328.	9.53	4348.	10.11
1330.	9.547	4350.	10.11
1332.	9.541	4352.	10.11
1334.	9.544	4354.	10.1
1336.	9.545	4356.	10.1

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1338.	9.559	4358.	10.08
1340.	9.568	4360.	10.1
1342.	9.578	4362.	10.1
1344.	9.572	4364.	10.09
1346.	9.579	4366.	10.1
1348.	9.576	4368.	10.11
1350.	9.575	4370.	10.1
1352.	9.565	4372.	10.1
1354.	9.555	4374.	10.11
1356.	9.551	4376.	10.13
1358.	9.554	4378.	10.1
1360.	9.579	4380.	10.11
1362.	9.589	4382.	10.1
1364.	9.584	4384.	10.11
1366.	9.562	4386.	10.12
1368.	9.578	4388.	10.11
1370.	9.597	4390.	10.09
1372.	9.582	4392.	10.09
1374.	9.554	4394.	10.09
1376.	9.567	4396.	10.08
1378.	9.574	4398.	10.1
1380.	9.579	4400.	10.08
1382.	9.592	4402.	10.09
1384.	9.582	4404.	10.09
1386.	9.588	4406.	10.09
1388.	9.595	4408.	10.12
1390.	9.582	4410.	10.12
1392.	9.579	4412.	10.11
1394.	9.578	4414.	10.11
1396.	9.567	4416.	10.11
1398.	9.57	4418.	10.11
1400.	9.574	4420.	10.1
1402.	9.586	4422.	10.1
1404.	9.603	4424.	10.1
1406.	9.611	4426.	10.1
1408.	9.594	4428.	10.12
1410.	9.584	4430.	10.12
1412.	9.567	4432.	10.11
1414.	9.581	4434.	10.12
1416.	9.582	4436.	10.12
1418.	9.577	4438.	10.12
1420.	9.587	4440.	10.11
1422.	9.571	4442.	10.12
1424.	9.58	4444.	10.11
1426.	9.594	4446.	10.09
1428.	9.587	4448.	10.09
1430.	9.594	4450.	10.1
1432.	9.612	4452.	10.11
1434.	9.615	4454.	10.12
1436.	9.595	4456.	10.11
1438.	9.595	4458.	10.12
1440.	9.605	4460.	10.11
1442.	9.588	4462.	10.12
1444.	9.602	4464.	10.12
1446.	9.601	4466.	10.12
1448.	9.598	4468.	10.1
1450.	9.59	4470.	10.1
1452.	9.601	4472.	10.1
1454.	9.574	4474.	10.1
1456.	9.606	4476.	10.1
1458.	9.602	4478.	10.09
1460.	9.604	4480.	10.1
1462.	9.614	4482.	10.1
1464.	9.603	4484.	10.12
1466.	9.613	4486.	10.12
1468.	9.623	4488.	10.12

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1470.	9.613	4490.	10.12
1472.	9.637	4492.	10.13
1474.	9.631	4494.	10.13
1476.	9.632	4496.	10.13
1478.	9.635	4498.	10.11
1480.	9.633	4500.	10.11
1482.	9.643	4502.	10.1
1484.	9.641	4504.	10.1
1486.	9.625	4506.	10.1
1488.	9.642	4508.	10.09
1490.	9.641	4510.	10.1
1492.	9.608	4512.	10.1
1494.	9.61	4514.	10.11
1496.	9.634	4516.	10.11
1498.	9.644	4518.	10.11
1500.	9.648	4520.	10.11
1502.	9.612	4522.	10.09
1504.	9.608	4524.	10.09
1506.	9.614	4526.	10.11
1508.	9.641	4528.	10.09
1510.	9.641	4530.	10.1
1512.	9.649	4532.	10.1
1514.	9.628	4534.	10.1
1516.	9.614	4536.	10.11
1518.	9.633	4538.	10.09
1520.	9.638	4540.	10.1
1522.	9.614	4542.	10.09
1524.	9.629	4544.	10.1
1526.	9.658	4546.	10.11
1528.	9.63	4548.	10.12
1530.	9.627	4550.	10.12
1532.	9.654	4552.	10.12
1534.	9.641	4554.	10.14
1536.	9.623	4556.	10.1
1538.	9.643	4558.	10.1
1540.	9.656	4560.	10.1
1542.	9.636	4562.	10.11
1544.	9.658	4564.	10.1
1546.	9.661	4566.	10.12
1548.	9.632	4568.	10.11
1550.	9.652	4570.	10.11
1552.	9.646	4572.	10.12
1554.	9.637	4574.	10.13
1556.	9.65	4576.	10.13
1558.	9.658	4578.	10.13
1560.	9.645	4580.	10.12
1562.	9.633	4582.	10.12
1564.	9.668	4584.	10.11
1566.	9.663	4586.	10.11
1568.	9.635	4588.	10.11
1570.	9.647	4590.	10.13
1572.	9.659	4592.	10.13
1574.	9.655	4594.	10.13
1576.	9.63	4596.	10.13
1578.	9.676	4598.	10.13
1580.	9.656	4600.	10.14
1582.	9.643	4602.	10.14
1584.	9.654	4604.	10.13
1586.	9.677	4606.	10.13
1588.	9.636	4608.	10.13
1590.	9.66	4610.	10.14
1592.	9.68	4612.	10.13
1594.	9.645	4614.	10.12
1596.	9.654	4616.	10.12
1598.	9.689	4618.	10.15
1600.	9.661	4620.	10.12

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1602.	9.648	4622.	10.13
1604.	9.675	4624.	10.12
1606.	9.674	4626.	10.12
1608.	9.674	4628.	10.12
1610.	9.648	4630.	10.1
1612.	9.65	4632.	10.12
1614.	9.659	4634.	10.11
1616.	9.682	4636.	10.1
1618.	9.694	4638.	10.1
1620.	9.661	4640.	10.14
1622.	9.665	4642.	10.13
1624.	9.658	4644.	10.13
1626.	9.682	4646.	10.14
1628.	9.693	4648.	10.13
1630.	9.668	4650.	10.14
1632.	9.658	4652.	10.14
1634.	9.666	4654.	10.13
1636.	9.678	4656.	10.14
1638.	9.662	4658.	10.13
1640.	9.666	4660.	10.13
1642.	9.689	4662.	10.14
1644.	9.669	4664.	10.15
1646.	9.65	4666.	10.15
1648.	9.665	4668.	10.15
1650.	9.689	4670.	10.11
1652.	9.658	4672.	10.13
1654.	9.678	4674.	10.14
1656.	9.684	4676.	10.13
1658.	9.678	4678.	10.13
1660.	9.671	4680.	10.12
1662.	9.692	4682.	10.14
1664.	9.703	4684.	10.12
1666.	9.696	4686.	10.11
1668.	9.69	4688.	10.1
1670.	9.669	4690.	10.11
1672.	9.678	4692.	10.1
1674.	9.7	4694.	10.11
1676.	9.696	4696.	10.11
1678.	9.677	4698.	10.11
1680.	9.681	4700.	10.11
1682.	9.695	4702.	10.13
1684.	9.71	4704.	10.12
1686.	9.684	4706.	10.13
1688.	9.67	4708.	10.12
1690.	9.684	4710.	10.11
1692.	9.702	4712.	10.1
1694.	9.691	4714.	10.12
1696.	9.704	4716.	10.14
1698.	9.703	4718.	10.13
1700.	9.694	4720.	10.14
1702.	9.69	4722.	10.15
1704.	9.679	4724.	10.14
1706.	9.678	4726.	10.14
1708.	9.689	4728.	10.14
1710.	9.718	4730.	10.12
1712.	9.707	4732.	10.11
1714.	9.702	4734.	10.12
1716.	9.699	4736.	10.11
1718.	9.684	4738.	10.12
1720.	9.697	4740.	10.12
1722.	9.697	4742.	10.11
1724.	9.722	4744.	10.12
1726.	9.686	4746.	10.13
1728.	9.686	4748.	10.13
1730.	9.712	4750.	10.14
1732.	9.716	4752.	10.14

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1734.	9.69	4754.	10.13
1736.	9.717	4756.	10.15
1738.	9.716	4758.	10.14
1740.	9.694	4760.	10.14
1742.	9.705	4762.	10.13
1744.	9.716	4764.	10.15
1746.	9.704	4766.	10.15
1748.	9.7	4768.	10.13
1750.	9.68	4770.	10.12
1752.	9.712	4772.	10.12
1754.	9.728	4774.	10.13
1756.	9.698	4776.	10.15
1758.	9.699	4778.	10.15
1760.	9.723	4780.	10.13
1762.	9.732	4782.	10.12
1764.	9.728	4784.	10.12
1766.	9.705	4786.	10.13
1768.	9.705	4788.	10.14
1770.	9.694	4790.	10.13
1772.	9.708	4792.	10.14
1774.	9.718	4794.	10.14
1776.	9.718	4796.	10.13
1778.	9.732	4798.	10.12
1780.	9.722	4800.	10.12
1782.	9.707	4802.	10.14
1784.	9.716	4804.	10.13
1786.	9.722	4806.	10.14
1788.	9.707	4808.	10.13
1790.	9.738	4810.	10.14
1792.	9.729	4812.	10.14
1794.	9.739	4814.	10.15
1796.	9.724	4816.	10.16
1798.	9.705	4818.	10.15
1800.	9.721	4820.	10.13
1802.	9.726	4822.	10.12
1804.	9.742	4824.	10.13
1806.	9.731	4826.	10.13
1808.	9.71	4828.	10.13
1810.	9.7	4830.	10.12
1812.	9.713	4832.	10.11
1814.	9.723	4834.	10.13
1816.	9.73	4836.	10.11
1818.	9.74	4838.	10.12
1820.	9.722	4840.	10.12
1822.	9.694	4842.	10.12
1824.	9.72	4844.	10.13
1826.	9.73	4846.	10.14
1828.	9.734	4848.	10.14
1830.	9.723	4850.	10.16
1832.	9.712	4852.	10.16
1834.	9.717	4854.	10.13
1836.	9.731	4856.	10.13
1838.	9.749	4858.	10.13
1840.	9.728	4860.	10.13
1842.	9.721	4862.	10.12
1844.	9.735	4864.	10.13
1846.	9.717	4866.	10.15
1848.	9.707	4868.	10.16
1850.	9.721	4870.	10.15
1852.	9.73	4872.	10.14
1854.	9.745	4874.	10.13
1856.	9.761	4876.	10.15
1858.	9.742	4878.	10.14
1860.	9.742	4880.	10.16
1862.	9.739	4882.	10.16
1864.	9.73	4884.	10.16

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1866.	9.719	4886.	10.14
1868.	9.716	4888.	10.15
1870.	9.736	4890.	10.14
1872.	9.749	4892.	10.15
1874.	9.765	4894.	10.15
1876.	9.755	4896.	10.16
1878.	9.754	4898.	10.15
1880.	9.747	4900.	10.14
1882.	9.75	4902.	10.13
1884.	9.745	4904.	10.15
1886.	9.746	4906.	10.14
1888.	9.743	4908.	10.17
1890.	9.717	4910.	10.16
1892.	9.728	4912.	10.16
1894.	9.735	4914.	10.14
1896.	9.754	4916.	10.13
1898.	9.75	4918.	10.13
1900.	9.773	4920.	10.13
1902.	9.749	4922.	10.13
1904.	9.75	4924.	10.13
1906.	9.745	4926.	10.15
1908.	9.731	4928.	10.16
1910.	9.734	4930.	10.16
1912.	9.732	4932.	10.16
1914.	9.748	4934.	10.17
1916.	9.76	4936.	10.15
1918.	9.78	4938.	10.14
1920.	9.764	4940.	10.13
1922.	9.759	4942.	10.13
1924.	9.746	4944.	10.14
1926.	9.74	4946.	10.14
1928.	9.741	4948.	10.13
1930.	9.734	4950.	10.15
1932.	9.738	4952.	10.14
1934.	9.738	4954.	10.13
1936.	9.746	4956.	10.15
1938.	9.761	4958.	10.15
1940.	9.754	4960.	10.16
1942.	9.77	4962.	10.17
1944.	9.777	4964.	10.16
1946.	9.767	4966.	10.15
1948.	9.769	4968.	10.16
1950.	9.739	4970.	10.17
1952.	9.754	4972.	10.15
1954.	9.748	4974.	10.15
1956.	9.735	4976.	10.13
1958.	9.762	4978.	10.15
1960.	9.774	4980.	10.15
1962.	9.786	4982.	10.15
1964.	9.777	4984.	10.15
1966.	9.759	4986.	10.17
1968.	9.749	4988.	10.14
1970.	9.766	4990.	10.16
1972.	9.777	4992.	10.15
1974.	9.759	4994.	10.16
1976.	9.751	4996.	10.17
1978.	9.753	4998.	10.17
1980.	9.751	5000.	10.15
1982.	9.781	5002.	10.14
1984.	9.772	5004.	10.14
1986.	9.792	5006.	10.15
1988.	9.785	5008.	10.17
1990.	9.787	5010.	10.15
1992.	9.76	5012.	10.16
1994.	9.752	5014.	10.14
1996.	9.764	5016.	10.15

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1998.	9.754	5018.	10.15
2000.	9.777	5020.	10.13
2002.	9.781	5022.	10.13
2004.	9.792	5024.	10.15
2006.	9.788	5026.	10.13
2008.	9.796	5028.	10.14
2010.	9.783	5030.	10.15
2012.	9.77	5032.	10.15
2014.	9.759	5034.	10.15
2016.	9.774	5036.	10.16
2018.	9.789	5038.	10.14
2020.	9.785	5040.	10.15
2022.	9.774	5042.	10.14
2024.	9.772	5044.	10.15
2026.	9.757	5046.	10.15
2028.	9.772	5048.	10.17
2030.	9.78	5050.	10.16
2032.	9.798	5052.	10.16
2034.	9.79	5054.	10.15
2036.	9.784	5056.	10.16
2038.	9.792	5058.	10.15
2040.	9.766	5060.	10.14
2042.	9.777	5062.	10.16
2044.	9.776	5064.	10.14
2046.	9.799	5066.	10.14
2048.	9.81	5068.	10.14
2050.	9.791	5070.	10.13
2052.	9.783	5072.	10.13
2054.	9.76	5074.	10.14
2056.	9.768	5076.	10.15
2058.	9.776	5078.	10.15
2060.	9.777	5080.	10.17
2062.	9.774	5082.	10.17
2064.	9.779	5084.	10.18
2066.	9.776	5086.	10.17
2068.	9.793	5088.	10.16
2070.	9.789	5090.	10.16
2072.	9.798	5092.	10.16
2074.	9.8	5094.	10.15
2076.	9.811	5096.	10.13
2078.	9.8	5098.	10.14
2080.	9.808	5100.	10.15
2082.	9.804	5102.	10.14
2084.	9.801	5104.	10.13
2086.	9.789	5106.	10.14
2088.	9.781	5108.	10.15
2090.	9.787	5110.	10.13
2092.	9.779	5112.	10.14
2094.	9.774	5114.	10.14
2096.	9.787	5116.	10.14
2098.	9.795	5118.	10.15
2100.	9.808	5120.	10.16
2102.	9.798	5122.	10.14
2104.	9.815	5124.	10.15
2106.	9.791	5126.	10.13
2108.	9.803	5128.	10.13
2110.	9.788	5130.	10.15
2112.	9.785	5132.	10.15
2114.	9.798	5134.	10.15
2116.	9.808	5136.	10.15
2118.	9.818	5138.	10.16
2120.	9.814	5140.	10.18
2122.	9.792	5142.	10.17
2124.	9.79	5144.	10.17
2126.	9.786	5146.	10.15
2128.	9.773	5148.	10.15

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2130.	9.792	5150.	10.15
2132.	9.809	5152.	10.14
2134.	9.812	5154.	10.17
2136.	9.816	5156.	10.17
2138.	9.814	5158.	10.18
2140.	9.816	5160.	10.17
2142.	9.826	5162.	10.16
2144.	9.809	5164.	10.15
2146.	9.801	5166.	10.15
2148.	9.798	5168.	10.15
2150.	9.786	5170.	10.15
2152.	9.785	5172.	10.14
2154.	9.806	5174.	10.16
2156.	9.818	5176.	10.16
2158.	9.825	5178.	10.16
2160.	9.828	5180.	10.19
2162.	9.816	5182.	10.18
2164.	9.818	5184.	10.17
2166.	9.826	5186.	10.16
2168.	9.812	5188.	10.15
2170.	9.821	5190.	10.15
2172.	9.815	5192.	10.16
2174.	9.813	5194.	10.15
2176.	9.803	5196.	10.14
2178.	9.788	5198.	10.14
2180.	9.787	5200.	10.16
2182.	9.814	5202.	10.15
2184.	9.822	5204.	10.14
2186.	9.83	5206.	10.15
2188.	9.82	5208.	10.16
2190.	9.803	5210.	10.17
2192.	9.81	5212.	10.15
2194.	9.819	5214.	10.16
2196.	9.834	5216.	10.15
2198.	9.818	5218.	10.15
2200.	9.807	5220.	10.15
2202.	9.813	5222.	10.16
2204.	9.827	5224.	10.17
2206.	9.832	5226.	10.18
2208.	9.803	5228.	10.16
2210.	9.803	5230.	10.18
2212.	9.818	5232.	10.16
2214.	9.834	5234.	10.15
2216.	9.839	5236.	10.17
2218.	9.818	5238.	10.16
2220.	9.838	5240.	10.18
2222.	9.821	5242.	10.17
2224.	9.814	5244.	10.16
2226.	9.8	5246.	10.18
2228.	9.807	5248.	10.15
2230.	9.836	5250.	10.16
2232.	9.834	5252.	10.16
2234.	9.832	5254.	10.15
2236.	9.828	5256.	10.15
2238.	9.807	5258.	10.17
2240.	9.81	5260.	10.18
2242.	9.828	5262.	10.19
2244.	9.84	5264.	10.18
2246.	9.841	5266.	10.17
2248.	9.839	5268.	10.2
2250.	9.829	5270.	10.19
2252.	9.824	5272.	10.18
2254.	9.83	5274.	10.18
2256.	9.835	5276.	10.17
2258.	9.82	5278.	10.17
2260.	9.819	5280.	10.16

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2262.	9.813	5282.	10.17
2264.	9.822	5284.	10.17
2266.	9.817	5286.	10.18
2268.	9.818	5288.	10.18
2270.	9.841	5290.	10.18
2272.	9.834	5292.	10.18
2274.	9.842	5294.	10.18
2276.	9.837	5296.	10.19
2278.	9.822	5298.	10.18
2280.	9.822	5300.	10.19
2282.	9.835	5302.	10.18
2284.	9.842	5304.	10.19
2286.	9.829	5306.	10.18
2288.	9.821	5308.	10.18
2290.	9.843	5310.	10.18
2292.	9.851	5312.	10.15
2294.	9.833	5314.	10.16
2296.	9.819	5316.	10.15
2298.	9.828	5318.	10.14
2300.	9.835	5320.	10.17
2302.	9.843	5322.	10.18
2304.	9.848	5324.	10.18
2306.	9.834	5326.	10.18
2308.	9.827	5328.	10.19
2310.	9.824	5330.	10.18
2312.	9.829	5332.	10.19
2314.	9.853	5334.	10.19
2316.	9.854	5336.	10.18
2318.	9.86	5338.	10.17
2320.	9.844	5340.	10.17
2322.	9.833	5342.	10.18
2324.	9.834	5344.	10.16
2326.	9.822	5346.	10.17
2328.	9.835	5348.	10.16
2330.	9.831	5350.	10.16
2332.	9.829	5352.	10.16
2334.	9.837	5354.	10.16
2336.	9.849	5356.	10.17
2338.	9.855	5358.	10.17
2340.	9.865	5360.	10.16
2342.	9.845	5362.	10.16
2344.	9.859	5364.	10.17
2346.	9.852	5366.	10.16
2348.	9.872	5368.	10.16
2350.	9.858	5370.	10.17
2352.	9.854	5372.	10.15
2354.	9.847	5374.	10.16
2356.	9.832	5376.	10.17
2358.	9.838	5378.	10.14
2360.	9.856	5380.	10.16
2362.	9.875	5382.	10.16
2364.	9.851	5384.	10.17
2366.	9.857	5386.	10.17
2368.	9.836	5388.	10.17
2370.	9.838	5390.	10.16
2372.	9.852	5392.	10.17
2374.	9.851	5394.	10.15
2376.	9.854	5396.	10.16
2378.	9.845	5398.	10.17
2380.	9.852	5400.	10.17
2382.	9.863	5402.	10.16
2384.	9.87	5404.	10.16
2386.	9.862	5406.	10.17
2388.	9.849	5408.	10.18
2390.	9.841	5410.	10.2
2392.	9.848	5412.	10.2

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2394.	9.858	5414.	10.19
2396.	9.879	5416.	10.19
2398.	9.859	5418.	10.18
2400.	9.85	5420.	10.17
2402.	9.862	5422.	10.17
2404.	9.855	5424.	10.17
2406.	9.849	5425.	10.06
2408.	9.854	5426.	9.635
2410.	9.847	5427.	9.22
2412.	9.845	5428.	8.805
2414.	9.834	5429.	8.427
2416.	9.825	5430.	8.063
2418.	9.85	5431.	7.723
2420.	9.854	5432.	7.416
2422.	9.868	5433.	7.101
2424.	9.862	5434.	6.798
2426.	9.841	5435.	6.496
2428.	9.844	5436.	6.236
2430.	9.86	5437.	5.989
2432.	9.863	5438.	5.754
2434.	9.871	5439.	5.534
2436.	9.888	5440.	5.334
2438.	9.882	5441.	5.131
2440.	9.883	5442.	4.945
2442.	9.866	5443.	4.768
2444.	9.869	5444.	4.605
2446.	9.854	5445.	4.45
2448.	9.847	5446.	4.301
2450.	9.851	5447.	4.161
2452.	9.861	5448.	4.027
2454.	9.891	5449.	3.917
2456.	9.88	5450.	3.799
2458.	9.878	5451.	3.691
2460.	9.856	5452.	3.591
2462.	9.849	5453.	3.496
2464.	9.858	5454.	3.404
2466.	9.882	5455.	3.317
2468.	9.882	5456.	3.238
2470.	9.868	5457.	3.16
2472.	9.861	5458.	3.098
2474.	9.844	5459.	3.017
2476.	9.868	5460.	2.96
2478.	9.875	5461.	2.902
2480.	9.871	5462.	2.849
2482.	9.887	5463.	2.802
2484.	9.874	5464.	2.751
2486.	9.87	5465.	2.71
2488.	9.876	5466.	2.667
2490.	9.881	5467.	2.628
2492.	9.889	5468.	2.602
2494.	9.875	5469.	2.574
2496.	9.875	5470.	2.536
2498.	9.857	5471.	2.515
2500.	9.86	5472.	2.493
2502.	9.872	5473.	2.475
2504.	9.865	5474.	2.457
2506.	9.857	5475.	2.445
2508.	9.874	5476.	2.429
2510.	9.854	5477.	2.416
2512.	9.862	5478.	2.41
2514.	9.872	5479.	2.399
2516.	9.885	5480.	2.396
2518.	9.889	5481.	2.386
2520.	9.876	5482.	2.365
2522.	9.881	5483.	2.361
2524.	9.868	5484.	2.349

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2526.	9.872	5485.	2.325
2528.	9.872	5486.	2.318
2530.	9.892	5487.	2.294
2532.	9.867	5488.	2.276
2534.	9.864	5489.	2.255
2536.	9.867	5490.	2.231
2538.	9.866	5491.	2.213
2540.	9.874	5492.	2.191
2542.	9.868	5493.	2.159
2544.	9.864	5494.	2.15
2546.	9.869	5495.	2.114
2548.	9.862	5496.	2.092
2550.	9.873	5497.	2.069
2552.	9.873	5498.	2.04
2554.	9.863	5499.	2.024
2556.	9.871	5500.	1.999
2558.	9.882	5501.	1.98
2560.	9.873	5502.	1.952
2562.	9.888	5503.	1.931
2564.	9.887	5504.	1.909
2566.	9.902	5505.	1.882
2568.	9.898	5506.	1.865
2570.	9.883	5507.	1.839
2572.	9.906	5508.	1.824
2574.	9.883	5509.	1.798
2576.	9.881	5510.	1.778
2578.	9.878	5511.	1.756
2580.	9.884	5512.	1.737
2582.	9.882	5513.	1.714
2584.	9.87	5514.	1.693
2586.	9.882	5515.	1.681
2588.	9.873	5516.	1.662
2590.	9.883	5517.	1.642
2592.	9.912	5518.	1.626
2594.	9.906	5519.	1.609
2596.	9.911	5520.	1.587
2598.	9.891	5521.	1.567
2600.	9.885	5522.	1.547
2602.	9.884	5523.	1.533
2604.	9.882	5524.	1.511
2606.	9.879	5525.	1.501
2608.	9.864	5526.	1.478
2610.	9.892	5527.	1.46
2612.	9.887	5528.	1.451
2614.	9.904	5529.	1.427
2616.	9.905	5530.	1.414
2618.	9.917	5531.	1.401
2620.	9.91	5532.	1.389
2622.	9.911	5533.	1.373
2624.	9.903	5534.	1.354
2626.	9.913	5535.	1.342
2628.	9.905	5536.	1.328
2630.	9.909	5537.	1.316
2632.	9.918	5538.	1.303
2634.	9.924	5539.	1.292
2636.	9.915	5540.	1.278
2638.	9.911	5541.	1.267
2640.	9.915	5542.	1.255
2642.	9.892	5543.	1.247
2644.	9.905	5544.	1.229
2646.	9.908	5545.	1.221
2648.	9.895	5546.	1.211
2650.	9.912	5547.	1.199
2652.	9.901	5548.	1.186
2654.	9.894	5549.	1.176
2656.	9.889	5550.	1.168

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2658.	9.89	5551.	1.157
2660.	9.903	5552.	1.146
2662.	9.897	5553.	1.135
2664.	9.909	5554.	1.121
2666.	9.922	5555.	1.117
2668.	9.916	5556.	1.103
2670.	9.899	5557.	1.093
2672.	9.893	5558.	1.083
2674.	9.891	5559.	1.074
2676.	9.896	5560.	1.064
2678.	9.894	5561.	1.056
2680.	9.896	5562.	1.044
2682.	9.906	5563.	1.036
2684.	9.919	5564.	1.029
2686.	9.922	5565.	1.019
2688.	9.91	5566.	1.012
2690.	9.922	5567.	1.
2692.	9.926	5568.	0.996
2694.	9.927	5569.	0.9864
2696.	9.92	5570.	0.9804
2698.	9.913	5571.	0.9723
2700.	9.91	5572.	0.963
2702.	9.895	5573.	0.9557
2704.	9.895	5574.	0.9514
2706.	9.897	5575.	0.9431
2708.	9.904	5576.	0.935
2710.	9.9	5577.	0.9263
2712.	9.901	5578.	0.9225
2714.	9.899	5579.	0.9175
2716.	9.896	5580.	0.909
2718.	9.893	5581.	0.9026
2720.	9.915	5582.	0.8946
2722.	9.907	5583.	0.8906
2724.	9.917	5584.	0.8833
2726.	9.918	5585.	0.8791
2728.	9.909	5586.	0.873
2730.	9.915	5587.	0.8661
2732.	9.926	5588.	0.8611
2734.	9.918	5589.	0.8562
2736.	9.905	5590.	0.8493
2738.	9.932	5591.	0.8447
2740.	9.922	5592.	0.8444
2742.	9.925	5593.	0.8369
2744.	9.919	5594.	0.8323
2746.	9.924	5595.	0.823
2748.	9.91	5596.	0.8226
2750.	9.906	5597.	0.8169
2752.	9.897	5598.	0.8108
2754.	9.887	5599.	0.8071
2756.	9.915	5600.	0.8005
2758.	9.905	5601.	0.8008
2760.	9.912	5602.	0.7947
2762.	9.905	5603.	0.7907
2764.	9.917	5604.	0.7854
2766.	9.916	5605.	0.7802
2768.	9.932	5606.	0.7795
2770.	9.927	5607.	0.7746
2772.	9.933	5608.	0.7704
2774.	9.93	5609.	0.7669
2776.	9.94	5610.	0.7612
2778.	9.927	5611.	0.7583
2780.	9.928	5612.	0.7553
2782.	9.922	5613.	0.7524
2784.	9.937	5614.	0.7475
2786.	9.94	5615.	0.7444
2788.	9.944	5616.	0.7444

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2790.	9.932	5617.	0.7377
2792.	9.949	5618.	0.7336
2794.	9.925	5619.	0.7321
2796.	9.928	5620.	0.7311
2798.	9.933	5621.	0.7264
2800.	9.906	5622.	0.7215
2802.	9.894	5623.	0.7228
2804.	9.91	5624.	0.716
2806.	9.913	5625.	0.7147
2808.	9.91	5626.	0.7106
2810.	9.914	5627.	0.7081
2812.	9.914	5628.	0.7043
2814.	9.914	5629.	0.7042
2816.	9.915	5630.	0.6993
2818.	9.907	5631.	0.6985
2820.	9.91	5632.	0.6953
2822.	9.912	5633.	0.6921
2824.	9.923	5634.	0.6902
2826.	9.928	5635.	0.6877
2828.	9.935	5636.	0.6873
2830.	9.944	5637.	0.6834
2832.	9.947	5638.	0.682
2834.	9.959	5639.	0.6797
2836.	9.941	5640.	0.6756
2838.	9.931	5641.	0.6741
2840.	9.93	5642.	0.6721
2842.	9.91	5643.	0.6684
2844.	9.912	5644.	0.6699
2846.	9.92	5645.	0.6657
2848.	9.93	5646.	0.666
2850.	9.937	5647.	0.6632
2852.	9.945	5648.	0.66
2854.	9.945	5649.	0.6573
2856.	9.947	5650.	0.655
2858.	9.936	5651.	0.6549
2860.	9.945	5652.	0.655
2862.	9.955	5653.	0.648
2864.	9.957	5654.	0.6486
2866.	9.926	5655.	0.6446
2868.	9.941	5656.	0.6439
2870.	9.929	5657.	0.643
2872.	9.922	5658.	0.6385
2874.	9.936	5659.	0.6393
2876.	9.925	5660.	0.6378
2878.	9.93	5661.	0.634
2880.	9.915	5662.	0.6323
2882.	9.911	5663.	0.6308
2884.	9.918	5664.	0.6323
2886.	9.916	5665.	0.627
2888.	9.92	5666.	0.6239
2890.	9.928	5667.	0.6243
2892.	9.931	5668.	0.6193
2894.	9.938	5669.	0.6216
2896.	9.932	5670.	0.6193
2898.	9.929	5671.	0.6132
2900.	9.925	5672.	0.6131
2902.	9.945	5673.	0.6112
2904.	9.937	5674.	0.6091
2906.	9.943	5675.	0.6075
2908.	9.937	5676.	0.6059
2910.	9.939	5677.	0.606
2912.	9.938	5678.	0.6047
2914.	9.96	5679.	0.6037
2916.	9.96	5680.	0.5992
2918.	9.949	5681.	0.6006
2920.	9.957	5682.	0.5996

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2922.	9.954	5683.	0.5971
2924.	9.958	5684.	0.5935
2926.	9.952	5685.	0.5952
2928.	9.946	5686.	0.5931
2930.	9.951	5687.	0.5915
2932.	9.932	5688.	0.5911
2934.	9.941	5689.	0.5871
2936.	9.936	5690.	0.5889
2938.	9.927	5691.	0.588
2940.	9.931	5692.	0.5865
2942.	9.929	5693.	0.585
2944.	9.922	5694.	0.5844
2946.	9.919	5695.	0.5864
2948.	9.94	5696.	0.5846
2950.	9.941	5697.	0.5839
2952.	9.937	5698.	0.5791
2954.	9.952	5699.	0.5833
2956.	9.943	5700.	0.5809
2958.	9.96	5701.	0.579
2960.	9.937	5702.	0.5786
2962.	9.943	5703.	0.5769
2964.	9.94	5704.	0.5741
2966.	9.938	5705.	0.5755
2968.	9.941	5706.	0.5753
2970.	9.926	5707.	0.5738
2972.	9.947	5708.	0.5696
2974.	9.93	5709.	0.5715
2976.	9.927	5710.	0.5699
2978.	9.944	5711.	0.5702
2980.	9.963	5712.	0.5652
2982.	9.955	5713.	0.5677
2984.	9.951	5714.	0.5668
2986.	9.928	5715.	0.5669
2988.	9.926	5716.	0.5646
2990.	9.934	5717.	0.5628
2992.	9.936	5718.	0.5609
2994.	9.95	5719.	0.5596
2996.	9.936	5720.	0.5572
2998.	9.952	5721.	0.5573
3000.	9.934	5722.	0.559
3002.	9.957	5723.	0.5605
3004.	9.968	5724.	0.5573
3006.	9.969	5725.	0.554
3008.	9.957	5726.	0.5556
3010.	9.966	5727.	0.5513
3012.	9.935	5728.	0.5548
3014.	9.965	5729.	0.5544
3016.	9.963	5730.	0.5537
3018.	9.947	5731.	0.5503
3020.	9.936	5732.	0.8651

SOLUTION

Pumping Test
Aquifer Model: Confined
Solution Method: Cooper-Jacob

VISUAL ESTIMATION RESULTS

Estimated Parameters

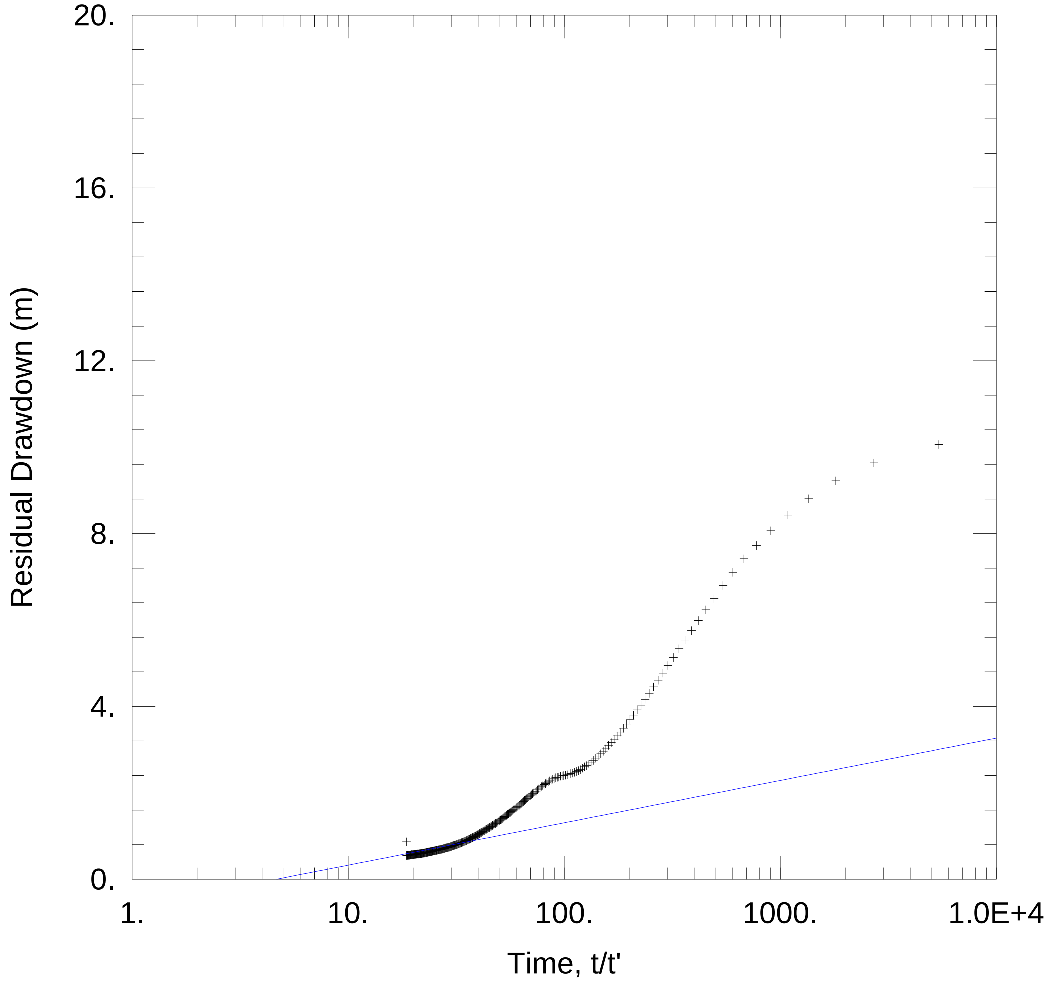
Parameter	Estimate	
T	14.97	m^2/day
S	4.658E-8	

K = T/b = 0.2139 m/day (0.0002475 cm/sec)

Ss = S/b = 6.655E-10 1/m

NOTES

Re-assessed by RPS Aquaterra



MB03_PUMPING TEST

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB3_CH01_AS recovery.aqt
Date: 09/24/12 Time: 08:59:02

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Well: MB03
Test Date: 10/09/2011

AQUIFER DATA

Saturated Thickness: 70. m Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
MB03	445383	7379099

Observation Wells

Well Name	X (m)	Y (m)
+ MB03	445383	7379099

SOLUTION

Aquifer Model: Confined Solution Method: Theis (Recovery)

T = 16.15 m^2/day S/S' = 4.673

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB3_CH01_AS recovery.aqt
Title: MB03_Pumping Test
Date: 09/24/12
Time: 08:58:24

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Date: 10/09/2011
Test Well: MB03

AQUIFER DATA

Saturated Thickness: 70. m
Anisotropy Ratio (Kz/Kr): 0.1

PUMPING WELL DATA

No. of pumping wells: 1

Pumping Well No. 1: MB03

X Location: 445383. m
Y Location: 7379099. m

Casing Radius: 0.05 m
Well Radius: 0.1 m

Partially Penetrating Well
Depth to Top of Screen: 49.63 m
Depth to Bottom of Screen: 60.63 m

No. of pumping periods: 2

Pumping Period Data

Time (sec)	Rate (cu. m/sec)	Time (sec)	Rate (cu. m/sec)
0.	0.001	5424.	0.

OBSERVATION WELL DATA

No. of observation wells: 1

Observation Well No. 1: MB03

X Location: 445383. m
Y Location: 7379099. m

Radial distance from MB03: 0. m

Partially Penetrating Well
Depth to Top of Screen: 49.63 m
Depth to Bottom of Screen: 60.63 m

No. of Observations: 3020

Observation Data

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2.	0.2367	3022.	9.948
4.	0.3833	3024.	9.955
6.	0.7122	3026.	9.948
8.	1.021	3028.	9.933
10.	1.312	3030.	9.942
12.	1.581	3032.	9.94
14.	1.808	3034.	9.928
16.	2.012	3036.	9.927

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
18.	2.168	3038.	9.934
20.	2.29	3040.	9.954
22.	2.528	3042.	9.95
24.	2.678	3044.	9.964
26.	2.766	3046.	9.945
28.	2.911	3048.	9.94
30.	2.986	3050.	9.948
32.	3.105	3052.	9.955
34.	3.176	3054.	9.958
36.	3.278	3056.	9.956
38.	3.286	3058.	9.939
40.	3.454	3060.	9.933
42.	3.469	3062.	9.93
44.	3.577	3064.	9.949
46.	3.621	3066.	9.963
48.	3.703	3068.	9.957
50.	3.761	3070.	9.943
52.	3.802	3072.	9.944
54.	3.906	3074.	9.942
56.	3.966	3076.	9.928
58.	4.003	3078.	9.949
60.	4.058	3080.	9.97
62.	4.13	3082.	9.947
64.	4.162	3084.	9.953
66.	4.219	3086.	9.927
68.	4.287	3088.	9.935
70.	4.319	3090.	9.931
72.	4.352	3092.	9.943
74.	4.426	3094.	9.96
76.	4.447	3096.	9.965
78.	4.493	3098.	9.952
80.	4.569	3100.	9.944
82.	4.629	3102.	9.928
84.	4.643	3104.	9.944
86.	4.678	3106.	9.944
88.	4.719	3108.	9.963
90.	4.788	3110.	9.96
92.	4.81	3112.	9.967
94.	4.86	3114.	9.968
96.	4.914	3116.	9.944
98.	4.946	3118.	9.938
100.	4.94	3120.	9.976
102.	4.996	3122.	9.974
104.	5.047	3124.	9.95
106.	5.062	3126.	9.958
108.	5.13	3128.	9.945
110.	5.16	3130.	9.94
112.	5.202	3132.	9.943
114.	5.226	3134.	9.952
116.	5.282	3136.	9.947
118.	5.299	3138.	9.953
120.	5.315	3140.	9.941
122.	5.345	3142.	9.941
124.	5.39	3144.	9.949
126.	5.429	3146.	9.982
128.	5.473	3148.	9.958
130.	5.485	3150.	9.963
132.	5.521	3152.	9.956
134.	5.55	3154.	9.944
136.	5.605	3156.	9.937
138.	5.636	3158.	9.945
140.	5.665	3160.	9.957
142.	5.665	3162.	9.971
144.	5.712	3164.	9.97
146.	5.743	3166.	9.963
148.	5.77	3168.	9.964

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
150.	5.801	3170.	9.954
152.	5.859	3172.	9.935
154.	5.842	3174.	9.941
156.	5.866	3176.	9.939
158.	5.952	3178.	9.945
160.	5.962	3180.	9.955
162.	5.953	3182.	9.947
164.	6.027	3184.	9.945
166.	6.059	3186.	9.964
168.	6.048	3188.	9.962
170.	6.125	3190.	9.976
172.	6.103	3192.	9.967
174.	6.149	3194.	9.973
176.	6.202	3196.	9.969
178.	6.214	3198.	9.966
180.	6.216	3200.	9.936
182.	6.254	3202.	9.955
184.	6.268	3204.	9.978
186.	6.3	3206.	9.962
188.	6.359	3208.	9.973
190.	6.38	3210.	9.957
192.	6.401	3212.	9.95
194.	6.38	3214.	9.949
196.	6.435	3216.	9.969
198.	6.463	3218.	9.982
200.	6.487	3220.	9.969
202.	6.514	3222.	9.951
204.	6.534	3224.	9.943
206.	6.546	3226.	9.952
208.	6.56	3228.	9.94
210.	6.607	3230.	9.946
212.	6.624	3232.	9.976
214.	6.641	3234.	9.96
216.	6.683	3236.	9.959
218.	6.694	3238.	9.974
220.	6.694	3240.	9.97
222.	6.707	3242.	9.943
224.	6.747	3244.	9.951
226.	6.767	3246.	9.953
228.	6.781	3248.	9.947
230.	6.815	3250.	9.951
232.	6.85	3252.	9.951
234.	6.866	3254.	9.954
236.	6.865	3256.	9.962
238.	6.876	3258.	9.97
240.	6.904	3260.	9.968
242.	6.925	3262.	9.958
244.	6.957	3264.	9.954
246.	6.981	3266.	9.94
248.	6.989	3268.	9.942
250.	7.	3270.	9.945
252.	7.024	3272.	9.959
254.	7.066	3274.	9.952
256.	7.067	3276.	9.947
258.	7.07	3278.	9.969
260.	7.091	3280.	9.989
262.	7.111	3282.	9.975
264.	7.141	3284.	9.985
266.	7.163	3286.	9.979
268.	7.191	3288.	9.966
270.	7.188	3290.	9.961
272.	7.187	3292.	9.957
274.	7.206	3294.	9.957
276.	7.224	3296.	9.96
278.	7.265	3298.	9.983
280.	7.282	3300.	9.98

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
282.	7.3	3302.	9.982
284.	7.322	3304.	9.973
286.	7.327	3306.	9.958
288.	7.345	3308.	9.97
290.	7.374	3310.	9.974
292.	7.369	3312.	9.99
294.	7.37	3314.	9.995
296.	7.398	3316.	9.985
298.	7.409	3318.	9.988
300.	7.428	3320.	9.973
302.	7.462	3322.	9.989
304.	7.477	3324.	9.976
306.	7.491	3326.	9.97
308.	7.508	3328.	9.962
310.	7.509	3330.	9.967
312.	7.546	3332.	9.963
314.	7.532	3334.	9.957
316.	7.566	3336.	9.964
318.	7.571	3338.	9.97
320.	7.564	3340.	9.96
322.	7.571	3342.	9.982
324.	7.617	3344.	9.977
326.	7.648	3346.	9.976
328.	7.65	3348.	9.996
330.	7.671	3350.	9.986
332.	7.656	3352.	9.98
334.	7.631	3354.	9.981
336.	7.664	3356.	9.986
338.	7.677	3358.	10.
340.	7.72	3360.	10.
342.	7.724	3362.	9.995
344.	7.717	3364.	9.989
346.	7.735	3366.	9.995
348.	7.745	3368.	9.985
350.	7.768	3370.	9.994
352.	7.78	3372.	10.
354.	7.803	3374.	10.
356.	7.813	3376.	9.995
358.	7.831	3378.	9.994
360.	7.825	3380.	9.989
362.	7.822	3382.	10.
364.	7.846	3384.	9.99
366.	7.873	3386.	9.995
368.	7.89	3388.	9.979
370.	7.896	3390.	9.988
372.	7.933	3392.	9.98
374.	7.926	3394.	9.975
376.	7.961	3396.	9.996
378.	7.957	3398.	10.
380.	7.933	3400.	10.
382.	7.99	3402.	10.01
384.	7.938	3404.	10.01
386.	7.989	3406.	10.
388.	8.01	3408.	10.
390.	7.999	3410.	9.991
392.	7.999	3412.	9.992
394.	7.988	3414.	9.984
396.	8.005	3416.	9.98
398.	8.025	3418.	9.989
400.	8.06	3420.	9.974
402.	8.067	3422.	9.98
404.	8.069	3424.	10.
406.	8.063	3426.	10.
408.	8.079	3428.	10.02
410.	8.083	3430.	10.02
412.	8.111	3432.	9.99

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
414.	8.138	3434.	9.994
416.	8.162	3436.	9.986
418.	8.145	3438.	9.978
420.	8.139	3440.	10.01
422.	8.147	3442.	10.01
424.	8.185	3444.	10.01
426.	8.194	3446.	9.987
428.	8.182	3448.	9.971
430.	8.176	3450.	9.99
432.	8.185	3452.	9.987
434.	8.205	3454.	10.01
436.	8.222	3456.	10.02
438.	8.213	3458.	10.
440.	8.219	3460.	9.983
442.	8.251	3462.	9.978
444.	8.255	3464.	9.982
446.	8.258	3466.	9.986
448.	8.274	3468.	10.01
450.	8.304	3470.	10.02
452.	8.308	3472.	10.02
454.	8.294	3474.	10.
456.	8.313	3476.	9.992
458.	8.318	3478.	9.983
460.	8.322	3480.	9.982
462.	8.326	3482.	9.982
464.	8.326	3484.	9.979
466.	8.328	3486.	9.998
468.	8.33	3488.	10.
470.	8.351	3490.	10.01
472.	8.381	3492.	10.
474.	8.408	3494.	10.01
476.	8.409	3496.	10.01
478.	8.378	3498.	10.03
480.	8.376	3500.	10.01
482.	8.374	3502.	10.01
484.	8.403	3504.	10.
486.	8.442	3506.	10.
488.	8.431	3508.	9.993
490.	8.446	3510.	10.02
492.	8.453	3512.	10.01
494.	8.444	3514.	10.01
496.	8.472	3516.	10.02
498.	8.484	3518.	10.02
500.	8.47	3520.	10.02
502.	8.498	3522.	9.994
504.	8.485	3524.	9.994
506.	8.508	3526.	9.985
508.	8.51	3528.	10.02
510.	8.519	3530.	10.02
512.	8.521	3532.	10.01
514.	8.496	3534.	10.
516.	8.511	3536.	9.991
518.	8.525	3538.	9.992
520.	8.524	3540.	9.986
522.	8.535	3542.	10.
524.	8.533	3544.	9.992
526.	8.535	3546.	10.01
528.	8.568	3548.	10.
530.	8.538	3550.	10.02
532.	8.557	3552.	10.03
534.	8.568	3554.	10.02
536.	8.58	3556.	10.
538.	8.592	3558.	9.982
540.	8.615	3560.	9.991
542.	8.618	3562.	9.991
544.	8.611	3564.	9.997

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
546.	8.602	3566.	9.997
548.	8.616	3568.	9.995
550.	8.607	3570.	10.
552.	8.636	3572.	10.01
554.	8.646	3574.	10.
556.	8.645	3576.	10.01
558.	8.643	3578.	10.01
560.	8.66	3580.	10.02
562.	8.671	3582.	10.02
564.	8.671	3584.	10.04
566.	8.676	3586.	10.04
568.	8.673	3588.	10.02
570.	8.674	3590.	10.01
572.	8.679	3592.	9.996
574.	8.681	3594.	9.998
576.	8.69	3596.	10.
578.	8.691	3598.	10.01
580.	8.726	3600.	10.03
582.	8.735	3602.	10.02
584.	8.757	3604.	10.01
586.	8.729	3606.	10.
588.	8.732	3608.	10.03
590.	8.731	3610.	10.04
592.	8.761	3612.	10.03
594.	8.761	3614.	10.02
596.	8.769	3616.	10.01
598.	8.762	3618.	10.01
600.	8.774	3620.	10.
602.	8.765	3622.	10.02
604.	8.773	3624.	10.03
606.	8.765	3626.	10.02
608.	8.772	3628.	10.
610.	8.773	3630.	10.
612.	8.786	3632.	10.
614.	8.779	3634.	10.01
616.	8.791	3636.	10.01
618.	8.803	3638.	10.01
620.	8.816	3640.	10.03
622.	8.814	3642.	10.03
624.	8.796	3644.	10.04
626.	8.803	3646.	10.04
628.	8.809	3648.	10.04
630.	8.813	3650.	10.02
632.	8.819	3652.	10.04
634.	8.817	3654.	10.03
636.	8.833	3656.	10.02
638.	8.869	3658.	10.01
640.	8.876	3660.	10.01
642.	8.846	3662.	10.02
644.	8.855	3664.	10.02
646.	8.838	3666.	10.02
648.	8.848	3668.	10.03
650.	8.87	3670.	10.04
652.	8.872	3672.	10.03
654.	8.887	3674.	10.05
656.	8.906	3676.	10.04
658.	8.914	3678.	10.04
660.	8.895	3680.	10.04
662.	8.886	3682.	10.03
664.	8.892	3684.	10.04
666.	8.894	3686.	10.02
668.	8.876	3688.	10.03
670.	8.871	3690.	10.03
672.	8.893	3692.	10.02
674.	8.907	3694.	10.01
676.	8.907	3696.	10.02

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
678.	8.922	3698.	10.03
680.	8.932	3700.	10.
682.	8.939	3702.	10.01
684.	8.938	3704.	10.01
686.	8.948	3706.	10.01
688.	8.929	3708.	10.02
690.	8.897	3710.	10.01
692.	8.95	3712.	10.04
694.	8.961	3714.	10.05
696.	8.964	3716.	10.05
698.	8.972	3718.	10.04
700.	8.96	3720.	10.05
702.	8.957	3722.	10.04
704.	8.955	3724.	10.03
706.	8.961	3726.	10.03
708.	8.952	3728.	10.04
710.	8.962	3730.	10.04
712.	8.987	3732.	10.04
714.	8.998	3734.	10.02
716.	8.986	3736.	10.03
718.	9.005	3738.	10.02
720.	8.999	3740.	10.03
722.	8.982	3742.	10.02
724.	8.992	3744.	10.01
726.	8.982	3746.	10.03
728.	8.992	3748.	10.03
730.	9.02	3750.	10.01
732.	9.036	3752.	10.02
734.	9.005	3754.	10.04
736.	9.014	3756.	10.05
738.	9.008	3758.	10.05
740.	9.034	3760.	10.03
742.	9.04	3762.	10.03
744.	9.034	3764.	10.01
746.	9.02	3766.	10.04
748.	9.015	3768.	10.06
750.	9.026	3770.	10.05
752.	9.024	3772.	10.05
754.	9.039	3774.	10.05
756.	9.057	3776.	10.03
758.	9.065	3778.	10.03
760.	9.083	3780.	10.02
762.	9.079	3782.	10.04
764.	9.074	3784.	10.05
766.	9.048	3786.	10.05
768.	9.052	3788.	10.06
770.	9.06	3790.	10.06
772.	9.07	3792.	10.04
774.	9.091	3794.	10.04
776.	9.081	3796.	10.04
778.	9.098	3798.	10.04
780.	9.106	3800.	10.01
782.	9.08	3802.	10.02
784.	9.072	3804.	10.04
786.	9.08	3806.	10.03
788.	9.07	3808.	10.03
790.	9.096	3810.	10.04
792.	9.111	3812.	10.05
794.	9.118	3814.	10.06
796.	9.099	3816.	10.05
798.	9.114	3818.	10.03
800.	9.124	3820.	10.03
802.	9.092	3822.	10.03
804.	9.096	3824.	10.05
806.	9.106	3826.	10.05
808.	9.113	3828.	10.06

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
810.	9.136	3830.	10.05
812.	9.148	3832.	10.07
814.	9.137	3834.	10.06
816.	9.125	3836.	10.05
818.	9.113	3838.	10.04
820.	9.12	3840.	10.04
822.	9.152	3842.	10.03
824.	9.155	3844.	10.04
826.	9.135	3846.	10.04
828.	9.129	3848.	10.03
830.	9.132	3850.	10.04
832.	9.139	3852.	10.04
834.	9.159	3854.	10.06
836.	9.163	3856.	10.07
838.	9.163	3858.	10.05
840.	9.172	3860.	10.03
842.	9.164	3862.	10.04
844.	9.164	3864.	10.05
846.	9.176	3866.	10.07
848.	9.16	3868.	10.07
850.	9.176	3870.	10.07
852.	9.152	3872.	10.08
854.	9.167	3874.	10.07
856.	9.162	3876.	10.07
858.	9.158	3878.	10.07
860.	9.168	3880.	10.08
862.	9.168	3882.	10.07
864.	9.188	3884.	10.07
866.	9.198	3886.	10.06
868.	9.203	3888.	10.05
870.	9.188	3890.	10.07
872.	9.173	3892.	10.05
874.	9.181	3894.	10.04
876.	9.195	3896.	10.04
878.	9.205	3898.	10.03
880.	9.221	3900.	10.05
882.	9.195	3902.	10.06
884.	9.193	3904.	10.06
886.	9.204	3906.	10.07
888.	9.188	3908.	10.07
890.	9.196	3910.	10.06
892.	9.216	3912.	10.05
894.	9.236	3914.	10.04
896.	9.223	3916.	10.04
898.	9.218	3918.	10.03
900.	9.202	3920.	10.05
902.	9.207	3922.	10.06
904.	9.196	3924.	10.06
906.	9.218	3926.	10.07
908.	9.226	3928.	10.08
910.	9.236	3930.	10.08
912.	9.238	3932.	10.06
914.	9.229	3934.	10.06
916.	9.248	3936.	10.03
918.	9.228	3938.	10.05
920.	9.225	3940.	10.05
922.	9.229	3942.	10.07
924.	9.243	3944.	10.07
926.	9.223	3946.	10.08
928.	9.237	3948.	10.05
930.	9.225	3950.	10.05
932.	9.239	3952.	10.04
934.	9.219	3954.	10.05
936.	9.249	3956.	10.07
938.	9.25	3958.	10.07
940.	9.247	3960.	10.07

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
942.	9.254	3962.	10.06
944.	9.244	3964.	10.08
946.	9.284	3966.	10.08
948.	9.289	3968.	10.08
950.	9.272	3970.	10.07
952.	9.253	3972.	10.08
954.	9.251	3974.	10.07
956.	9.269	3976.	10.06
958.	9.3	3978.	10.06
960.	9.296	3980.	10.06
962.	9.279	3982.	10.05
964.	9.286	3984.	10.06
966.	9.268	3986.	10.05
968.	9.268	3988.	10.05
970.	9.281	3990.	10.06
972.	9.269	3992.	10.09
974.	9.3	3994.	10.09
976.	9.293	3996.	10.09
978.	9.298	3998.	10.08
980.	9.298	4000.	10.08
982.	9.269	4002.	10.08
984.	9.289	4004.	10.07
986.	9.286	4006.	10.07
988.	9.286	4008.	10.08
990.	9.292	4010.	10.08
992.	9.314	4012.	10.07
994.	9.316	4014.	10.07
996.	9.335	4016.	10.05
998.	9.345	4018.	10.05
1000.	9.325	4020.	10.05
1002.	9.314	4022.	10.05
1004.	9.319	4024.	10.06
1006.	9.306	4026.	10.07
1008.	9.341	4028.	10.07
1010.	9.349	4030.	10.07
1012.	9.359	4032.	10.09
1014.	9.366	4034.	10.07
1016.	9.338	4036.	10.09
1018.	9.333	4038.	10.07
1020.	9.328	4040.	10.07
1022.	9.318	4042.	10.07
1024.	9.324	4044.	10.05
1026.	9.328	4046.	10.05
1028.	9.354	4048.	10.05
1030.	9.373	4050.	10.06
1032.	9.372	4052.	10.07
1034.	9.344	4054.	10.06
1036.	9.353	4056.	10.06
1038.	9.359	4058.	10.07
1040.	9.36	4060.	10.05
1042.	9.368	4062.	10.07
1044.	9.375	4064.	10.06
1046.	9.348	4066.	10.06
1048.	9.346	4068.	10.08
1050.	9.367	4070.	10.1
1052.	9.383	4072.	10.08
1054.	9.369	4074.	10.08
1056.	9.356	4076.	10.07
1058.	9.363	4078.	10.07
1060.	9.357	4080.	10.06
1062.	9.39	4082.	10.07
1064.	9.398	4084.	10.05
1066.	9.401	4086.	10.05
1068.	9.387	4088.	10.08
1070.	9.368	4090.	10.09
1072.	9.366	4092.	10.07

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1074.	9.385	4094.	10.08
1076.	9.391	4096.	10.07
1078.	9.394	4098.	10.05
1080.	9.409	4100.	10.05
1082.	9.419	4102.	10.06
1084.	9.39	4104.	10.06
1086.	9.389	4106.	10.06
1088.	9.392	4108.	10.07
1090.	9.395	4110.	10.06
1092.	9.417	4112.	10.07
1094.	9.393	4114.	10.09
1096.	9.372	4116.	10.08
1098.	9.416	4118.	10.09
1100.	9.427	4120.	10.1
1102.	9.434	4122.	10.1
1104.	9.402	4124.	10.09
1106.	9.408	4126.	10.09
1108.	9.409	4128.	10.09
1110.	9.414	4130.	10.08
1112.	9.418	4132.	10.09
1114.	9.444	4134.	10.07
1116.	9.441	4136.	10.07
1118.	9.412	4138.	10.06
1120.	9.414	4140.	10.08
1122.	9.416	4142.	10.06
1124.	9.427	4144.	10.06
1126.	9.439	4146.	10.07
1128.	9.446	4148.	10.08
1130.	9.446	4150.	10.07
1132.	9.42	4152.	10.08
1134.	9.428	4154.	10.07
1136.	9.445	4156.	10.08
1138.	9.46	4158.	10.09
1140.	9.44	4160.	10.1
1142.	9.443	4162.	10.1
1144.	9.442	4164.	10.09
1146.	9.452	4166.	10.11
1148.	9.451	4168.	10.1
1150.	9.475	4170.	10.09
1152.	9.471	4172.	10.1
1154.	9.463	4174.	10.09
1156.	9.442	4176.	10.09
1158.	9.454	4178.	10.08
1160.	9.45	4180.	10.06
1162.	9.445	4182.	10.08
1164.	9.46	4184.	10.1
1166.	9.473	4186.	10.11
1168.	9.482	4188.	10.1
1170.	9.47	4190.	10.11
1172.	9.48	4192.	10.1
1174.	9.466	4194.	10.11
1176.	9.467	4196.	10.1
1178.	9.455	4198.	10.1
1180.	9.489	4200.	10.08
1182.	9.49	4202.	10.09
1184.	9.483	4204.	10.08
1186.	9.451	4206.	10.08
1188.	9.458	4208.	10.08
1190.	9.482	4210.	10.07
1192.	9.481	4212.	10.08
1194.	9.476	4214.	10.09
1196.	9.473	4216.	10.11
1198.	9.468	4218.	10.1
1200.	9.469	4220.	10.1
1202.	9.495	4222.	10.08
1204.	9.516	4224.	10.09

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1206.	9.516	4226.	10.06
1208.	9.482	4228.	10.06
1210.	9.484	4230.	10.1
1212.	9.486	4232.	10.1
1214.	9.479	4234.	10.11
1216.	9.508	4236.	10.09
1218.	9.515	4238.	10.1
1220.	9.493	4240.	10.09
1222.	9.483	4242.	10.09
1224.	9.493	4244.	10.1
1226.	9.505	4246.	10.1
1228.	9.518	4248.	10.08
1230.	9.505	4250.	10.08
1232.	9.502	4252.	10.08
1234.	9.502	4254.	10.06
1236.	9.507	4256.	10.07
1238.	9.511	4258.	10.07
1240.	9.513	4260.	10.08
1242.	9.513	4262.	10.07
1244.	9.532	4264.	10.08
1246.	9.513	4266.	10.08
1248.	9.527	4268.	10.08
1250.	9.51	4270.	10.09
1252.	9.531	4272.	10.09
1254.	9.526	4274.	10.1
1256.	9.516	4276.	10.09
1258.	9.503	4278.	10.11
1260.	9.504	4280.	10.12
1262.	9.508	4282.	10.11
1264.	9.535	4284.	10.11
1266.	9.553	4286.	10.11
1268.	9.513	4288.	10.09
1270.	9.512	4290.	10.09
1272.	9.522	4292.	10.1
1274.	9.531	4294.	10.1
1276.	9.532	4296.	10.11
1278.	9.522	4298.	10.11
1280.	9.531	4300.	10.11
1282.	9.532	4302.	10.09
1284.	9.527	4304.	10.09
1286.	9.553	4306.	10.09
1288.	9.562	4308.	10.09
1290.	9.549	4310.	10.1
1292.	9.539	4312.	10.11
1294.	9.532	4314.	10.12
1296.	9.535	4316.	10.11
1298.	9.528	4318.	10.1
1300.	9.525	4320.	10.11
1302.	9.529	4322.	10.11
1304.	9.557	4324.	10.11
1306.	9.55	4326.	10.11
1308.	9.566	4328.	10.11
1310.	9.539	4330.	10.12
1312.	9.542	4332.	10.11
1314.	9.534	4334.	10.12
1316.	9.544	4336.	10.1
1318.	9.529	4338.	10.11
1320.	9.533	4340.	10.1
1322.	9.536	4342.	10.11
1324.	9.538	4344.	10.11
1326.	9.56	4346.	10.12
1328.	9.53	4348.	10.11
1330.	9.547	4350.	10.11
1332.	9.541	4352.	10.11
1334.	9.544	4354.	10.1
1336.	9.545	4356.	10.1

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1338.	9.559	4358.	10.08
1340.	9.568	4360.	10.1
1342.	9.578	4362.	10.1
1344.	9.572	4364.	10.09
1346.	9.579	4366.	10.1
1348.	9.576	4368.	10.11
1350.	9.575	4370.	10.1
1352.	9.565	4372.	10.1
1354.	9.555	4374.	10.11
1356.	9.551	4376.	10.13
1358.	9.554	4378.	10.1
1360.	9.579	4380.	10.11
1362.	9.589	4382.	10.1
1364.	9.584	4384.	10.11
1366.	9.562	4386.	10.12
1368.	9.578	4388.	10.11
1370.	9.597	4390.	10.09
1372.	9.582	4392.	10.09
1374.	9.554	4394.	10.09
1376.	9.567	4396.	10.08
1378.	9.574	4398.	10.1
1380.	9.579	4400.	10.08
1382.	9.592	4402.	10.09
1384.	9.582	4404.	10.09
1386.	9.588	4406.	10.09
1388.	9.595	4408.	10.12
1390.	9.582	4410.	10.12
1392.	9.579	4412.	10.11
1394.	9.578	4414.	10.11
1396.	9.567	4416.	10.11
1398.	9.57	4418.	10.11
1400.	9.574	4420.	10.1
1402.	9.586	4422.	10.1
1404.	9.603	4424.	10.1
1406.	9.611	4426.	10.1
1408.	9.594	4428.	10.12
1410.	9.584	4430.	10.12
1412.	9.567	4432.	10.11
1414.	9.581	4434.	10.12
1416.	9.582	4436.	10.12
1418.	9.577	4438.	10.12
1420.	9.587	4440.	10.11
1422.	9.571	4442.	10.12
1424.	9.58	4444.	10.11
1426.	9.594	4446.	10.09
1428.	9.587	4448.	10.09
1430.	9.594	4450.	10.1
1432.	9.612	4452.	10.11
1434.	9.615	4454.	10.12
1436.	9.595	4456.	10.11
1438.	9.595	4458.	10.12
1440.	9.605	4460.	10.11
1442.	9.588	4462.	10.12
1444.	9.602	4464.	10.12
1446.	9.601	4466.	10.12
1448.	9.598	4468.	10.1
1450.	9.59	4470.	10.1
1452.	9.601	4472.	10.1
1454.	9.574	4474.	10.1
1456.	9.606	4476.	10.1
1458.	9.602	4478.	10.09
1460.	9.604	4480.	10.1
1462.	9.614	4482.	10.1
1464.	9.603	4484.	10.12
1466.	9.613	4486.	10.12
1468.	9.623	4488.	10.12

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1470.	9.613	4490.	10.12
1472.	9.637	4492.	10.13
1474.	9.631	4494.	10.13
1476.	9.632	4496.	10.13
1478.	9.635	4498.	10.11
1480.	9.633	4500.	10.11
1482.	9.643	4502.	10.1
1484.	9.641	4504.	10.1
1486.	9.625	4506.	10.1
1488.	9.642	4508.	10.09
1490.	9.641	4510.	10.1
1492.	9.608	4512.	10.1
1494.	9.61	4514.	10.11
1496.	9.634	4516.	10.11
1498.	9.644	4518.	10.11
1500.	9.648	4520.	10.11
1502.	9.612	4522.	10.09
1504.	9.608	4524.	10.09
1506.	9.614	4526.	10.11
1508.	9.641	4528.	10.09
1510.	9.641	4530.	10.1
1512.	9.649	4532.	10.1
1514.	9.628	4534.	10.1
1516.	9.614	4536.	10.11
1518.	9.633	4538.	10.09
1520.	9.638	4540.	10.1
1522.	9.614	4542.	10.09
1524.	9.629	4544.	10.1
1526.	9.658	4546.	10.11
1528.	9.63	4548.	10.12
1530.	9.627	4550.	10.12
1532.	9.654	4552.	10.12
1534.	9.641	4554.	10.14
1536.	9.623	4556.	10.1
1538.	9.643	4558.	10.1
1540.	9.656	4560.	10.1
1542.	9.636	4562.	10.11
1544.	9.658	4564.	10.1
1546.	9.661	4566.	10.12
1548.	9.632	4568.	10.11
1550.	9.652	4570.	10.11
1552.	9.646	4572.	10.12
1554.	9.637	4574.	10.13
1556.	9.65	4576.	10.13
1558.	9.658	4578.	10.13
1560.	9.645	4580.	10.12
1562.	9.633	4582.	10.12
1564.	9.668	4584.	10.11
1566.	9.663	4586.	10.11
1568.	9.635	4588.	10.11
1570.	9.647	4590.	10.13
1572.	9.659	4592.	10.13
1574.	9.655	4594.	10.13
1576.	9.63	4596.	10.13
1578.	9.676	4598.	10.13
1580.	9.656	4600.	10.14
1582.	9.643	4602.	10.14
1584.	9.654	4604.	10.13
1586.	9.677	4606.	10.13
1588.	9.636	4608.	10.13
1590.	9.66	4610.	10.14
1592.	9.68	4612.	10.13
1594.	9.645	4614.	10.12
1596.	9.654	4616.	10.12
1598.	9.689	4618.	10.15
1600.	9.661	4620.	10.12

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1602.	9.648	4622.	10.13
1604.	9.675	4624.	10.12
1606.	9.674	4626.	10.12
1608.	9.674	4628.	10.12
1610.	9.648	4630.	10.1
1612.	9.65	4632.	10.12
1614.	9.659	4634.	10.11
1616.	9.682	4636.	10.1
1618.	9.694	4638.	10.1
1620.	9.661	4640.	10.14
1622.	9.665	4642.	10.13
1624.	9.658	4644.	10.13
1626.	9.682	4646.	10.14
1628.	9.693	4648.	10.13
1630.	9.668	4650.	10.14
1632.	9.658	4652.	10.14
1634.	9.666	4654.	10.13
1636.	9.678	4656.	10.14
1638.	9.662	4658.	10.13
1640.	9.666	4660.	10.13
1642.	9.689	4662.	10.14
1644.	9.669	4664.	10.15
1646.	9.65	4666.	10.15
1648.	9.665	4668.	10.15
1650.	9.689	4670.	10.11
1652.	9.658	4672.	10.13
1654.	9.678	4674.	10.14
1656.	9.684	4676.	10.13
1658.	9.678	4678.	10.13
1660.	9.671	4680.	10.12
1662.	9.692	4682.	10.14
1664.	9.703	4684.	10.12
1666.	9.696	4686.	10.11
1668.	9.69	4688.	10.1
1670.	9.669	4690.	10.11
1672.	9.678	4692.	10.1
1674.	9.7	4694.	10.11
1676.	9.696	4696.	10.11
1678.	9.677	4698.	10.11
1680.	9.681	4700.	10.11
1682.	9.695	4702.	10.13
1684.	9.71	4704.	10.12
1686.	9.684	4706.	10.13
1688.	9.67	4708.	10.12
1690.	9.684	4710.	10.11
1692.	9.702	4712.	10.1
1694.	9.691	4714.	10.12
1696.	9.704	4716.	10.14
1698.	9.703	4718.	10.13
1700.	9.694	4720.	10.14
1702.	9.69	4722.	10.15
1704.	9.679	4724.	10.14
1706.	9.678	4726.	10.14
1708.	9.689	4728.	10.14
1710.	9.718	4730.	10.12
1712.	9.707	4732.	10.11
1714.	9.702	4734.	10.12
1716.	9.699	4736.	10.11
1718.	9.684	4738.	10.12
1720.	9.697	4740.	10.12
1722.	9.697	4742.	10.11
1724.	9.722	4744.	10.12
1726.	9.686	4746.	10.13
1728.	9.686	4748.	10.13
1730.	9.712	4750.	10.14
1732.	9.716	4752.	10.14

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1734.	9.69	4754.	10.13
1736.	9.717	4756.	10.15
1738.	9.716	4758.	10.14
1740.	9.694	4760.	10.14
1742.	9.705	4762.	10.13
1744.	9.716	4764.	10.15
1746.	9.704	4766.	10.15
1748.	9.7	4768.	10.13
1750.	9.68	4770.	10.12
1752.	9.712	4772.	10.12
1754.	9.728	4774.	10.13
1756.	9.698	4776.	10.15
1758.	9.699	4778.	10.15
1760.	9.723	4780.	10.13
1762.	9.732	4782.	10.12
1764.	9.728	4784.	10.12
1766.	9.705	4786.	10.13
1768.	9.705	4788.	10.14
1770.	9.694	4790.	10.13
1772.	9.708	4792.	10.14
1774.	9.718	4794.	10.14
1776.	9.718	4796.	10.13
1778.	9.732	4798.	10.12
1780.	9.722	4800.	10.12
1782.	9.707	4802.	10.14
1784.	9.716	4804.	10.13
1786.	9.722	4806.	10.14
1788.	9.707	4808.	10.13
1790.	9.738	4810.	10.14
1792.	9.729	4812.	10.14
1794.	9.739	4814.	10.15
1796.	9.724	4816.	10.16
1798.	9.705	4818.	10.15
1800.	9.721	4820.	10.13
1802.	9.726	4822.	10.12
1804.	9.742	4824.	10.13
1806.	9.731	4826.	10.13
1808.	9.71	4828.	10.13
1810.	9.7	4830.	10.12
1812.	9.713	4832.	10.11
1814.	9.723	4834.	10.13
1816.	9.73	4836.	10.11
1818.	9.74	4838.	10.12
1820.	9.722	4840.	10.12
1822.	9.694	4842.	10.12
1824.	9.72	4844.	10.13
1826.	9.73	4846.	10.14
1828.	9.734	4848.	10.14
1830.	9.723	4850.	10.16
1832.	9.712	4852.	10.16
1834.	9.717	4854.	10.13
1836.	9.731	4856.	10.13
1838.	9.749	4858.	10.13
1840.	9.728	4860.	10.13
1842.	9.721	4862.	10.12
1844.	9.735	4864.	10.13
1846.	9.717	4866.	10.15
1848.	9.707	4868.	10.16
1850.	9.721	4870.	10.15
1852.	9.73	4872.	10.14
1854.	9.745	4874.	10.13
1856.	9.761	4876.	10.15
1858.	9.742	4878.	10.14
1860.	9.742	4880.	10.16
1862.	9.739	4882.	10.16
1864.	9.73	4884.	10.16

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1866.	9.719	4886.	10.14
1868.	9.716	4888.	10.15
1870.	9.736	4890.	10.14
1872.	9.749	4892.	10.15
1874.	9.765	4894.	10.15
1876.	9.755	4896.	10.16
1878.	9.754	4898.	10.15
1880.	9.747	4900.	10.14
1882.	9.75	4902.	10.13
1884.	9.745	4904.	10.15
1886.	9.746	4906.	10.14
1888.	9.743	4908.	10.17
1890.	9.717	4910.	10.16
1892.	9.728	4912.	10.16
1894.	9.735	4914.	10.14
1896.	9.754	4916.	10.13
1898.	9.75	4918.	10.13
1900.	9.773	4920.	10.13
1902.	9.749	4922.	10.13
1904.	9.75	4924.	10.13
1906.	9.745	4926.	10.15
1908.	9.731	4928.	10.16
1910.	9.734	4930.	10.16
1912.	9.732	4932.	10.16
1914.	9.748	4934.	10.17
1916.	9.76	4936.	10.15
1918.	9.78	4938.	10.14
1920.	9.764	4940.	10.13
1922.	9.759	4942.	10.13
1924.	9.746	4944.	10.14
1926.	9.74	4946.	10.14
1928.	9.741	4948.	10.13
1930.	9.734	4950.	10.15
1932.	9.738	4952.	10.14
1934.	9.738	4954.	10.13
1936.	9.746	4956.	10.15
1938.	9.761	4958.	10.15
1940.	9.754	4960.	10.16
1942.	9.77	4962.	10.17
1944.	9.777	4964.	10.16
1946.	9.767	4966.	10.15
1948.	9.769	4968.	10.16
1950.	9.739	4970.	10.17
1952.	9.754	4972.	10.15
1954.	9.748	4974.	10.15
1956.	9.735	4976.	10.13
1958.	9.762	4978.	10.15
1960.	9.774	4980.	10.15
1962.	9.786	4982.	10.15
1964.	9.777	4984.	10.15
1966.	9.759	4986.	10.17
1968.	9.749	4988.	10.14
1970.	9.766	4990.	10.16
1972.	9.777	4992.	10.15
1974.	9.759	4994.	10.16
1976.	9.751	4996.	10.17
1978.	9.753	4998.	10.17
1980.	9.751	5000.	10.15
1982.	9.781	5002.	10.14
1984.	9.772	5004.	10.14
1986.	9.792	5006.	10.15
1988.	9.785	5008.	10.17
1990.	9.787	5010.	10.15
1992.	9.76	5012.	10.16
1994.	9.752	5014.	10.14
1996.	9.764	5016.	10.15

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
1998.	9.754	5018.	10.15
2000.	9.777	5020.	10.13
2002.	9.781	5022.	10.13
2004.	9.792	5024.	10.15
2006.	9.788	5026.	10.13
2008.	9.796	5028.	10.14
2010.	9.783	5030.	10.15
2012.	9.77	5032.	10.15
2014.	9.759	5034.	10.15
2016.	9.774	5036.	10.16
2018.	9.789	5038.	10.14
2020.	9.785	5040.	10.15
2022.	9.774	5042.	10.14
2024.	9.772	5044.	10.15
2026.	9.757	5046.	10.15
2028.	9.772	5048.	10.17
2030.	9.78	5050.	10.16
2032.	9.798	5052.	10.16
2034.	9.79	5054.	10.15
2036.	9.784	5056.	10.16
2038.	9.792	5058.	10.15
2040.	9.766	5060.	10.14
2042.	9.777	5062.	10.16
2044.	9.776	5064.	10.14
2046.	9.799	5066.	10.14
2048.	9.81	5068.	10.14
2050.	9.791	5070.	10.13
2052.	9.783	5072.	10.13
2054.	9.76	5074.	10.14
2056.	9.768	5076.	10.15
2058.	9.776	5078.	10.15
2060.	9.777	5080.	10.17
2062.	9.774	5082.	10.17
2064.	9.779	5084.	10.18
2066.	9.776	5086.	10.17
2068.	9.793	5088.	10.16
2070.	9.789	5090.	10.16
2072.	9.798	5092.	10.16
2074.	9.8	5094.	10.15
2076.	9.811	5096.	10.13
2078.	9.8	5098.	10.14
2080.	9.808	5100.	10.15
2082.	9.804	5102.	10.14
2084.	9.801	5104.	10.13
2086.	9.789	5106.	10.14
2088.	9.781	5108.	10.15
2090.	9.787	5110.	10.13
2092.	9.779	5112.	10.14
2094.	9.774	5114.	10.14
2096.	9.787	5116.	10.14
2098.	9.795	5118.	10.15
2100.	9.808	5120.	10.16
2102.	9.798	5122.	10.14
2104.	9.815	5124.	10.15
2106.	9.791	5126.	10.13
2108.	9.803	5128.	10.13
2110.	9.788	5130.	10.15
2112.	9.785	5132.	10.15
2114.	9.798	5134.	10.15
2116.	9.808	5136.	10.15
2118.	9.818	5138.	10.16
2120.	9.814	5140.	10.18
2122.	9.792	5142.	10.17
2124.	9.79	5144.	10.17
2126.	9.786	5146.	10.15
2128.	9.773	5148.	10.15

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2130.	9.792	5150.	10.15
2132.	9.809	5152.	10.14
2134.	9.812	5154.	10.17
2136.	9.816	5156.	10.17
2138.	9.814	5158.	10.18
2140.	9.816	5160.	10.17
2142.	9.826	5162.	10.16
2144.	9.809	5164.	10.15
2146.	9.801	5166.	10.15
2148.	9.798	5168.	10.15
2150.	9.786	5170.	10.15
2152.	9.785	5172.	10.14
2154.	9.806	5174.	10.16
2156.	9.818	5176.	10.16
2158.	9.825	5178.	10.16
2160.	9.828	5180.	10.19
2162.	9.816	5182.	10.18
2164.	9.818	5184.	10.17
2166.	9.826	5186.	10.16
2168.	9.812	5188.	10.15
2170.	9.821	5190.	10.15
2172.	9.815	5192.	10.16
2174.	9.813	5194.	10.15
2176.	9.803	5196.	10.14
2178.	9.788	5198.	10.14
2180.	9.787	5200.	10.16
2182.	9.814	5202.	10.15
2184.	9.822	5204.	10.14
2186.	9.83	5206.	10.15
2188.	9.82	5208.	10.16
2190.	9.803	5210.	10.17
2192.	9.81	5212.	10.15
2194.	9.819	5214.	10.16
2196.	9.834	5216.	10.15
2198.	9.818	5218.	10.15
2200.	9.807	5220.	10.15
2202.	9.813	5222.	10.16
2204.	9.827	5224.	10.17
2206.	9.832	5226.	10.18
2208.	9.803	5228.	10.16
2210.	9.803	5230.	10.18
2212.	9.818	5232.	10.16
2214.	9.834	5234.	10.15
2216.	9.839	5236.	10.17
2218.	9.818	5238.	10.16
2220.	9.838	5240.	10.18
2222.	9.821	5242.	10.17
2224.	9.814	5244.	10.16
2226.	9.8	5246.	10.18
2228.	9.807	5248.	10.15
2230.	9.836	5250.	10.16
2232.	9.834	5252.	10.16
2234.	9.832	5254.	10.15
2236.	9.828	5256.	10.15
2238.	9.807	5258.	10.17
2240.	9.81	5260.	10.18
2242.	9.828	5262.	10.19
2244.	9.84	5264.	10.18
2246.	9.841	5266.	10.17
2248.	9.839	5268.	10.2
2250.	9.829	5270.	10.19
2252.	9.824	5272.	10.18
2254.	9.83	5274.	10.18
2256.	9.835	5276.	10.17
2258.	9.82	5278.	10.17
2260.	9.819	5280.	10.16

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2262.	9.813	5282.	10.17
2264.	9.822	5284.	10.17
2266.	9.817	5286.	10.18
2268.	9.818	5288.	10.18
2270.	9.841	5290.	10.18
2272.	9.834	5292.	10.18
2274.	9.842	5294.	10.18
2276.	9.837	5296.	10.19
2278.	9.822	5298.	10.18
2280.	9.822	5300.	10.19
2282.	9.835	5302.	10.18
2284.	9.842	5304.	10.19
2286.	9.829	5306.	10.18
2288.	9.821	5308.	10.18
2290.	9.843	5310.	10.18
2292.	9.851	5312.	10.15
2294.	9.833	5314.	10.16
2296.	9.819	5316.	10.15
2298.	9.828	5318.	10.14
2300.	9.835	5320.	10.17
2302.	9.843	5322.	10.18
2304.	9.848	5324.	10.18
2306.	9.834	5326.	10.18
2308.	9.827	5328.	10.19
2310.	9.824	5330.	10.18
2312.	9.829	5332.	10.19
2314.	9.853	5334.	10.19
2316.	9.854	5336.	10.18
2318.	9.86	5338.	10.17
2320.	9.844	5340.	10.17
2322.	9.833	5342.	10.18
2324.	9.834	5344.	10.16
2326.	9.822	5346.	10.17
2328.	9.835	5348.	10.16
2330.	9.831	5350.	10.16
2332.	9.829	5352.	10.16
2334.	9.837	5354.	10.16
2336.	9.849	5356.	10.17
2338.	9.855	5358.	10.17
2340.	9.865	5360.	10.16
2342.	9.845	5362.	10.16
2344.	9.859	5364.	10.17
2346.	9.852	5366.	10.16
2348.	9.872	5368.	10.16
2350.	9.858	5370.	10.17
2352.	9.854	5372.	10.15
2354.	9.847	5374.	10.16
2356.	9.832	5376.	10.17
2358.	9.838	5378.	10.14
2360.	9.856	5380.	10.16
2362.	9.875	5382.	10.16
2364.	9.851	5384.	10.17
2366.	9.857	5386.	10.17
2368.	9.836	5388.	10.17
2370.	9.838	5390.	10.16
2372.	9.852	5392.	10.17
2374.	9.851	5394.	10.15
2376.	9.854	5396.	10.16
2378.	9.845	5398.	10.17
2380.	9.852	5400.	10.17
2382.	9.863	5402.	10.16
2384.	9.87	5404.	10.16
2386.	9.862	5406.	10.17
2388.	9.849	5408.	10.18
2390.	9.841	5410.	10.2
2392.	9.848	5412.	10.2

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2394.	9.858	5414.	10.19
2396.	9.879	5416.	10.19
2398.	9.859	5418.	10.18
2400.	9.85	5420.	10.17
2402.	9.862	5422.	10.17
2404.	9.855	5424.	10.17
2406.	9.849	5425.	10.06
2408.	9.854	5426.	9.635
2410.	9.847	5427.	9.22
2412.	9.845	5428.	8.805
2414.	9.834	5429.	8.427
2416.	9.825	5430.	8.063
2418.	9.85	5431.	7.723
2420.	9.854	5432.	7.416
2422.	9.868	5433.	7.101
2424.	9.862	5434.	6.798
2426.	9.841	5435.	6.496
2428.	9.844	5436.	6.236
2430.	9.86	5437.	5.989
2432.	9.863	5438.	5.754
2434.	9.871	5439.	5.534
2436.	9.888	5440.	5.334
2438.	9.882	5441.	5.131
2440.	9.883	5442.	4.945
2442.	9.866	5443.	4.768
2444.	9.869	5444.	4.605
2446.	9.854	5445.	4.45
2448.	9.847	5446.	4.301
2450.	9.851	5447.	4.161
2452.	9.861	5448.	4.027
2454.	9.891	5449.	3.917
2456.	9.88	5450.	3.799
2458.	9.878	5451.	3.691
2460.	9.856	5452.	3.591
2462.	9.849	5453.	3.496
2464.	9.858	5454.	3.404
2466.	9.882	5455.	3.317
2468.	9.882	5456.	3.238
2470.	9.868	5457.	3.16
2472.	9.861	5458.	3.098
2474.	9.844	5459.	3.017
2476.	9.868	5460.	2.96
2478.	9.875	5461.	2.902
2480.	9.871	5462.	2.849
2482.	9.887	5463.	2.802
2484.	9.874	5464.	2.751
2486.	9.87	5465.	2.71
2488.	9.876	5466.	2.667
2490.	9.881	5467.	2.628
2492.	9.889	5468.	2.602
2494.	9.875	5469.	2.574
2496.	9.875	5470.	2.536
2498.	9.857	5471.	2.515
2500.	9.86	5472.	2.493
2502.	9.872	5473.	2.475
2504.	9.865	5474.	2.457
2506.	9.857	5475.	2.445
2508.	9.874	5476.	2.429
2510.	9.854	5477.	2.416
2512.	9.862	5478.	2.41
2514.	9.872	5479.	2.399
2516.	9.885	5480.	2.396
2518.	9.889	5481.	2.386
2520.	9.876	5482.	2.365
2522.	9.881	5483.	2.361
2524.	9.868	5484.	2.349

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2526.	9.872	5485.	2.325
2528.	9.872	5486.	2.318
2530.	9.892	5487.	2.294
2532.	9.867	5488.	2.276
2534.	9.864	5489.	2.255
2536.	9.867	5490.	2.231
2538.	9.866	5491.	2.213
2540.	9.874	5492.	2.191
2542.	9.868	5493.	2.159
2544.	9.864	5494.	2.15
2546.	9.869	5495.	2.114
2548.	9.862	5496.	2.092
2550.	9.873	5497.	2.069
2552.	9.873	5498.	2.04
2554.	9.863	5499.	2.024
2556.	9.871	5500.	1.999
2558.	9.882	5501.	1.98
2560.	9.873	5502.	1.952
2562.	9.888	5503.	1.931
2564.	9.887	5504.	1.909
2566.	9.902	5505.	1.882
2568.	9.898	5506.	1.865
2570.	9.883	5507.	1.839
2572.	9.906	5508.	1.824
2574.	9.883	5509.	1.798
2576.	9.881	5510.	1.778
2578.	9.878	5511.	1.756
2580.	9.884	5512.	1.737
2582.	9.882	5513.	1.714
2584.	9.87	5514.	1.693
2586.	9.882	5515.	1.681
2588.	9.873	5516.	1.662
2590.	9.883	5517.	1.642
2592.	9.912	5518.	1.626
2594.	9.906	5519.	1.609
2596.	9.911	5520.	1.587
2598.	9.891	5521.	1.567
2600.	9.885	5522.	1.547
2602.	9.884	5523.	1.533
2604.	9.882	5524.	1.511
2606.	9.879	5525.	1.501
2608.	9.864	5526.	1.478
2610.	9.892	5527.	1.46
2612.	9.887	5528.	1.451
2614.	9.904	5529.	1.427
2616.	9.905	5530.	1.414
2618.	9.917	5531.	1.401
2620.	9.91	5532.	1.389
2622.	9.911	5533.	1.373
2624.	9.903	5534.	1.354
2626.	9.913	5535.	1.342
2628.	9.905	5536.	1.328
2630.	9.909	5537.	1.316
2632.	9.918	5538.	1.303
2634.	9.924	5539.	1.292
2636.	9.915	5540.	1.278
2638.	9.911	5541.	1.267
2640.	9.915	5542.	1.255
2642.	9.892	5543.	1.247
2644.	9.905	5544.	1.229
2646.	9.908	5545.	1.221
2648.	9.895	5546.	1.211
2650.	9.912	5547.	1.199
2652.	9.901	5548.	1.186
2654.	9.894	5549.	1.176
2656.	9.889	5550.	1.168

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2658.	9.89	5551.	1.157
2660.	9.903	5552.	1.146
2662.	9.897	5553.	1.135
2664.	9.909	5554.	1.121
2666.	9.922	5555.	1.117
2668.	9.916	5556.	1.103
2670.	9.899	5557.	1.093
2672.	9.893	5558.	1.083
2674.	9.891	5559.	1.074
2676.	9.896	5560.	1.064
2678.	9.894	5561.	1.056
2680.	9.896	5562.	1.044
2682.	9.906	5563.	1.036
2684.	9.919	5564.	1.029
2686.	9.922	5565.	1.019
2688.	9.91	5566.	1.012
2690.	9.922	5567.	1.
2692.	9.926	5568.	0.996
2694.	9.927	5569.	0.9864
2696.	9.92	5570.	0.9804
2698.	9.913	5571.	0.9723
2700.	9.91	5572.	0.963
2702.	9.895	5573.	0.9557
2704.	9.895	5574.	0.9514
2706.	9.897	5575.	0.9431
2708.	9.904	5576.	0.935
2710.	9.9	5577.	0.9263
2712.	9.901	5578.	0.9225
2714.	9.899	5579.	0.9175
2716.	9.896	5580.	0.909
2718.	9.893	5581.	0.9026
2720.	9.915	5582.	0.8946
2722.	9.907	5583.	0.8906
2724.	9.917	5584.	0.8833
2726.	9.918	5585.	0.8791
2728.	9.909	5586.	0.873
2730.	9.915	5587.	0.8661
2732.	9.926	5588.	0.8611
2734.	9.918	5589.	0.8562
2736.	9.905	5590.	0.8493
2738.	9.932	5591.	0.8447
2740.	9.922	5592.	0.8444
2742.	9.925	5593.	0.8369
2744.	9.919	5594.	0.8323
2746.	9.924	5595.	0.823
2748.	9.91	5596.	0.8226
2750.	9.906	5597.	0.8169
2752.	9.897	5598.	0.8108
2754.	9.887	5599.	0.8071
2756.	9.915	5600.	0.8005
2758.	9.905	5601.	0.8008
2760.	9.912	5602.	0.7947
2762.	9.905	5603.	0.7907
2764.	9.917	5604.	0.7854
2766.	9.916	5605.	0.7802
2768.	9.932	5606.	0.7795
2770.	9.927	5607.	0.7746
2772.	9.933	5608.	0.7704
2774.	9.93	5609.	0.7669
2776.	9.94	5610.	0.7612
2778.	9.927	5611.	0.7583
2780.	9.928	5612.	0.7553
2782.	9.922	5613.	0.7524
2784.	9.937	5614.	0.7475
2786.	9.94	5615.	0.7444
2788.	9.944	5616.	0.7444

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2790.	9.932	5617.	0.7377
2792.	9.949	5618.	0.7336
2794.	9.925	5619.	0.7321
2796.	9.928	5620.	0.7311
2798.	9.933	5621.	0.7264
2800.	9.906	5622.	0.7215
2802.	9.894	5623.	0.7228
2804.	9.91	5624.	0.716
2806.	9.913	5625.	0.7147
2808.	9.91	5626.	0.7106
2810.	9.914	5627.	0.7081
2812.	9.914	5628.	0.7043
2814.	9.914	5629.	0.7042
2816.	9.915	5630.	0.6993
2818.	9.907	5631.	0.6985
2820.	9.91	5632.	0.6953
2822.	9.912	5633.	0.6921
2824.	9.923	5634.	0.6902
2826.	9.928	5635.	0.6877
2828.	9.935	5636.	0.6873
2830.	9.944	5637.	0.6834
2832.	9.947	5638.	0.682
2834.	9.959	5639.	0.6797
2836.	9.941	5640.	0.6756
2838.	9.931	5641.	0.6741
2840.	9.93	5642.	0.6721
2842.	9.91	5643.	0.6684
2844.	9.912	5644.	0.6699
2846.	9.92	5645.	0.6657
2848.	9.93	5646.	0.666
2850.	9.937	5647.	0.6632
2852.	9.945	5648.	0.66
2854.	9.945	5649.	0.6573
2856.	9.947	5650.	0.655
2858.	9.936	5651.	0.6549
2860.	9.945	5652.	0.655
2862.	9.955	5653.	0.648
2864.	9.957	5654.	0.6486
2866.	9.926	5655.	0.6446
2868.	9.941	5656.	0.6439
2870.	9.929	5657.	0.643
2872.	9.922	5658.	0.6385
2874.	9.936	5659.	0.6393
2876.	9.925	5660.	0.6378
2878.	9.93	5661.	0.634
2880.	9.915	5662.	0.6323
2882.	9.911	5663.	0.6308
2884.	9.918	5664.	0.6323
2886.	9.916	5665.	0.627
2888.	9.92	5666.	0.6239
2890.	9.928	5667.	0.6243
2892.	9.931	5668.	0.6193
2894.	9.938	5669.	0.6216
2896.	9.932	5670.	0.6193
2898.	9.929	5671.	0.6132
2900.	9.925	5672.	0.6131
2902.	9.945	5673.	0.6112
2904.	9.937	5674.	0.6091
2906.	9.943	5675.	0.6075
2908.	9.937	5676.	0.6059
2910.	9.939	5677.	0.606
2912.	9.938	5678.	0.6047
2914.	9.96	5679.	0.6037
2916.	9.96	5680.	0.5992
2918.	9.949	5681.	0.6006
2920.	9.957	5682.	0.5996

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2922.	9.954	5683.	0.5971
2924.	9.958	5684.	0.5935
2926.	9.952	5685.	0.5952
2928.	9.946	5686.	0.5931
2930.	9.951	5687.	0.5915
2932.	9.932	5688.	0.5911
2934.	9.941	5689.	0.5871
2936.	9.936	5690.	0.5889
2938.	9.927	5691.	0.588
2940.	9.931	5692.	0.5865
2942.	9.929	5693.	0.585
2944.	9.922	5694.	0.5844
2946.	9.919	5695.	0.5864
2948.	9.94	5696.	0.5846
2950.	9.941	5697.	0.5839
2952.	9.937	5698.	0.5791
2954.	9.952	5699.	0.5833
2956.	9.943	5700.	0.5809
2958.	9.96	5701.	0.579
2960.	9.937	5702.	0.5786
2962.	9.943	5703.	0.5769
2964.	9.94	5704.	0.5741
2966.	9.938	5705.	0.5755
2968.	9.941	5706.	0.5753
2970.	9.926	5707.	0.5738
2972.	9.947	5708.	0.5696
2974.	9.93	5709.	0.5715
2976.	9.927	5710.	0.5699
2978.	9.944	5711.	0.5702
2980.	9.963	5712.	0.5652
2982.	9.955	5713.	0.5677
2984.	9.951	5714.	0.5668
2986.	9.928	5715.	0.5669
2988.	9.926	5716.	0.5646
2990.	9.934	5717.	0.5628
2992.	9.936	5718.	0.5609
2994.	9.95	5719.	0.5596
2996.	9.936	5720.	0.5572
2998.	9.952	5721.	0.5573
3000.	9.934	5722.	0.559
3002.	9.957	5723.	0.5605
3004.	9.968	5724.	0.5573
3006.	9.969	5725.	0.554
3008.	9.957	5726.	0.5556
3010.	9.966	5727.	0.5513
3012.	9.935	5728.	0.5548
3014.	9.965	5729.	0.5544
3016.	9.963	5730.	0.5537
3018.	9.947	5731.	0.5503
3020.	9.936	5732.	0.8651

SOLUTION

Pumping Test
Aquifer Model: Confined
Solution Method: Theis (Recovery)

VISUAL ESTIMATION RESULTS

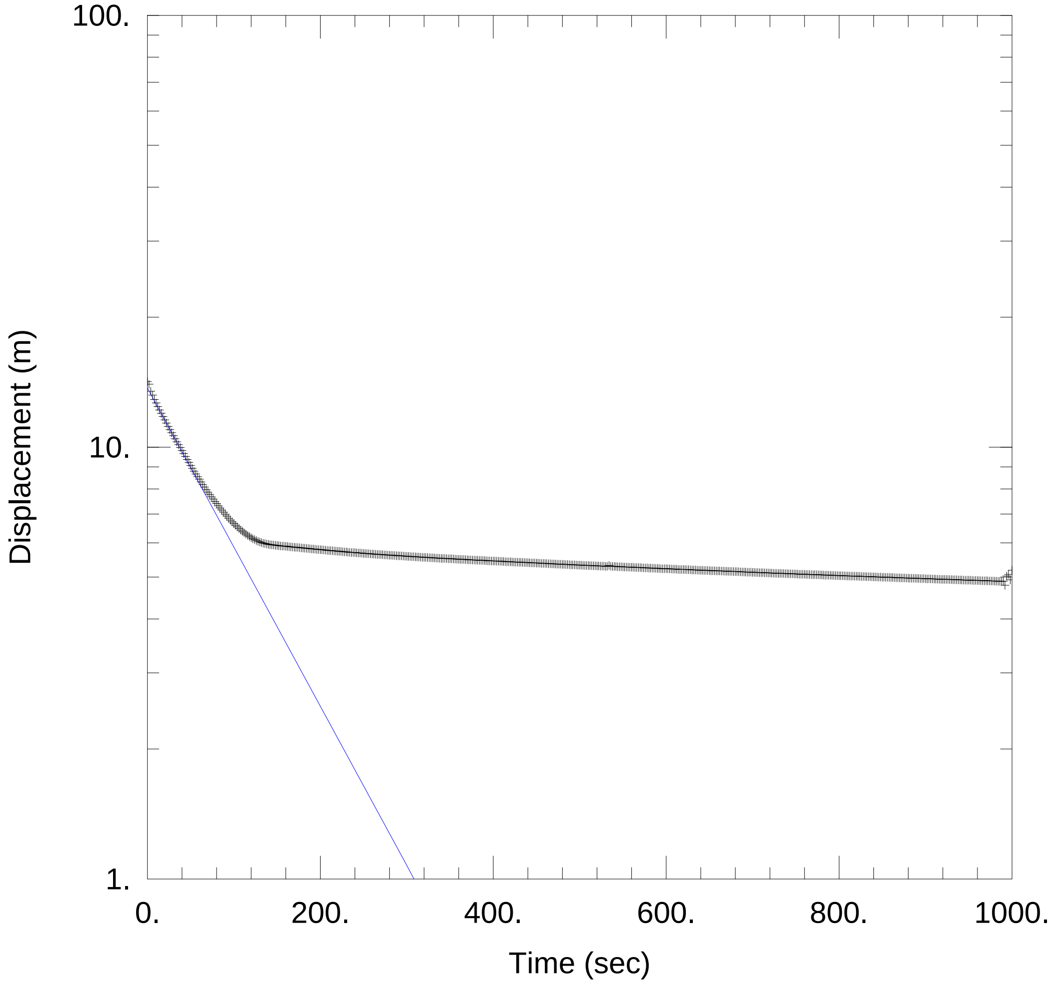
Estimated Parameters

Parameter	Estimate	
T	16.15	m^2/day
S/S'	4.673	

K = T/b = 0.2307 m/day (0.000267 cm/sec)

NOTES

Re-assessed by RPS Aquaterra



WELL TEST ANALYSIS

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB4_AS.aqt
Date: 09/24/12 Time: 08:50:25

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Well: MB04
Test Date: 10/09/2011

AQUIFER DATA

Saturated Thickness: 25. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (MB04)

Initial Displacement: 14.18 m
Total Well Penetration Depth: 25. m
Casing Radius: 0.05 m

Static Water Column Height: 25. m
Screen Length: 13. m
Well Radius: 0.1 m
Gravel Pack Porosity: 0.3

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.2945 m/day y0 = 13.7 m

AQTESOLV for Windows

Data Set: F:\Jobs\A302C\AS data\Slug test analysis\SGCP_MB4_AS.aqt
Date: 09/24/12
Time: 08:49:53

PROJECT INFORMATION

Company: Geoaxiom Pty Ltd
Client: SGCP
Location: Alpha
Test Date: 10/09/2011
Test Well: MB04

AQUIFER DATA

Saturated Thickness: 25. m
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: MB04

X Location: 0. m
Y Location: 0. m

Initial Displacement: 14.18 m
Static Water Column Height: 25. m
Casing Radius: 0.05 m
Well Radius: 0.1 m
Well Skin Radius: 1. m
Screen Length: 13. m
Total Well Penetration Depth: 25. m
Corrected Casing Radius (Bouwer-Rice Method): 0.05 m
Gravel Pack Porosity: 0.3

No. of Observations: 820

Observation Data

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
2.	13.99	822.	5.025
4.	13.48	824.	5.025
6.	13.2	826.	5.019
8.	12.89	828.	5.02
10.	12.66	830.	5.02
12.	12.42	832.	5.015
14.	12.2	834.	5.016
16.	11.98	836.	5.013
18.	11.77	838.	5.01
20.	11.56	840.	5.01
22.	11.37	842.	5.005
24.	11.17	844.	5.005
26.	10.98	846.	5.003
28.	10.8	848.	5.004
30.	10.63	850.	4.997
32.	10.46	852.	5.
34.	10.29	854.	4.997
36.	10.13	856.	4.996
38.	9.978	858.	4.996
40.	9.82	860.	4.992
42.	9.671	862.	4.991
44.	9.512	864.	4.989
46.	9.357	866.	4.986
48.	9.219	868.	4.984
50.	9.07	870.	4.985
52.	8.933	872.	4.981
54.	8.798	874.	4.982
56.	8.671	876.	4.981
58.	8.546	878.	4.977

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
60.	8.426	880.	4.975
62.	8.305	882.	4.973
64.	8.191	884.	4.97
66.	8.082	886.	4.971
68.	7.976	888.	4.97
70.	7.868	890.	4.968
72.	7.774	892.	4.966
74.	7.676	894.	4.965
76.	7.582	896.	4.964
78.	7.489	898.	4.961
80.	7.402	900.	4.961
82.	7.314	902.	4.956
84.	7.228	904.	4.957
86.	7.15	906.	4.954
88.	7.067	908.	4.954
90.	6.991	910.	4.951
92.	6.92	912.	4.95
94.	6.846	914.	4.948
96.	6.778	916.	4.944
98.	6.714	918.	4.943
100.	6.653	920.	4.944
102.	6.591	922.	4.943
104.	6.535	924.	4.942
106.	6.483	926.	4.94
108.	6.427	928.	4.939
110.	6.381	930.	4.937
112.	6.336	932.	4.934
114.	6.29	934.	4.932
116.	6.248	936.	4.933
118.	6.21	938.	4.931
120.	6.171	940.	4.928
122.	6.138	942.	4.927
124.	6.111	944.	4.924
126.	6.079	946.	4.922
128.	6.055	948.	4.922
130.	6.034	950.	4.923
132.	6.014	952.	4.92
134.	5.995	954.	4.916
136.	5.982	956.	4.914
138.	5.965	958.	4.915
140.	5.956	960.	4.912
142.	5.947	962.	4.911
144.	5.94	964.	4.909
146.	5.936	966.	4.909
148.	5.929	968.	4.904
150.	5.922	970.	4.907
152.	5.917	972.	4.903
154.	5.904	974.	4.901
156.	5.903	976.	4.9
158.	5.899	978.	4.899
160.	5.894	980.	4.896
162.	5.89	982.	4.895
164.	5.882	984.	4.893
166.	5.878	986.	4.891
168.	5.873	988.	4.89
170.	5.868	990.	4.89
172.	5.859	992.	4.79
174.	5.859	994.	5.032
176.	5.85	996.	5.075
178.	5.847	998.	4.928
180.	5.841	1000.	5.19
182.	5.837	1002.	5.108
184.	5.829	1004.	5.164
186.	5.827	1006.	5.247
188.	5.822	1008.	5.017
190.	5.812	1010.	5.286

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
192.	5.813	1012.	5.198
194.	5.805	1014.	5.26
196.	5.798	1016.	5.205
198.	5.795	1018.	5.232
200.	5.79	1020.	4.808
202.	5.784	1022.	5.456
204.	5.782	1024.	5.051
206.	5.776	1026.	5.051
208.	5.769	1028.	5.042
210.	5.763	1030.	5.033
212.	5.761	1032.	5.033
214.	5.758	1034.	5.029
216.	5.752	1036.	5.03
218.	5.746	1038.	5.028
220.	5.742	1040.	5.226
222.	5.736	1042.	5.164
224.	5.735	1044.	5.241
226.	5.726	1046.	5.081
228.	5.723	1048.	5.28
230.	5.723	1050.	5.476
232.	5.714	1052.	5.275
234.	5.709	1054.	5.286
236.	5.705	1056.	5.299
238.	5.702	1058.	5.383
240.	5.701	1060.	5.773
242.	5.694	1062.	5.327
244.	5.691	1064.	5.087
246.	5.686	1066.	5.279
248.	5.681	1068.	5.254
250.	5.676	1070.	5.458
252.	5.676	1072.	5.402
254.	5.668	1074.	5.321
256.	5.667	1076.	5.441
258.	5.66	1078.	5.306
260.	5.657	1080.	5.478
262.	5.655	1082.	5.702
264.	5.649	1084.	5.885
266.	5.645	1086.	5.844
268.	5.644	1088.	5.823
270.	5.64	1090.	5.8
272.	5.639	1092.	5.794
274.	5.632	1094.	5.776
276.	5.63	1096.	5.77
278.	5.625	1098.	5.749
280.	5.621	1100.	5.756
282.	5.62	1102.	5.75
284.	5.616	1104.	5.74
286.	5.616	1106.	5.734
288.	5.607	1108.	5.727
290.	5.608	1110.	5.737
292.	5.603	1112.	5.721
294.	5.601	1114.	5.721
296.	5.596	1116.	5.712
298.	5.592	1118.	5.708
300.	5.588	1120.	5.701
302.	5.587	1122.	5.699
304.	5.581	1124.	5.693
306.	5.577	1126.	5.689
308.	5.577	1128.	5.687
310.	5.573	1130.	5.684
312.	5.57	1132.	5.68
314.	5.568	1134.	5.679
316.	5.563	1136.	5.673
318.	5.56	1138.	5.67
320.	5.559	1140.	5.669
322.	5.552	1142.	5.661

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
324.	5.553	1144.	5.665
326.	5.548	1146.	5.656
328.	5.547	1148.	5.655
330.	5.545	1150.	5.646
332.	5.539	1152.	5.645
334.	5.536	1154.	5.643
336.	5.534	1156.	5.634
338.	5.531	1158.	5.629
340.	5.528	1160.	5.632
342.	5.527	1162.	5.627
344.	5.526	1164.	5.623
346.	5.522	1166.	5.612
348.	5.518	1168.	5.618
350.	5.516	1170.	5.614
352.	5.515	1172.	5.612
354.	5.51	1174.	5.61
356.	5.506	1176.	5.6
358.	5.503	1178.	5.599
360.	5.503	1180.	5.599
362.	5.499	1182.	5.588
364.	5.498	1184.	5.584
366.	5.496	1186.	5.582
368.	5.493	1188.	5.582
370.	5.489	1190.	5.58
372.	5.483	1192.	5.58
374.	5.482	1194.	5.569
376.	5.481	1196.	5.572
378.	5.479	1198.	5.567
380.	5.476	1200.	5.563
382.	5.473	1202.	5.562
384.	5.471	1204.	5.559
386.	5.47	1206.	5.554
388.	5.468	1208.	5.55
390.	5.463	1210.	5.553
392.	5.462	1212.	5.553
394.	5.457	1214.	5.545
396.	5.458	1216.	5.543
398.	5.453	1218.	5.545
400.	5.451	1220.	5.541
402.	5.451	1222.	5.539
404.	5.447	1224.	5.536
406.	5.444	1226.	5.534
408.	5.442	1228.	5.531
410.	5.439	1230.	5.531
412.	5.437	1232.	5.528
414.	5.434	1234.	5.526
416.	5.429	1236.	5.516
418.	5.43	1238.	5.526
420.	5.427	1240.	5.521
422.	5.424	1242.	5.51
424.	5.419	1244.	5.506
426.	5.419	1246.	5.514
428.	5.418	1248.	5.51
430.	5.413	1250.	5.502
432.	5.412	1252.	5.506
434.	5.411	1254.	5.507
436.	5.407	1256.	5.507
438.	5.405	1258.	5.5
440.	5.404	1260.	5.5
442.	5.399	1262.	5.497
444.	5.397	1264.	5.489
446.	5.395	1266.	5.487
448.	5.395	1268.	5.49
450.	5.391	1270.	5.482
452.	5.389	1272.	5.485
454.	5.386	1274.	5.487

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
456.	5.383	1276.	5.473
458.	5.38	1278.	5.481
460.	5.38	1280.	5.475
462.	5.376	1282.	5.475
464.	5.374	1284.	5.472
466.	5.371	1286.	5.473
468.	5.368	1288.	5.47
470.	5.366	1290.	5.467
472.	5.364	1292.	5.466
474.	5.361	1294.	5.462
476.	5.357	1296.	5.461
478.	5.357	1298.	5.458
480.	5.354	1300.	5.457
482.	5.354	1302.	5.455
484.	5.351	1304.	5.452
486.	5.348	1306.	5.453
488.	5.346	1308.	5.45
490.	5.342	1310.	5.445
492.	5.342	1312.	5.446
494.	5.343	1314.	5.444
496.	5.336	1316.	5.441
498.	5.333	1318.	5.444
500.	5.333	1320.	5.446
502.	5.33	1322.	5.435
504.	5.327	1324.	5.438
506.	5.324	1326.	5.434
508.	5.324	1328.	5.432
510.	5.322	1330.	5.431
512.	5.32	1332.	5.429
514.	5.316	1334.	5.433
516.	5.314	1336.	5.426
518.	5.313	1338.	5.424
520.	5.31	1340.	5.423
522.	5.308	1342.	5.421
524.	5.305	1344.	5.42
526.	5.303	1346.	5.42
528.	5.302	1348.	5.414
530.	5.297	1350.	5.417
532.	5.298	1352.	5.412
534.	5.324	1354.	5.408
536.	5.298	1356.	5.406
538.	5.297	1358.	5.405
540.	5.293	1360.	5.405
542.	5.294	1362.	5.405
544.	5.288	1364.	5.403
546.	5.287	1366.	5.394
548.	5.286	1368.	5.399
550.	5.282	1370.	5.395
552.	5.279	1372.	5.396
554.	5.279	1374.	5.392
556.	5.277	1376.	5.39
558.	5.274	1378.	5.39
560.	5.272	1380.	5.387
562.	5.271	1382.	5.387
564.	5.265	1384.	5.384
566.	5.266	1386.	5.381
568.	5.263	1388.	5.38
570.	5.263	1390.	5.379
572.	5.259	1392.	5.375
574.	5.254	1394.	5.375
576.	5.253	1396.	5.376
578.	5.253	1398.	5.37
580.	5.247	1400.	5.369
582.	5.25	1402.	5.369
584.	5.247	1404.	5.362
586.	5.244	1406.	5.361

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
588.	5.24	1408.	5.362
590.	5.241	1410.	5.363
592.	5.239	1412.	5.361
594.	5.234	1414.	5.359
596.	5.229	1416.	5.357
598.	5.232	1418.	5.356
600.	5.231	1420.	5.352
602.	5.227	1422.	5.347
604.	5.228	1424.	5.353
606.	5.224	1426.	5.348
608.	5.221	1428.	5.348
610.	5.218	1430.	5.347
612.	5.218	1432.	5.346
614.	5.212	1434.	5.343
616.	5.212	1436.	5.343
618.	5.211	1438.	5.337
620.	5.209	1440.	5.338
622.	5.209	1442.	5.335
624.	5.205	1444.	5.335
626.	5.204	1446.	5.333
628.	5.201	1448.	5.332
630.	5.199	1450.	5.327
632.	5.199	1452.	5.326
634.	5.195	1454.	5.325
636.	5.194	1456.	5.326
638.	5.189	1458.	5.322
640.	5.189	1460.	5.322
642.	5.189	1462.	5.32
644.	5.183	1464.	5.319
646.	5.185	1466.	5.317
648.	5.184	1468.	5.315
650.	5.181	1470.	5.315
652.	5.176	1472.	5.313
654.	5.176	1474.	5.312
656.	5.176	1476.	5.31
658.	5.171	1478.	5.308
660.	5.171	1480.	5.348
662.	5.168	1482.	5.299
664.	5.168	1484.	5.299
666.	5.164	1486.	5.299
668.	5.161	1488.	5.296
670.	5.164	1490.	5.295
672.	5.157	1492.	5.292
674.	5.157	1494.	5.292
676.	5.155	1496.	5.288
678.	5.152	1498.	5.289
680.	5.151	1500.	5.287
682.	5.151	1502.	5.284
684.	5.146	1504.	5.283
686.	5.144	1506.	5.283
688.	5.142	1508.	5.279
690.	5.139	1510.	5.28
692.	5.139	1512.	5.279
694.	5.137	1514.	5.276
696.	5.136	1516.	5.273
698.	5.133	1518.	5.273
700.	5.132	1520.	5.271
702.	5.129	1522.	5.27
704.	5.126	1524.	5.269
706.	5.127	1526.	5.269
708.	5.123	1528.	5.265
710.	5.123	1530.	5.265
712.	5.12	1532.	5.262
714.	5.118	1534.	5.261
716.	5.116	1536.	5.26
718.	5.114	1538.	5.258

Time (sec)	Displacement (m)	Time (sec)	Displacement (m)
720.	5.112	1540.	5.254
722.	5.111	1542.	5.254
724.	5.109	1544.	5.256
726.	5.106	1546.	5.252
728.	5.104	1548.	5.25
730.	5.102	1550.	5.25
732.	5.103	1552.	5.246
734.	5.1	1554.	5.244
736.	5.1	1556.	5.244
738.	5.097	1558.	5.244
740.	5.098	1560.	5.24
742.	5.092	1562.	5.241
744.	5.091	1564.	5.24
746.	5.093	1566.	5.237
748.	5.087	1568.	5.237
750.	5.086	1570.	5.234
752.	5.083	1572.	5.235
754.	5.081	1574.	5.231
756.	5.079	1576.	5.229
758.	5.079	1578.	5.228
760.	5.077	1580.	5.228
762.	5.076	1582.	5.225
764.	5.073	1584.	5.222
766.	5.072	1586.	5.221
768.	5.07	1588.	5.221
770.	5.067	1590.	5.219
772.	5.069	1592.	5.218
774.	5.064	1594.	5.215
776.	5.066	1596.	5.214
778.	5.062	1598.	5.215
780.	5.06	1600.	5.21
782.	5.056	1602.	5.211
784.	5.054	1604.	5.207
786.	5.055	1606.	5.208
788.	5.051	1608.	5.205
790.	5.051	1610.	5.205
792.	5.049	1612.	5.203
794.	5.049	1614.	5.202
796.	5.045	1616.	5.202
798.	5.043	1618.	5.198
800.	5.04	1620.	5.197
802.	5.039	1622.	5.197
804.	5.038	1624.	5.195
806.	5.035	1626.	5.193
808.	5.036	1628.	5.194
810.	5.031	1630.	5.189
812.	5.031	1632.	5.19
814.	5.029	1634.	5.186
816.	5.03	1636.	5.186
818.	5.028	1638.	5.186
820.	5.025	1640.	5.183

SOLUTION

Slug Test
Aquifer Model: Confined
Solution Method: Bouwer-Rice
ln(Re/rw): 4.178

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.2945	m/day
y0	13.7	m

K = 0.0003408 cm/sec
T = K*b = 7.362 m²/day (0.8521 sq. cm/sec)

APPENDIX B:
QUALITY DATA DNRM BORES

REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
																Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
1134	28/07/1969	43250		1530	8.1				5	771			15.31	1495.75	1017.95	432		2	0	940		120	1.75	0	0									
5609	9/01/1987	118210	54.8	7200	7.5			26	922	140	0.4	17.2		4170.11	4109.7	1200	21	130	145	170	0.6	2350	0.1		135				0.1	17	0.16	0.8	0.35	
12159	11/06/1953	B2895	109						88	66	0.7	2.6		256	256	56.7		7.6	16.6		39.4	99	0.3		36.4									
12181	29/06/1953	13371	49	0					421	260	0.4	10.8		1712.5	1712.5	509.1		34.3	81.5	0	155.9	812.2	0.8		118.7									
12254	23/02/1954	13928	43	0					222	129	0.6	4.7	0	618.1	0	160.2		15.7	44.3	0	77.2	300.3	0.4		20									
14512	15/05/2010	1	43	3480	7.7		1.5		163	77	0.2	16.1		1425.1	1377.83	473	5	52	8	93		738			56				0.1					
15591	23/07/1963	1		0	6.3				82	98	1.5	1.2	0.32	143	143	24.3		18.6	8.6	0	58.6	20	0		12.9									
	23/07/1963	2		0	6.3				89	98	1.9	1	0.17	140.3	0	21.5		21.5	8.6	0	58.6	21.5	0		8.6									
17299	4/03/1969	41977		790	6.2				109	50	0.4	5		449.3	418.29	121		14	18	61		215	0.1		19				1.2					
	1/02/1967	36616	89	800	8.1				95	34	0.4	5.5		432.25	411.41	124		10	17	41		214	0.25		26									
	20/03/1986	114122	0	2250	8.3			25	630	485	0.4	14.3	0	3050	2780	135	0.9	200	70	295	4.5	570	0.1	0.7	71				0.06	1.6				
	27/09/1999	201715		780	6.3	0	0.4	12	89	26	0.4	5.3	0	412.92	408.68	114.5	8.3	7.3	17.2	31.7	0	212.6	0.13	0	21.1					0.11	0.01	0.01	0.1	0.04
36638	26/03/1971	48463	37	1950	7.9				340	164	0.6	6.4		1122.35	1020.69	271		52	51	200		528	0.35	5	15									
36640	26/03/1971	48464	37	3400	7.7				188	172	0.1	21.1		1985.35	1878.61	665		26	30	210		1000	0.35	12	42									
36641	19/05/1971	48786	17	8420	7.5				2641	790	1.1	9		5923.65	5433.65	1063		240	496	964		2360	0.65		800									
36649	25/01/1971	1	27	360	7.8									88	88	37						40	11											
36652	25/01/1971	1	33	2070	7.2									829	829	255						565		9										
36653	23/01/1971	1	24	1150	7.3									405	405	145						225		35										
	1/04/1997	JSC003	24	1000	7.1		3	45	193	181	0.7	4.2		682.65	615.82	135	12	28.5	29.5	220	0.2	180	0.3	41.5	34.5				0.03	0.17	0.5	0.05	0.4	
36654	23/01/1971	1	24	1760	7.4									721	721	263						405		53										
36657	6/01/1999	192385	30	3390	7.9	2	8.6	74	683	64	0.7	7	0	1872.73	1907.82	422.1	17.6	89.6	111.8	77.1	0.5	1015	0.28	8	130.8					0.46	0.2		0.2	
36658	21/01/1971	1	24	1280	7.5									521	521	170						255		96										
	1/04/1997	JSC004	24	1550	6.9				343	148	0.9	4.3		975.56	884.07	185	13.5	50	53	180	0.1	330	0.2	105	58				0.02	0.44			0.3	
36659	26/01/1973	1	25	450	7.1									104.1	104.1	39						65		0.1										
36773	21/01/1971	1	41	1680	7.2									652.1	652.1	202						450		0.1										
36783	20/02/1998	185404		7100	7.6			43	1500	281	0.7	10.6		4172.59	4042.77	940	20.5	345	155	340	1.4	2250	0.3		120					0.02	0.07		0.3	
38031	30/03/1971	48476	21	2340	7.6				392	246	0.5	7.7	0	1428.55	0	349		40	71	300		588	0.55	31	49									
38087	27/03/1971	48509	23	660	7.1				158	106	1	2.6	0	418.2	0	76		22	25	129	0	129	0.2	18	19									
38088	27/03/1971	48510	30	1550	7.3				288	152	0.6	5.7	0	960.4	0	223		38	47	185	0	369	0.4	0	98									
38089	27/03/1971	48509	32	660	7.1				158	106	1	2.6	0	418.2	0	76		22	25	129	0	129	0.2	18	19									
38090	23/01/1971	1	27	1900	8.4									686	686	210						450		26										
38092	23/03/1971	48405	49	1100	8.3				161	115	0.5	5.4		642.2	577.14	158		25	24	128	6	260	0.2	0	21				20					
	19/01/1999	192962		1027	7.7	0	45	81	141	110	0.4	5.7	0	617.36	630.68	156.7	8.6	19.4	22.6	132.8	0.4	254.6	0.14	5.7	16.4					0.03	3.4	0.01	0.2	
38093	23/03/1971	48506	24	1940	8.3				371	135	0.7	5.4		1061.2	990.04	240		58	55	140	12	500	0.2	24	32									
38094	23/03/1971	48507	46	1660	8.1				286	220	0.5	6.3		1041.3	905.08	243		60	33	268		385	0.3	21	31									
38095	25/03/1971	48508	153	1820	7.6				283	190	0.5			1071.95	954.02	259		113		232		450	0.95	0	17									
38100	27/03/1971	48489	44	1540	7.4				203	185	0.4	7.5	0	942.3	0	247		35	28	225		370	0.3	11	26									
38101	27/03/1971	48490		1950	7.4				296	180	0.5	7.4	0	1143.25	0	294		46	44	219		520	0.25	0	20									
38107	25/03/1971	48496		2030	7.8				191	290	0.2	12.2	1.98	1339.3	0	386		32	27	354	0	480	0.3		60									

REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Cations (mg/L) Na	K	Ca	Mg	Anions (mg/L) HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Metals (mg/L) Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
38108	25/03/1971	48495		1070	8.1				120	75	0.4	6.1	0	566	0	154		30	11	92	0	245			34									
38112	22/07/1970	60/70		1900	6.5				291	210	0.4	7.7		1195.4	1065.28	301		34	50	256		455	0.4	44	55									
	22/03/1976	70776		1950	7				209	220	0.3	8.9	0.22	1138	1001.78	296		34.8	29.6	268		448	0.5	1	60				0.1					
	22/03/1977	79177		1900	7.2				256	205	0.4	7.8		1153.6	1026.52	286	11	43	36	250		424	0.5	53	50				0.1					
38134	21/11/1994	170265		2157	7.8	0	0	24	241	454	0.3	10.6	4.26	1481.49	1226.13	377.5	5	60.4	21.9	548.6	2.6	416.4	0.44	6.1	42.5					0.01			0.2	
44467	25/09/1973	58975	30	3700	7.9				516	340	0.4	10.8		2166.78	1955.84	564	17.8	70	83	415	0	960	0.58	6	50				0.4					
44468	25/09/1992	140592	18	1100	7.8			100	61	178	0.1	11.7	2.32	690.61	681.33	210	4.4	8.8	9.6	215	0.8	220	0.4	3	18.5				0.07	0.04				
51099	13/12/1977	538		1450	6.8				201	140	0.5	6		804.6	717.68	196	13	31	30	171		328	0.3	7.2	28				0	0.1				
	11/03/1980	1156		1560	7.4			81	212	143	0.4	6.7		912.46	905.02	224	9	32	32	174	0.2	390	0.2	11	40				0.05	0.01				
	10/03/1981	2200		1595	6.7			78	215	148	0.4	6.8		927.86	915.38	228	7.5	30	34	178	1	386	0.3	20	43				0.05	0.01				
	20/12/1983	W1346		1600	6.8			66	225	164	0.5	6.5		945.87	910.21	225	9.4	34	34	200	0.1	350	0.3	38	55				0.06	0.01				
	3/04/1984	W2075		1450	6.7			69	216	160	0.5	6.4		893.71	863.59	215	9	32	33	195	0.1	330	0.3	35	44				0.3	0.01				
	26/06/1984	W2512		1450	6.8			74	205	160	0.4	6.5		874.96	849.84	215	8.5	31	31	195	0.1	320	0.3	31	43				0.05	0.01				
51366	17/03/1980	84875	69	3900	7.4			14	126	11	1	2.2		200	207.34	58	2.4	22.7	16.9	13.1	0.1	81.4			5.4									
51401	20/05/1980	86283	24	985	7			65	166	150	0.6	4.2		589.3	561.28	123	10	22	27	183	0.1	190	0.2	22	12									
	21/05/1980	86269	24	1260	7.2			67	246	170	0.7	4.4		781.4	743.18	160	13	36	38	207	0.2	290	0.2	22	15									
	29/09/1980	767		1850	6.5			70	305	177	0.6	5.8		735.36	695.57	232	12	43	48	216	0.1	136	0.2	23	25				0.05	0.01				
	20/12/1983	W1343		1600	6.9			64	274	164	0.6	5.8		970.36	932.7	220	13	39	43	200	0.1	380	0.2	47	28				0.05	0.01				
	3/04/1984	W2073		2100	6.9			68	340	189	0.6	6.6		1204.86	1155.95	280	12.5	47	54	230	0.1	495	0.2	45	41				0.05	0.01				
	26/06/1984	W2510		2100	6.8			73	338	197	0.5	6.7		1224.36	1175.37	285	12	48	53	240	0.1	495	0.2	52	39				0.05	0.01				
	11/12/1984	W1102		1650	7			81	228	181	0.4	7.2		1027.81	996.98	250	9.1	50	25	220	0.2	400	0.3	27	46				0.2	0.01				
	19/02/1985	W1416		2000	7.1			68	322	193	0.5	6.9		1215.06	1163.61	285	13.5	45	51	235	0.3	475	0.2	52	58				0.05	0.01				
	14/06/1985	W2079		770	7.1			59	141	123	0.7	3.2		476.74	459.49	88	12	17	24	150	0.1	150	0.3	19	16				0.32	0.02				
	21/01/1986	W1279		2000	6.8			67	312	197	0.5	6.9		1212.42	1157.43	280	12	46	48	240	0.1	490	0.3	56	40				0.01	0.01				
	30/09/1987	W540		1550	7.1			70	201	177	0.4	7.7		980.34	941.06	250	8.7	31	30	215	0.2	360	0.4	43	42				0.03	0.01				
	6/03/1990	W1787		1700	8.3			75	317	182	0.5	6.7		1107.25	1072.97	275	10.5	48	48	215	3.5	465	0.2	12.5	29.5				0.01	0.04				
	29/05/1990	W2120		1100	7.4			80	198	86	0.6	4.6		664.46	691.09	150	14	25	33	105	0.2	290	0.2	25	22				0.04	0.02				
	12/06/1990	W2228		890	6.9			85	152	82	0.6	4.2		521.41	555.58	120	12	18	26	100	0.1	205	0.2	19	21				0.1	0.01				
	14/11/1990	529-7		1050	7			75	207	82	0.8	3.6		606.8	630.97	120	14	23.5	36	100	0.1	255	0.2	28	30									
	19/03/1991	W1937		1500	7.4			70	240	136	0.6	5.6		864.55	850.68	200	13.5	33.5	38	165	0.3	360	0.2	25	29				0.04	0.01				
	14/10/1991	W948		1800	7.3			75	289	181	0.5	7.2		1134.14	1097.31	280	14.5	40	46	220	0.4	465	0.2	36	32				0.02	0.02				
	10/12/1991	W		1900	7.1			80	292	181	0.5	6.9		1110.94	1079.11	270	12	41	46	220	0.2	455	0.2	36.5	30				0.02	0.02				
	9/03/1992	W		1150	6.8			75	157	140	0.4	5.7		678.14	666.73	165	9.7	21	25.5	170	0.1	255	0.3	12.5	19				0.02	0.02				
51402	26/05/1980	86250	39	1890	7.9			80	314	137	0.6	6.2		1104	1099.62	252	12	50	46	166	0.8	437	0.2	104	36									
	27/05/1980	86252	39	1780	7.2			85	314	137	0.6	6.1		1153.4	1153.51	248	12	50	46	167	0.2	424	0.2	172	34									
	10/04/1981	2502		1700	6.6			85	316	132	0.6	5.7		1094.17	1098.35	234	12	49	47	159	1	440	0.1	110	42				0.05	0.02				
	11/04/1981	2499		1650	6.7			85	299	142	0.6	5.6		1041.36	1039.44	224	12	47	44	171	1	420	0.3	85	37				0.05	0.01				
	12/04/1981	2501		1630	6.8			85	294	138	0.6	5.7		1034.26	1034.88	224	12	45	44	166	1	420	0.2	85	37				0.05	0.01				
	13/04/1981	2553		1650	6.6			85	298	139	0.6	5.7		1035.16	1035.27	226	12	45	45	167	1	423	0.1	80	36				0.05	0.01				
	20/12/1983	W1344		1850	6.5			73	308	144	0.6	6.1		1088.26	1072.31	245	12	49	45	175	0	425	0.2	94	43				0.05	0.01				

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
	11/02/1984	W1632		1750	6.7			75	280	140	0.5	6.1		1025.36	1013.95	235	11	43	42	170	0.1	420	0.2	69	35				0.05	0.01				
	3/04/1984	W2074		1750	6.6			77	280	156	0.5	6.1		1041.36	1021.78	235	11	43	42	190	0.1	420	0.2	65	35				0.05	0.01				
	26/06/1984	W2511		1750	6.5			83	287	139	0.6	6		1023.26	1019.85	235	11	44	43	170	0	420	0.2	60	40				0.05	0.01				
	11/12/1984	W1100		2000	6.6			77	326	197	0.6	6.5		1192.91	1147.92	270	13.5	46.5	51	240	0.1	480	0.2	53	38.5				0.1	0.01				
	14/06/1985	W2077		1750	7.9			64	269	240	0.5	6.9		1134.47	1051.06	260	9.4	55	32	290	1.6	365	0.3	67	54				0.14	0.03				
	30/09/1987	W541		1550	6.7			74	246	140	0.5	6		925.48	913.07	215	10	39	36	170	0.1	380	0.2	46	29				0.17	0.01				
	29/05/1990	W2121		1050	7.5			65	310	206	1.4	2.6		729.95	667.88	105	24	60	39	250	0.5	215	0.4	13	23				0.02	0.03				
51402	10/12/1991	W		1650	7.2			85	262	148	0.5	6.1		949.45	942.96	225	12	40.5	39	180	0.2	375	0.2	46.5	31				0.03	0.02				
	29/06/1990	W2229		990	7.3			65	308	206	1.4	2.5		712.62	650.54	100	26	59	39	250	0.3	205	0.4	9.9	23				0.01	0.01				
	14/11/1990	W1155		1650	7.4			65	438	222	1.4	2.9		1009.9	937.66	140	27.5	70	64	270	0.5	350	0.4	40	47.5									
	14/10/1991	W949		1550	6.9			80	253	144	0.5	6		938.84	929.89	220	14	38.5	38	175	0.1	375	0.2	46	32				0.02	0.02				
	20/01/1992	W1858		1650	7			80	257	144	0.5	6.2		964.84	955.89	230	12	39.5	38.5	175	0.1	385	0.2	50	34.5				0.02	0.02				
	9/03/1992	W2269		1650	6.8			85	255	140	0.5	6.3		956.84	955.43	230	11	39.5	38	170	0.1	385	0.2	49.5	33.5				0.02	0.02				
	27/04/1992	W2635		1600	6.8			85	241	144	0.5	6.7		950.37	946.42	240	12	39	35	175	0.1	370	0.2	43	36				0.03	0.04				
	7/07/1992	W		1550	7			90	241	148	0.5	6.3		926.92	925.43	225	11	37	36	180	0.1	360	0.2	47	30.5				0.1	0.02				
	24/08/1992	W558		1650	7.2	5	1	90	248	144	0.5	6.1		924.34	925.39	220	11.5	37.5	37.5	175	0.2	365	0.2	47	30				0.1	0.02	0.02	0.05	0.2	0.05
	1/12/1992	W1602		1650	7.9			90	255	141	0.5	6		946.96	950.55	220	10.5	38.5	38.5	170	0.9	385	0.2	50	33				0.02	0.02	0.02	0.05	0.2	0.05
	17/02/1997	W1683		1400	6.9			65	209	164	0.5	6.3		854.7	818.04	210	9.8	33.5	30.5	200	0.1	330	0.3	12	28.5									
	1/07/1998	JER011		1450	6.7				220	148	0.5	6		866.84	775.35	205	9.6	35.5	35.5	180	0.1	330	0.2	43	31				0.02	0.02	0.10	0.05	0.2	0.05
	22/07/1996	192933		1500	6.8			80	232	144	0.5	6.3		905	896.05	220	10.5	36	34.5	175	0.1	355	0.2	42.5	31								0.2	
	20/10/1999	201750		1594	7.7	2	0.2	79	265	156	0.5	6.2	0	983.56	966.5	232.1	10.3	41.3	39.4	189	0.7	387.3	0.23	46.9	36.4						0.03	0.02	0.2	0.010
	13/03/2001	JER005		1350	6.8	14	13	85	207	132	0.5	5.6		769.9	773.57	185	8.7	31.5	31	160	0.1	300	0.2	28.5	24.5				0.03	0.03	0.02	0.05	0.22	0.05
51408	3/04/1981	2445		1600	6.9			80	236	120	0.4	7.4		1007.41	1014.21	262	9	35	36	144	1	469	0.3	4	47				0.1	0.01				
	5/04/1981	2445		1600	6.9	10	100	80	236	118	0.4	7.4		1006.42	1013.22	262	9	35	36	144		469	0.3	4	47				0.1	0.01	0.01			
	6/04/1981	2447		1650	6.9	5	2	80	242	117	0.4	7.4		1026.38	1033.69	265	9	36	37	143		485	0.3	4	47				0.05	0.02	0.01			
	7/04/1981	2448		1650	6.7			80	253	119	0.4	7.4		1041.86	1049.17	270	9.5	37	39	143	1	489	0.3	5	48				0.05	0.01				
	8/04/1981	2494		1670	7.3	5	7	80	248	116	0.4	7.2		1025.87	1034.71	260	9.5	35	39	140	1	490	0.3	6	45				0.05	0.01	0.01			
	9/04/1981	2489		1700	6.8	5	6	80	250	116	0.4	7.2		1027.33	1035.66	261	9	36	39	141		495	0.3	5	41				0.01	0.01	0.01			
	4/10/1983	W690		1600	6.8			81	192	135	0.4	7.9		945.46	942.59	250	8	29	29	165	0.1	400	0.3	15	49				0.05	0.01				
51881	30/12/1983	W1363		1650	7			36	207	135	0.4	7.7		967.97	920.1	255	8.5	30	32	165	0.1	405	0.3	18	54				0.06	0.01				
	31/12/1983	W1364		1650	6.9			37	200	135	0.3	8.2		1011.16	964.29	265	8.6	29	31	165	0.1	380	0.4	32	100				0.05	0.01				
	1/01/1984	W1385		1600	7			36	193	135	0.4	7.8		937.71	889.84	250	8	28	30	165	0.1	390	0.4	16	50				0.2	0.01				
	2/01/1984	W1386		1600	7.1			36	193	136	0.4	7.7		937.69	889.82	245	8	28	30	165	0.2	395	0.4	16	50				0.08	0.01				
	3/01/1984	W1387		1600	7			36	185	135	0.3	7.8		929.49	881.62	245	7.9	28	28	165	0.1	390	0.4	16	49				0.08	0.01				
	3/04/1984	W2076		1500	6.8			69	218	160	0.5	6.5		903.68	873.56	220	9.2	33	33	195	0.1	330	0.3	36	47				0.07	0.01				
	19/02/1985	W1417		1550	7			70	171	140	0.3	8.2		919.56	903.15	245	8	24	27	170	0.1	375	0.4	14	56				0.05	0.01				
	2/01/1986	W1282		1550	4.8			71	169	139	0.3	8.2		905.53	890.12	245	7.8	25	26	170	0	365	0.2	20.5	46				0.02	0.01				
	30/09/1987	W544		1450	7.2			890	169	152	0.3	7.9		897.51	1693.47	235	7.3	25	26	185	0.2	350	0.4	23	45.5				0.1	0.01				
	6/03/1990	W1790		810	8.4			55	107	110	0.3	6.1	0.05	540.92	529.84	145	8.2	15	17	130	1.9	195	0.3	7	21.5				0.01	0.01				
	29/05/1990	W2123		1150	7.4			70	165	132	0.4	6.1		733.64	722.31	180	11	25	25	160	0.3	280	0.3	20	32				0.02	0.02				

REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Cations (mg/L) Na	K	Ca	Mg	Anions (mg/L) HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Metals (mg/L) Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
	12/06/1990	W2226		270	6.8			49	46	69	0.7	2	0.45	194.51	200.81	31	12	8.2	6.3	84	0	41	0.1	5.5	6.3				0.1	0.01				
	14/11/1990	529-10		1350	7.2			70	175	144	0.4	7.1		837.92	818.97	215	8.8	24	28	175	0.2	320	0.4	25.5	41				0.01	0.01				
	19/03/1991	W1939		1550	7.5			65	189	152	0.4	7.6		907.33	878.29	240	10	28	29	185	0.4	345	0.4	27	42.5				0.02	0.01				
	14/10/1991	W951		1600	7.7			75	202	149	0.4	8		972.14	955.65	260	10	28	32	180	0.7	385	0.4	29	47				0.02	0.02				
	10/12/1991	598-13		1700	7.7			80	210	149	0.4	8		986.25	974.76	265	9.1	30.5	32.5	180	0.7	390	0.4	29.5	48.5				0.03	0.02				
	20/01/1992	W1860		1650	7.2			1	207	156	0.4	8		993.94	898.36	265	9.7	29.5	32.5	190	0.3	385	0.4	30.5	51				0.02	0.02				
	9/03/1992	W		1700	7			75	213	152	0.4	7.9		997.34	978.3	265	9.3	31	33	185	0.1	395	0.4	29.5	49				0.02	0.02				
	27/04/1992	W2636		1700	8.1			80	218	150	0.4	8.1		1024.95	1013.46	275	10	33	33	180	1.5	415	0.4	30	47				0.03	0.02				
	7/07/1992	W115		1700	7			85	207	152	0.4	8.2		985.12	976.08	270	9.1	30	32	185	0.1	385	0.3	28	45.5				0.1	0.02				
	1/12/1992	W1604		1750	7.9			85	213	153	0.4	7.6		988.27	979.23	255	8.5	30	33.5	185	1	395	0.3	30	49.5				0.02	0.02	0.030	0.05	0.3	0.05
51968	19/03/1981	W1941		1600	7.1			90	270	144	0.6	5.2		897.42	898.47	195	7	44	39	175	0.2	365	0.2	40	32				0.01	0.01				
	24/01/1984	W1536		1950	6.8			66	288	189	0.5	6.9		1116.46	1065.55	270	11	46	42	230	0.1	420	0.3	95	2				0.05	0.01				
	25/01/1984	W1534		1950	6.7			67	285	185	0.5	7		1107.86	1060.49	270	10.5	45	42	225	0.1	425	0.2	88	2				0.05	0.01				
	25/01/1984	W1535		2050	6.9			64	314	189	0.5	6.7		1160.36	1107.45	275	12	50	46	230	0.1	440	0.2	105	2				0.05	0.01				
	26/01/1984	W1580		1900	6.7			67	270	189	0.5	7.2		1104.36	1054.45	270	11	42	40	230	0.1	400	0.2	81	30				0.05	0.01				
	27/01/1984	W1578		1900	6.5			68	270	189	0.5	7.2		1127.36	1078.45	270	11	42	40	230	0.1	395	0.2	80	59				0.05	0.01				
	28/01/1984	W1579		1850	6.7			67	270	189	0.5	6.9		1101.36	1051.45	260	11	42	40	230	0.1	390	0.2	74	54				0.05	0.01				
	14/06/1985	W2076		1700	6.7			64	239	201	0.4	7.2		1068.02	1007.49	255	9.6	38	35	245	0.1	360	0.3	69	56				0.01	0.01				
	21/01/1986	W1281		1800	7.1			63	235	214	0.4	7.9		1138.72	1069.56	280	11	38	34	260	0.3	385	0.4	78	52				0.01	0.01				
	30/09/1987	W542		1700	7.2			67	236	201	0.4	7.6		1090.74	1033.21	270	10	37	35	245	0.3	385	0.4	66	42				0.03	0.01				
	29/05/1990	W2122		365	8			40	131	123	2.6	0.9		286.32	250.07	23	12	31	13	150	0.1	43	0.2	5.5	8.5				0.01	0.01				
	12/06/1990	W2224		500	7.4			47	134	132	1.2	1.9		360.5	326.17	50	13	29	15	160	0.2	66	0.3	16	11									
	14/11/1990	W1156		1550	7.2			70	228	189	0.5	6.3		958.7	911.79	220	11.5	34.5	34.5	230	0.3	320	0.4	68	39.5									
	19/03/1991	W1940		1550	7.7			75	240	190	0.5	5.9		951.82	909.91	210	8.7	40	34	230	0.8	320	0.3	68	40				0.01	0.01				
	19/03/1991	W1941		1600	7.1	5	1	90	270	144	0.6	5.2		897.78	898.83	195	7	44	39	175	0.2	365	0.2	40	32				0.01	0.01	0.030	0.05	0.2	0.08
	14/10/1991	W950		1600	7.7			70	227	202	0.4	7.4		1048.24	993.71	255	13.5	35.5	33.5	245	0.9	335	0.3	84	45.5				0.02	0.02				
	10/12/1991	W		1700	8			70	240	212	0.4	7.6		1102.14	1042.52	270	12	37.5	35.5	255	1.7	345	0.4	98	47				0.02	0.02				
	20/01/1992	603-6		1650	7.3			70	221	197	0.4	7.6		1042.34	990.35	260	11.5	34	33	240	0.4	335	0.4	82	46				0.02	0.02				
	9/03/1992	W2270		1750	7.2			70	232	197	0.4	7.6		1052.54	1000.55	265	11.3	36	34.5	240	0.3	330	0.4	88	47				0.02	0.02				
	27/04/1992	W		1150	7.6			65	125	181	0.3	7.4	1.13	736.21	689.38	190	13	17	20	220	0.6	195	0.5	49	31				0.09	0.02				
	7/07/1992	W		1700	7.2			80	222	210	0.4	7.9		1073.82	1024.2	270	11	34.5	33	255	0.3	340	0.4	85	44.5				0.1	0.02				
	24/08/1992	W562		1700	7.9	5	1	7575	220	211	0.4	7.6		1044.75	8490.13	260	11.5	33	33.5	255	1.4	325	0.3	81	43.5				0.1	0.02	0.030	0.05	0.3	0.05
	1/12/1992	W1603		1650	8.1			80	210	200	0.4	7.2		989.68	947.69	240	10	32	31.5	240	1.9	315	0.3	75	43.5				0.02	0.02	0.040	0.05	0.3	0.05
	12/10/1993	W788		1600	7.8			70	217	194	0.4	7.5		1023.77	974.32	255	11.5	35	31.5	235	1	340	0.3	69	45				0.03	0.02	0.020	0.05	0.3	0.05
	22/07/1996	192934		1950	7			70	280	214	0.4	7.7		1202.32	1140.16	295	12.5	43	42	260	0.2	425	0.3	71	53						0.020		0.3	
	17/02/1997	W1682		1800	7.1			65	272	209	0.4	7.4		1169.1	1104.48	280	13	41.5	41	255	0.2	420	0.4	67	51									
	1/07/1998	JER013		1850	7.2				250	230	0.4	8		1169.26	1026.94	290	12	39	37	280	0.3	390	0.4	67	53				0.02	0.02	0.020	0.05	0.4	0.05
	13/02/2001	JER002	34	1800	7.3	4	1	70	251	227	0.4	8		1152.59	1082.81	290	12.5	37.5	38	275	0.4	375	0.4	70	53				0.04	0.02	0.19	0.05	0.44	0.05
51984	5/05/1994	155334		7630	7.9			26	1459	193	0.6	12.4	0	4472.24	4380.33	1090	27.5	317.8	161.9	231.4	1.8	2519	0.34	0	122.5				0.01	0.01				
69428	26/02/1987	119123	50	21500	8.2			50	2178	540	0.2	42.4		14368.9	14098.67	4550	7	180	420	630	14	7700	0.9	13	850					4				

REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Cations (mg/L) Na	K	Ca	Mg	Anions (mg/L) HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Metals (mg/L) Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
69696	12/06/1991	141006	53	1449	7.9			13	16	53	0	30.3	0.73	759.85	739.99	279	1.4	5.6	0.5	63.7	0.4	406	3.33	0	0									
69715	31/01/1992	141078	45	1564	8.1			99	240	116	0.5	6	0	873	900.77	214.6	12.3	36.9	36	139.4	1.3	408.2	0.18	5.4	18.8									
	2/10/1992	20752	40	1420	6.2				247	102	0.5	5.8		844.39	782.38	210	10	33	40	122	1	415		1.3	12				0.08	0.01				
69716	14/10/1991	141064	28	12672	7.9			22	1258	430	0.2	30.4	0	8111.84	7872.27	2481	32.5	102	244	514	5.2	4039	0.14	0	694					0.15				
69720	19/10/1991	141068	56	9093	7.9			49	1914	314	0.7	12.4	0	5389.65	5247.65	1243	33.9	332	264	376	3.5	2968	0.3	0	169					0.12				
69729	9/01/1992	141076	33	2375	8.4			61	176	184	0.2	14.2	0.15	1423.75	1375.51	431.8	13.5	29.2	25	214.5	4.5	558.3	0.35	86.4	60.1				0.02	0.07				
69749	18/05/1992	146209	42	1171	7.9			77	157	157	0.4	6.2	0	710.26	691.08	179.3	10.1	27	21.7	189.2	0.9	248.7	0.28	7.5	25.5									
	17/05/1992	146208	42	1273	8.1			82	193	144	0.5	5.3		742.48	736.9	169.4	10.8	29.4	29.1	172.3	1.6	282.3	0.22	24	23.3					0.06				
	7/07/1992	W		1200	8			17	151	175	0.3	7.1	0.48	761.92	672.18	200	10.5	20	24.5	210	1.5	265	0.2	8.1	22				0.1	0.02				
	21/06/1993	W3219		1700	7.5			90	232	153	0.4	7.4		1013.2	1009.16	260	11	37	34	185	0.5	395	0.2	39	51				0.02	0.02	0.030	0.08	0.3	0.05
	12/10/1993	W786		1450	7.5			65	286	140	0.7	4.6		867.3	845.89	180	15	42	44	170	0.4	365	0.2	21	27				0.05	0.05	2.3	0.05	0.2	0.05
	22/07/1996	192932		1400	6.9			65	204	164	0.4	6.4		852.9	816.24	210	9.4	34	29	200	0.1	330	0.2	11	29								0.2	
	17/02/1997	W1681		1450	6.7			80	232	144	0.5	6.1		898.3	889.35	215	10.5	36	34.5	175	0.1	355	0.2	41.5	30.5									
69749	1/07/1998	JER012		1900	6.8				315	172	0.6	6.4		1112.78	1006.04	260	12.5	48.5	47	210	0.1	470	0.2	31.5	32.5				0.02	0.04	0.12	0.05	0.2	0.05
	13/02/2001	JER001	49	1500	7	1	1	70	225	165	0.5	6.4		891.42	859.76	220	9.6	37	32	200	0.1	340	0.3	20.5	31.5				0.04	0.02	0.020	0.05	0.24	0.05
90084	15/12/1993	155317	130	5240	8			6	608	115	0.4	14.3	0	2911.47	2847.96	809.2	37.9	133.4	67	136.9	1.4	1552	1.03	4.9	167.7					0.04				
	15/12/1993	155318	147	1580	8.2			7	112	146	0.2	10.6	0.66	914.62	833.53	259	16.6	23.6	13	173.9	1.8	362.3	1.41	2.9	60.1									
	15/12/1993	155319		1103	8.6			19	86	94	0.2	8.6	0.15	636.32	599.52	183.1	13.9	25.2	5.7	109.2	2.6	270.7	0.32	0	25.5									
90085	15/12/1993	155316	156	924	7.5			10	105	51	0.4	5.6	0	488.77	467.59	132	8.5	14.1	17	61.3	0.1	231.3	0.2	0	24.2					0.1				
90150	21/12/1998	192951		2880	7.3	1	0.4	81	540	232	0.6	7.3	0	1721.81	1659.35	389.9	23.1	85.6	79.3	281.6	0.4	748.9	0.22	43.7	69					0.01	0.08		0.2	0.02
90155	5/05/1994	155335		6800	8			29	1325	218	0.7	11.3	0	3930.66	3826.89	944	22	292.9	144.4	261	2.5	2210	0.37	0	53.5				0.02	0.01				
90192	10/07/1995	170294		1481	8.1	9	1.8	66	235	212	0.5	6.2		950.88	887.52	218.1	16.4	33.6	36.7	254.5	1.9	289.6	0.32	63.1	36.3						0.03		0.3	0.03
	22/12/1998	192950		1750	7.5	3	4.8	69	419	163	1.1	3.8	0	1014.55	983.24	177.2	23.3	56.2	67.9	197.7	0.4	423.8	0.24	34.9	32.9						0.15		0.2	0.03
90193	10/07/1995	170295		1560	7.3	1	0.7	57	285	185	0.7	5.2		966.77	909.5	200.5	23.3	41.6	44	224.8	0.3	317	0.22	67.2	47.4						0.13		0.3	0.02
	21/12/1998	192952		1760	7.3	1	0.3	64	321	207	0.7	5.4	0	1081.11	1017.77	223.2	25.2	48.5	48.6	251.1	0.4	370.6	0.22	65	48.2						0.11		0.3	0.02
90453	19/06/1996	175775		1360	7.3	2	5.7	68	201	167	0.5	5.9	0	819.56	784.23	192.7	10.7	30.3	30.6	203.1	0.3	295.8	0.49	18.1	37.5					0.01	0.15		0.5	0.01
103113	15/12/1997	185327		1000	7.8	2		60	130	104	0.4	5.5		580.52	576.98	145	11	19	20	125	0.6	230	0.3	4.9	24.5				0.02				0.2	
	1/07/1998	JER010		1400	7				160	144	0.3	7.9		849.58	760.63	230	9	24.5	24	175	0.1	325	0.4	21	40				0.02	0.02	0.14	0.05	0.3	0.05
	13/03/2001	JER004		330	7.2	13	1	47	31	91	0.3	4.4	1.2	229.3	220.39	55	4.3	4.2	4.8	110	0.1	40.5	0.2	4.1	5.8				0.02	0.02	0.02	0.05	0.14	0.05
103183	27/04/1992	W2638		900	6.9	5	1	80	95	127	0.3	6.5	0.64	543.57	544.78	145	10	15	14	155	0.1	180	0.2	0.5	23				0.08	0.36	0.02		0.28	0.03
	1/04/1997	JSC002	68	770	6.6	1	55	75	102	148	0.4	5.2	0.92	506.82	490.33	120	7.5	16	15	180	0	150	0.2	0.5	17.5				0.04	0.08				
	9/12/1998	192378		890	8.1			75	106	129	0.3	5.9	0.46	557.23	553.44	140	7.6	17	15.5	155	1.3	195	0.2	0.4	25						0.03		0.2	
103184	25/11/1990	W1251	47	480	7.8	5	100	80	64	70	0.4	3.9	0.12	287.8	324.59	71	6.7	7.5	11	85	0.3	96	0.2	1.1	9									
	8/07/1998	JER014	54	600	6.5	1	1	70	97	59	0.6	3.2		325.34	358.74	72	7.5	11	17	72	0	140	0.2	2.1	3.5				0.02	0.02				
	9/12/1998	192376		600	7.7			75	102	56	0.6	3.1		334.84	375.28	73	8	10.5	18.5	68	0.2	150	0.2	2.3	4						0.04		0.1	
103186	13/11/1991	W1433	60	370	6.8		10	75	69	77	0.8	2.1	0.16	235.98	263.2	40	7	8.8	11.5	94	0	61	0.1	2.1	5.7					0.7	5		0.08	
	19/01/1999	192992		365	8.2	1	2.3	67	74	71	0.9	2	0	226.52	250.04	39.9	6.4	9.9	11.9	85.6	0.8	65.9	0.14	1.4	4.7						0.03		0.1	
	9/12/1998	192377		340	7.8			70	70	65	0.9	2		211.35	241.19	37.5	6.5	8.1	12	79	0.3	61	0.1	1.3	5.2					0.04	0.21		0.1	
103194	21/12/1998	192947		1380	7.6	1	2.6	79	232	161	0.6	5.4	0	820.22	800.07	188.4	9.8	40.4	31.9	195.7	0.6	318	0.26	9.5	25.7						0.29		0.2	0.02
103218	12/09/1999	201713		2310	7.3	21	5.8	69	557	413	0.9	5.5	0	1517.07	1331	300.4	17.3	126.8	58.4	502.4	0.7	485.9	0.27	0	24.9				1.31	4.55	0.01	0.01	0.2	0.04

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
	12/09/1999	201714		2020	7.1	23	9.8	87	331	279	0.5	7.3	0	1251.87	1166.43	305.8	15.9	52.3	48.7	339.6	0.3	483.4	0.31	0	5.6				2.37	3.47			0.3	
103222	6/09/1999	ALP 5	66	1330	8				160		0.3	7.9		668.22	668.22	230	5.8	36	17			344		0.1	35				0.12	0.1	0.1			
	6/09/1999	201705		1350	8.2	27	12.2	34	147	209	0.3	8.2	1.25	861.25	767.76	227.9	6.9	34.4	14.8	249.9	2.5	292.1	0.42	2	30.4						0.03		0.3	
103224	14/09/1999	201706		1660	7.8	11	130	60	252	330	0.4	7.2	1.55	1146.47	1003.7	263.4	10.5	55.1	27.9	398.9	1.8	330.5	0.35	9.2	48.7				0.02		0.16		0.2	0.01
103225	14/09/1999	201707		1340	8.2	16	31	43	164	260	0.3	7.6	1.93	913.37	798.16	222.3	11.4	42.3	14.2	311.3	3.1	250.1	0.41	6.2	52.1						0.04		0.2	
	15/09/1999	201708		1600	7.8	11	11.9	67	201	252	0.3	8.3	1.03	1073.08	985.39	269.1	10.2	44.3	21.9	304.5	1.4	354.7	0.37	7.6	59						0.17		0.2	0.01
	14/09/1999	201709		1850	7.4	17	33.8	46	303	208	0.5	7.1	0	1253.17	1170.15	286	14.5	96.2	15.4	252.8	0.5	360.6	0.5	9.1	217.6				0.01		0.14		0.1	
103226	12/09/1999	201711		1480	8	5	1.5	48	204	201	0.4	7.1	0	939.62	864.58	233.3	8.3	45.2	22.1	242.3	1.5	342.2	0.47	5.8	38.5				0.01		0.03	0.02	0.2	
	12/09/1999	201710		1560	8.2	6	3.6	32	197	193	0.4	7.6	0	962.24	876.8	246.1	8	48	18.8	231.1	2.4	364.2	0.5	5.8	37.4						0.05		0.3	
	12/09/1999	201712		1810	7.8	10	6	81	317	207	0.6	6.3	0	1116.01	1069.22	258.7	10.2	57.7	42.1	250.6	1	453.5	0.3	8.8	33				0.01	0.01	0.02	0.02	0.2	
103671	23/06/2011	1		2290					100	1	0.1	18.7		528.3	528.3	427		10	18						73				0.05			0.01	0.24	
132744	23/06/2011	1		1250					33	1	0.1	20		277.51	277.51	261	5	8	3										0.05			0.01	0.45	
132790	12/05/2010	XXX		3210	7.6				301	136	0.1	32.1		3611.14	3527.27	1280	16	66	33	165		1890			161				0.06	0.08				
132791	13/05/2010	XXX		6250	6.9				745	135	0.2	34.8		6591.87	6508.51	2180	24	97	122	164		3790			214				0.63	0.23	0.01			
132792	14/05/2010	XXX		9030	7.1				1906	107	0.5	16.3		6316.89	6250.81	1640	36	555	126	130		3740			89				0.47	0.31	0.11			
12030028	10/08/1977	73709	12.8	920	7.9				58	330	0.1	10.3	5.44	728.6	525.79	180	9.2	14	5.6	399	1.8	80	0.4	0.6	38									
12030028	6/11/1978	79597		770	7.3			35	44	290	0.1	10.3	4.91	609	464.57	158	6	12	3.5	353	0.4	55	0.4	0.7	20									
12030029	10/08/1977	73710	8.75	820	7.8				113	330	0.4	6	4.34	696.1	493.29	146	7.4	31	8.6	399	1.6	60	0.5	13	29									
	6/11/1978	79598		820	7.4			36	114	310	0.4	5.8	3.91	663.8	508.17	142	9	26	12	377	0.6	50	0.5	6.7	40									
12030030	6/11/1978	79599		510	7.2			58	34	210	0.1	8.3	3.53	430.2	358.08	110	4.5	6	4.5	256	0.2	30	0.5	0.5	18									
12030036	10/08/1977	73712	17	310	8.3				63	140	0.8	2.1	1.55	265.9	181.01	38	12	13	7.4	167	2	20	0.1	0.4	6									
	3/07/1998	185427		337	7.1	17	57	27	95	136	1.6	1.2	0.82	266.14	208.97	26.5	16.1	18.6	11.7	165.2	0.1	20.4	0.12	0.7	6.8				0.04		0.01	0.05	0.1	0.01
	20/10/1999	201741		297	7.4	3	8950	31	71	123	1.2	1.4	1.05	233.99	188.99	27.4	12.9	13.3	9.1	150.1	0.2	10.4	0.1	1.6	8.9				0.02		0.02	0.01	0.1	0.01
12030039	10/08/1977	73713	30.6	900	8				125	140	0.4	5.8	0.31	598	512.1	148	6.8	22	17	169	1	195	0.2	19	20									
	7/11/1978	79600		880	7.6			65	113	135	0.4	5.3	0.44	545.4	527.04	129	5.5	19	16	164	0.4	190	0.2	7.3	14									
	13/12/1983	104352		690	8.1			80	84	121	0.4	4.6	0.73	422.83	429.13	98	4.4	14	12	145	1.2	115	0.2	19	14				0.02	0.01				
	3/07/1998	185423		255	6.7	20	13	19	55	48	1	1.5		162.72	152.24	25	6.8	13.5	5.2	58	0	37		14.5	2.5				0.08		0.08	0.06		
	10/11/1998	192941		267	7.4	4	48.3	20	56	54	1	1.6	0	170.64	157.4	27.2	5.9	13.2	5.7	65.6	0.1	40.7	0.09	9.4	2.8						0.02		0.1	0.01
	20/10/1999	201726		360	7.6	7	141	25	64	65	0.8	2.1	0.02	218.63	203.9	39.2	7.2	14.2	6.9	78.6	0.2	61.5	0.1	6.7	4				0.08		0.13		0.1	0.01
12030040	10/08/1977	73714	12.4	1850	7.3				335	385	0.5	6.8	1	1342.1	1104.22	286	25	50	51	468	0.7	380	0.5	3.9	77									
	3/07/1998	185424		1750	7.4	1	7.5	58	360	284	0.8	5	0	1116.5	999.17	218.8	26	58.4	52	345.5	0.6	382.7	0.31	3.7	28.5				0.01	0.16	0.03		0.4	0.01
	20/10/1999	201738		2090	7.9	6	688	49	359	368	0.6	6.8	0.18	1346.09	1170.38	295.3	21.8	53.6	54.7	442.7	3	428.6	0.4	0	46						0.02		0.5	
12030041	10/08/1977	73715	23.7	1500	7.6				201	160	0.4	7.2		952	853.39	234	22	31	30	194	0.5	400	0.5	0	40									
	7/11/1978	79601		2050	7.5			57	293	145	0.4	7.7		1241.9	1209.44	302	11	43	45	176	0.4	520	0.5	100	44									
	13/12/1983	104388		1900	8			77	302	146	0.6	6.3	0	1074.62	1062.67	250	11	45	46	175	1.4	460	0.2	48	38				0.01	0.01				
	3/07/1998	185425		255	6.7	12	9	22	44	34	0.7	1.8		152.22	153.13	27.5	7.2	8.6	5.5	41.5	0	42.5	0.1	16	3				0.08	0.04	0.13	0.07		
	10/11/1998	192942		848	7.6	2	4952	73	102	121	0.4	5.8	0.36	532.2	530.47	135.3	7.5	15.7	15.4	146.4	0.3	174.7	0.24	22.1	14.5						0.02	0.01	0.2	
	20/10/1999	201737		1058	7.1	5	126	75	126	137	0.4	6.4	0.22	638.73	628.77	164.4	9.2	19.8	18.6	166.9	0.2	229.1	0.2	10.2	20.1					0.01	0.23		0.2	0.01
12030042	10/08/1977	73716	4.7	110	6.5				22	20	1.5	0.6		59.7	47.5	6.7	5.4	4	3	24	0	5	0	1.6	10									
12030043	10/08/1977	73717	5.4	167	6.6				62	78	5	0.3	0.32	148.3	100.01	5.7	6.9	17	4.7	95	0	5	0	8	6									

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
12030044	1/01/1977	73718	9.2	220	7.3				75	100	2.9	0.6	0.5	200.9	138.89	12	11	14	9.8	122	0.1	12	0.3	2.7	17									
	13/12/1983	104335		260	7.2			48	73	90	1.9	0.9	0.34	192.41	184.5	18	9.8	14	9.3	110	0.1	20	0.4	3.9	5				1.9	0.01				
12030046	10/08/1977	73719	7.7	600	7.3				211	275	2.4	1.2	1.27	501.7	331.93	40	16	40	27	334	0.4	32	0.3	5	7									
12030047	10/08/1977	73720	10.7	228	7.5				87	95	4.4	0.4	0.15	177.2	118.75	9.1	7.5	21	8.4	115	0.2	10	0.2	0.8	5									
	13/12/1983	104033		570	8.1			53	202	259	2.4	1.2	1.13	454.11	349.54	39	7.4	38	26	310	2.6	23	0.4	0.8	6.9				0.01					
12030048	10/08/1977	73721	19.7	965	7.8				112	305	0.3	6.8	3.86	710.8	523.24	164	13	20	15	369	1.4	92	0.4	4	32									
	6/11/1978	79602		970	7.7			59	127	289	0.3	6.9	3.24	747.7	628.29	179	10	23	17	351	1	125	0.5	1.2	40									
12030052	7/11/1978	79603		790	7.4			44	48	305	0.1	10.7	5.15	662	517.42	170	9.5	7.5	7	371	0.6	50	1.4	1	44									
12030068	10/08/1977	73722	9.7	4400	7.7				796	310	0.9	6.4		2141.1	1950.49	418	26	98	134	375	1.6	940	0.5	0	148									
	13/12/1983	104098		3800	8			51	662	485	0.6	8.8		2312.91	2069.1	520	19	92	105	580	5.5	890	0.8	0.5	100				0.1	0.01				
12030076	11/08/1977	73723	27.6	20800	8				1627	280	0.2	52.4		13791.3	13617.97	4860	30	190	280	341	0	7200	0.3	0	890									
	7/11/1978	79604		22700	7.8			20	1600	335	0.2	52.5		14398.4	14211.01	4830	30	130	310	408	0	7700	0.4	10	980									
	13/12/1983	104450		20500	8.1			18	1539	290	0.2	49.4	0	13469.52	13314.7	4450	27	130	295	340	6.6	7300	0.4	0.5	920				0.01	0.01				
12030077	11/08/1977	73724	5.5	210	7.5				22	36	0.3	3.2	0.29	140.1	117.73	34	0.2	3.9	2.9	44	0.1	42		0	13									
	13/12/1983	104008		190	7.4			64	23	30	0.4	2.7	0.14	122.81	168.26	30	4	4.5	2.9	36.5	0.1	32	0.1	1.5	5.1				6.1	0.01				
12030144	1/10/2003	5621		11900	8.4				1388	192	0.3	23.1		6154.1	6036.17	1980	51	160	240	232	1	2900	0.1		590									
15405	15/05/2010	1	43	7710	7		0.4		801	333	0.3	17.5		3747.27	3540.9	1140	21	126	118	406		1690			246				0.27					
36826	2/09/1991	140510	106	10500	7.2			20	757	317	0.2	34.8		6602.4	6426.7	2200	28.5	130	105	385	0.6	3450	2.3	0	300				0.1	0.9				
51594	27/02/1980	1080		4200	6.5	5	40	17	725	250	0.6	9.4		2344.56	2206.53	584	23	86	124	305	0.1	1140	0.3	0.1	81				0.2	0.37	0.49			
51594	23/02/1982	2080		1150	6.1	5	40	13	167	40	0.5	5.2		606.71	594.8	155	12	14	32	49	0	299	0.2	0.5	42				2.8	0.19	0.02			
	16/03/1982	2060		3370	6.2	10	40	10	570	55	0.6	7.5		1764.21	1740.1	414	20	60	102	67.1	0	1040	0.1	0.5	52				8	0.5	0.01			
	16/03/1982	2061		2730	6.2	5	40	12	336	71	0.4	8.2		1404.95	1372.93	346	18	6	78	86.6	0	810	0.1	0.5	57				2.4	0.32	0.03			
	16/03/1982	2062		2470	6.3	5	40	12	386	73	0.6	6.9		1305.32	1272.08	313	16	41	69	89	0	717	0.1	0.5	57				2.45	0.26	0.01			
	17/03/1982	2063		1510	6.2	5	40	14	202	50	0.5	6		790.76	773.75	197	11	20	37	61	0	410	0.1	0.5	49				4.95	0.2	0.01			
	18/03/1982	2064		1290	6.2	5	40	14	161	50	0.4	5.9		680.84	663.83	171	10.5	15	30	61	0	340	0.1	0.5	47				5.55	0.18	0.01			
	19/03/1982	2076		1180	6.1	5	38	13	146	37	0.5	5		590.49	580.62	139	10	14	27	45	0	308	0.2	0.5	45				1.6	0.17	0.02			
	20/03/1982	2077		1160	6.1	5	40	13	139	42	0.4	5.7		597.99	585.07	155	10	13	26	51	0	297	0.2	0.5	43				2.1	0.17	0.02			
	21/03/1982	2078		1140	6.1			13	137	41	0.4	5.8		592.88	580.47	155	10	12	26	50	0	294	0.2	0.5	43				2	0.18				
	22/03/1982	2079		1130	6	5	40	13	137	41	0.4	5.7		591.31	578.9	154	10	12	26	50	0	293	0.2	0.5	42				3.4	0.19	0.02			
	24/03/1982	2112		1140	6	15	25	13	134	38	0.4	5.8		593.12	582.74	155	10	11	26	46	0	301	0.2	0	40				3.7	0.2	0.02			
	25/03/1982	2113		1140	6	5	12	13	141	38	0.4	5.8		600.12	589.74	158	10	12	27	46	0	302	0.2	0.5	41				3.2	0.2	0.02			
	28/02/1983	29653		950	6.3	1	16.3		110	60	0.4	5.9		524.84	487.63	142.5	11.7	10	20.7	73.2	0	248.3			4.8				13.4	0.24				
	23/09/1985	W592		1600	6.1			9	220	60	0.5	6		819.7	791.59	205	14.5	22	40	73	0	435	0.1	0.5	29				0.06	0.3	0.01	0.1	0.12	0.01
	26/05/1986	W2169		1100	8			11	109	80	0.3	7.1		628.55	590.75	170	11	9.1	21	96	0.6	260	0.1	0.5	60				0.01	0.01	0.01	0.1	0.11	0.01
	6/10/1987	W567		1050	6.5			13	119	58	0.4	5.8		565.38	542.29	145	11	13	21	71	0	260	0.2	0.5	41.5				2	0.18				
	13/11/1991	W1329		980	6.5			13	106	52	0.3	5.9		529.9	510.88	140	13	8.7	20.5	63	0	240	0.2	0.5	44									
	10/12/1991	W1605		990	6.9	5	54	12	108	43	0.3	6.1		526.08	511.65	145	10.5	8.8	21	52	0	245	0.2	0.5	42.5				0.04	0.18	0.04	0.11	0.11	0.1
	20/01/1992	W1862		960	6.5	5	48	12	107	48	0.3	6.1		528.3	510.82	145	11	8.2	21	58	0	240	0.2	0.5	44				0.02	0.17	0.02	0.05	0.12	0.02
	9/03/1992	W2272		970	6.5		27	13	108	46	0.3	6.1		525.23	509.77	145	10.5	8.6	21	56	0	240	0.2	0.5	43				0.02	0.18	0.02	0.05	0.14	0.02
	27/04/1992	W2640		1200	8	5	2	11	96	129	0.2	9.3	0.66	712.12	644.33	210	12	7	19	155	1.1	245	0.2	0.5	62				0.06	0.02	0.02		0.19	0.03

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
	7/07/1992	W120		980	6.4	5	24	15	110	53	0.3	6.2		538.54	520.5	150	10	8.7	21.5	65	0	240	0.2	0.5	42				0.22	0.2	0.02	0.05	0.12	0.03
	1/12/1992	W1606		990	7.4			16	110	54	0.3	6		542.28	524.73	145	10.5	9.3	21	66	0.1	245	0.2	0.5	44.5				0.02	0.16				
	14/10/1993	W784		950	6.9	5	38	13	102	41	0.3	6.2		525.94	513.78	145	11	8.9	19.5	49.5	0	245	0.2	0.5	45.5				0.43	0.19	0.02	0.05	0.1	0.05
69268	26/11/1987	122799		980	7			14	126	18	0.4	5.4		507.03	510.1	140	10.5	9.3	25	21.5	0	270	0.2	0.5	30				0.01	0.02				
69091	13/12/1985	113279	0	820	8			17	125	93	0.5	4.1	0	480	440	105	8.5	33	10	110	0.7	180	0.2	0.7	28	0			0.02					
103202	9/05/2000	201777		900	6.7	0	0.5	12	88	43	0.3	6.4	0	485.63	471.18	138.3	8.2	6.3	17.6	52.6	0	225.3	0.21	0	37.1					0.03	0.39		0.1	
	6/05/2000	201779		885	6.8	0	4.5	12	87	44	0.3	6.4	0	487.07	472.18	137.9	8.1	6.5	17.2	53.5	0	226.5	0.2	0.2	37					0.03	0.41		0.1	
	6/05/2000	201779		890	6.7	1	5	12	87	44	0.3	6.6		487.96	473.02	140	8.1	6.5	17	53	0	225	0.2	0.5	37				0.02	0.03	0.41	0.05	0.1	0.05
	7/05/2000	201778		890	6.7	1	2	12	86	44	0.3	6.3		487.86	472.92	135	8.1	6.4	17	53	0	230	0.2	0.5	37				0.02	0.03	0.41	0.05	0.1	0.05
	8/05/2000	201780		890	6.7	1	1	12	88	42	0.3	6.5		486.42	472.5	140	8.3	6.3	17.5	51	0	225	0.2	0.5	37				0.02	0.03	0.37	0.05	0.1	0.05
	9/05/2000	201777		900	6.7	1	1	12	88	44	0.3	6.5		488.34	473.4	140	8.2	6.3	17.5	53	0	225	0.2	0.5	37				0.02	0.03	0.39	0.05	0.1	0.05
	7/05/2000	201778		888	6.7	0	2.1	12	87	44	0.3	6.4	0	488.33	473.57	136.9	8.1	6.4	17.2	53.2	0	228.9	0.2	0.3	37.1					0.03	0.41		0.1	
	8/05/2000	201780		888	6.7	0	0.5	12	87	42	0.3	6.4	0	483.29	469.58	137.6	8.3	6.3	17.4	51	0	225.3	0.2	0.2	37.1					0.03	0.37		0.1	
	9/05/2000	46994/	119	900	5.9				86	32	0.3	6.6		481.39	461.57	140	7	8	16	39		240		0.2	31				0.16	0.03				
103203	7/06/2000	201781		960	6.6	1	4	12	116	64	0.4	5.9		542.57	514.92	145	8.4	17.5	17.5	78	0	235	0.3	0.5	36				0.02	0.15	4	0.05	0.1	0.05
	8/06/2000	201781		960	6.7	0	4.3	12	115	64	0.4	5.8	0	535.52	508.24	142.5	8.4	17.3	17.4	78.1	0	235.3	0.26	0.5	35.8					0.15	4		0.1	
	8/06/2000	201782		910	6.8	0	2	12	95	55	0.3	6.2	0	503.98	482.02	139.9	8.2	9.8	17.2	67.2	0	224.7	0.24	0	36.8					0.12	1.87		0.1	
	9/06/2000	201784		900	6.6	1	9		92	46	0.3	6.4		497.04	469.08	140	8.1	7.8	17.5	55	0	230	0.2	0.5	37				0.02	0.02	0.7	0.05	0.1	0.05
	9/06/2000	201783		895	6.7	0	2.1	12	90	48	0.3	6.3	0	493.19	475.63	137.7	8.3	7.5	17.3	58.2	0	227	0.21	0.2	36.8					0.04	0.85		0.1	
	9/06/2000	201784		896	6.6	0	8.9	12	92	45	0.3	6.3	0	492.23	476.33	137.9	8.1	7.8	17.7	54.9	0	228.3	0.21	0.5	36.8						0.65		0.1	
	10/06/2000	201783		900	6.7	1	2	12	91	48	0.3	6.4		495.16	477.68	140	8.3	7.5	17.5	58	0	225	0.2	0.5	37				0.02	0.04	0.9	0.05	0.1	0.05
103214	17/06/1999	192984	54	1770	7.6	0	105	12	297	30	0.6	5.7	0	909.2	902.81	225	15.7	23.6	58	36.2	0.1	480.6	0.12	0	69.9					0.07	0.04		0.1	
103214	21/06/1999	19288	109	1150	7.8	1	44	9	144	51	0.4	6		624.2	602.19	165	12	12	27.5	61	0.2	300	0.6	1	44.5				0.02	0.14	0.04	0.05	0.1	0.05
	21/06/1999	19287	104	950	7.8	1	41	10	112	36	0.4	5.6		505.69	493.83	135	9.9	8.5	22	43	0.2	250	0.3	1.3	35				0.02	0.15	0.12	0.05	0.1	0.05

SOUTH GALILEE WATER CHEMISTRY DATA (DERM)

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2
	21/06/1999	192986	94	1046	7.6	1	296	11	130	32	0.4	5.7	0	556.69	547.41	148.1	11.1	10.1	25.4	39.3	0.1	282.9	0.24	0.3	39.1					0.22	0.3		0.1	
	21/06/1999	192987	104	946	7.8	1	40.8	10	111	35	0.4	5.6	0	507.54	495.94	136.4	9.9	8.5	21.9	42.9	0.2	251	0.25	1.3	35.2					0.15	0.12		0.1	
	21/06/1999	192988	109	1142	7.7	1	43.6	9	142	51	0.4	6.1	0	625.49	603.7	166.7	11.8	11.8	27.3	61.4	0.2	301.1	0.59	0.2	44.4					0.14	0.04		0.1	
	18/06/1999	192985	70	1109	7.5	0	310	12	148	16	0.4	5.5	0	582.83	584.58	154.7	11.7	11.2	29.1	19.2	0	315.7	0.05	0	41.2					0.08	0.03		0.1	
	18/06/2000	192985	70	1100	7.5	1	310	12	147	16	0.4	5.6		582.93	585.27	155	11.5	11	29	19	0	315	0.1	1	41				0.02	0.08	0.03	0.05	0.1	0.05
103215	23/06/1999	192982	78	1204	6.6	0	286	5	161	10	0.4	5.9	0	630.71	629.51	171.8	13	12.6	31.5	12.2	0	346.7	0.16	0	42.7					0.31	0.84	0.01	0.1	
	23/06/1999	192983	92	999	7.1	0	66.8	10	129	13	0.4	5.4	0	517.01	518.83	139.8	10.7	10	25.2	15.3	0	278.6	0.07	0	37.4					0.42	0.06		0.1	
103216	2/07/1999	192978	104	689	7.8	0	215	11	76	38	0.3	5.1	0	375.92	363.68	101.9	7.5	6.4	14.7	45.7	0.2	177.1	0.38	0	22.1					0.11	0.01		0.1	
	2/07/1999	192979	109	691	7.6	0	146	11	74	33	0.3	5.2	0	371.17	361.67	102.1	7.7	5.5	14.7	40.1	0.1	177.9	0.14	0	22.9					0.13	0.02		0.1	
	2/07/1999	192980	114	696	7.7	0	295	11	75	33	0.3	5.2	0	369.1	359.64	103.1	7.8	5.7	14.7	39.9	0.1	174.9	0.12	0	22.8					0.15	0.06		0.1	
	2/07/1999	192981	119	742	7.6	0	89.3	5	74	37	0.3	5.9	0	405.97	388.43	117.2	7.2	5	15	44.5	0.1	189.9	0.13	0	26.9					0.1	0.01	0.01	0.1	
	8/09/1999	JSC2B	75	737	7				93		0.4	5.2		375.53	375.53	115	8.2	11	16			185		0.1	25				15	0.22	0.01			
	9/09/2000	201700	75	740	7.3	1	31	14	84	48	0.4	5.2		413.9	398.42	110	8.8	10.5	14	58	0.1	185	0.2	0.5	26.5				0.02	0.02	0.06	0.05	0.1	0.05
	16/08/1999	JSC2B	75	801	7.2				105		0.4	4.6		350.39	350.39	109	7.7	23	11.6			172		0.1	19				7.7	0.29				
	8/09/1999	192999		691	7.3	0	30.1	12	75	38	0.3	5.2	0	373.42	361.9	102.9	7.7	5.8	14.8	45.7	0.1	174	0.22	0	22.3					0.16	0.05		0.1	
	9/09/1999	201700		737	7.3	0	30.9	14	84	47	0.4	5.2	0	409.93	394.11	109.2	8.8	10.4	14.1	57.7	0.1	183.2	0.22	0	26.3						0.06		0.1	
	16/08/1999	JSC2A	111	724	7.2				57		0.3	5.9		328.92	328.92	102	7.2	6	10.3			176		0.1	23				4	0.32				
	9/09/1999	JSC2A	111	694	7.2				87		0.4	5.1		350.76	350.76	110	7.3	7	17			182		0.1	21				6.2	0.16				
103217	10/07/1999	192974	99	859	7.5	0	566	12	86	25	0.3	6	0	461.86	458.18	128.2	12	7.3	16.4	30.8	0.1	231	1.24	0	34.8					0.08	0.01		0.1	
	10/07/1999	192975	104	1380	8.5	0	2685	22	183	313	0.4	7.4	2.6	965.35	800.88	229.6	13.6	20.8	31.8	366.3	7.6	239.9	0.11	7.1	48.5					0.02			0.3	
	10/07/1999	192976	114	936	7.8	0	223	12	100	40	0.3	6.2	0	513.49	500.42	143.9	9.1	8.3	19.4	48.9	0.2	244.4	0.21	0.4	38.6					0.1	0.01		0.1	
	10/07/1999	192977	119	920	7.8	0	310	11	94	37	0.3	6.3	0	502.5	490.79	141.3	8.3	7.2	18.6	44.7	0.2	242.9	0.16	0.4	38.7					0.07	0.02		0.1	
	16/08/1999	201701		887	6.9	1	0.8	12	88	36	0.3	6.4	0	478.43	468.21	138.5	7.5	6.5	17.5	43.9	0	225.7	0.23	0.8	37.8				0.01	0.03	0.06		0.1	
	16/08/1999	201702		887	7.1	2	0.8	12	88	39	0.3	6.5	0	489.4	477.51	140.6	7.5	6.5	17.5	47.4	0	231.2	0.23	0.9	37.6				0.01	0.03	0.05		0.1	
	6/09/1999	JSC1	118	922	6.3				61	40	0.2	7.7		474.77	450.37	137	6.9	4.2	12.2	48		223		0.1	43				0.17	0.05	0.15			
	10/09/1999	201703		900	7.4	2	0.6	13	96	37	0.3	6.1	0	486.44	475.91	136	7.8	9.2	17.7	45.5	0.1	231.6	0.21	0.8	37.6				0.03	0.04	0.03		0.1	
	10/09/1999	201703	105	900	7.5	2		13	95	38	0.3	6		483.9	473.77	135	7.8	9.2	17.5	45.5	0.1	230	0.2	0.8	37.5				0.03	0.04	0.03	0.05	0.1	0.05
	13/09/1999	201704		1187	7.5	2	56.5	13	165	53	0.5	5.8	0	656.89	637.39	170.2	11.7	21.6	27.1	63.8	0.1	310	0.16	1.3	50.9					0.01	0.01		0.1	
	13/09/2000	201704	78	1200	7.6	2	57	13	165	53	0.4	5.8		656.86	637.33	170	11.5	21.5	27	64	0.1	310	0.2	1.3	51				0.02	0.02	0.02	0.05	0.1	0.05
103441	16/06/2010	XXX			6.4								1.52	232.24	184.97	77	3			93		54		0.2	5					0.02	0.02			
103801	16/06/2010	XXX			5.3				15	14	0.2	3.8		104.39	95.75	34	2	1	3	17		46		0.2	1				0.16	0.02				

ANZECC 2000	Concentration exceeds ANZECC 2000 guidelines for 95% freshwater protection level
ANZECC 2000	Concentration exceeds ANZECC 2000 guidelines for 95% marine water protection level
ANZECC 2000	Concentration exceeds ANZECC 2000 guidelines for recreational water protection level

SOUTH GALILEE WATER CHEMISTRY DATA (DERM)

																Cations (mg/L)				Anions (mg/L)									Metals (mg/L)					
REDISTERED NUMBER	DATE	ANALYSIS NUMBER	DEPTH (mbgl)	CONDUCTIVITY (µS/cm)	PH	COLOUR (Hazen)	TURBIDITY (NTU)	SiO2 (mg/L)	HARDNESS	ALKALINITY (meq/L)	FIGURE OF MERIT	SODIUM ADSORPTION RATIO	RESIDUAL ALKALINITY (meq/L)	TOTAL DISSOLVED IONS (mg/L)	TOTAL DISSOLVED SOLIDS (mg/L)	Na	K	Ca	Mg	HCO3	CO3	Cl	F	NO3	SO4	PO4	Br	I	Fe	Mn	Zn	Al	B	Cu
ANZECC 2000 Freshwater 95% Protection Level																														1.9	0.008	0.055	0.37	0.0014
ANZECC 2000 Marine Water 95% Protection Level																															0.015			0.0013
ANZECC 2000 Recreational Water Protection Level																								10	400				0.3	0.1	5	0.2	1	1
ANZECC 2000 Irrigation and Livestock Watering																							1	22	1000				0.2	2	2	5	0.5	0.2

ANZECC 2000 Irrigation and Livestock Watering	Concentration exceeds ANZECC 2000 guidelines for irrigation and livestock

APPENDIX C:
QUALITY DATA SGCP
MONITORING BORES (MB01_04)

		Analyte grouping/Analyte	pH Value	Electrical Conductivity @ 25°C	Total Dissolved Solids @180°C	Hydroxide Alkalinity as CaCO3	Carbonate Alkalinity as CaCO3	Bicarbonate Alkalinity as CaCO3	Total Alkalinity as CaCO3	Sulfate as SO4 - Turbidimetric	Chloride	Calcium	Magnesium	Sodium	Potassium	Aluminium	Arsenic	Chromium	Cobalt	Copper	Lead	Manganese	Molybdenum	Nickel	Selenium	Silver	Uranium	Vanadium	Zinc	Boron	Iron	Bromine	Mercury	Fluoride	Ammonia as N	Nitrite as N	Nitrate as N	Nitrite + Nitrate as N
		Units	pH Unit	µS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		LOR	0	1	10	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0	0.1	0	0	0	0
ANZECC 2000 Freshwater 95% Protection Level																0.055	0.024			0.0014	0.0034				0.011	0.00005			0.008	0.37			0.0006		0.9			
ANZECC 2000 Marine Water 95% Protection Level																			0.001	0.0013	0.0044					0.0014		0.1	0.015				0.0004		0.91			
ANZECC 2000 Recreational Water Protection Level										400	400					0.2	0.05			1	0.05				0.01	0.05			5	1	0.3		0.001			1	10	
ANZECC 2000 Irrigation and Livestock Watering																5	0.1	0.1		0.2	0.1	0.2	0.01	0.2	0.02		0.01	0.1	2	0.5	0.2		0.002				22	
BORE ID	Sample date	ALS Sample number:																																				
MB01	15/08/2012	EB1221685001	8.5	6570	3520	<1	4	22	26	188	1880	70	30	1390	13	<0.01	<0.001	<0.001	<0.001	0.001	<0.001	0.056	0.002	0.001	<0.01	<0.001	<0.001	<0.01	0.022	0.21	<0.05	6.6	<0.0001	0.1	1.69	<0.01	<0.01	<0.01
	19/09/2011						1	94		161	1940	85	31	1190	13																0.05							
MB02	14/08/2012	EB1221685002	8.77	1920	967	<1	16	85	101	<1	558	14	10	364	10	<0.01	<0.001	<0.001	<0.001	0.001	<0.001	0.027	0.004	<0.001	<0.01	<0.001	<0.001	<0.01	0.018	0.23	<0.05	1.7	<0.0001	0.5	0.57	<0.01	<0.01	<0.01
	2/06/2011						10	59		1	109	6	5	81	6																0.05							
	19/09/2011						2	64		1	117	5	5	78	6																0.05							
MB03	9/08/2012	EB1221685003	7.2	5310	3240	<1	<1	170	170	152	1470	98	85	940	28	<0.01	<0.001	0.001	<0.001	0.002	<0.001	0.102	0.001	0.004	<0.01	<0.001	<0.001	<0.01	0.034	0.6	7.05	5.3	<0.0001	0.3	0.09	<0.01	0.01	0.01
	19/09/2011						1	146		6	1550	94	87	857	30																1.18							
MB04	8/08/2012	EB1221685004	7.76	941	525	<1	<1	302	302	5	117	21	4	175	4	<0.01	<0.001	0.002	<0.001	<0.001	<0.001	0.068	0.005	0.005	<0.01	<0.001	<0.001	<0.01	0.022	0.19	0.48	0.5	<0.0001	0.2	2.26	<0.01	<0.01	<0.01
	19/09/2011						1	286		6	94	24	5	152	5																0.05							

Hydrocarbons

		Analyte grouping/Analyte	C6 - C9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 Fraction (sum)	C6 - C10 Fraction	>C10 - C16 Fraction	>C16 - C34 Fraction	>C34 - C40 Fraction	>C10 - C40 Fraction (sum)	1.2-Dichloroethane-D4	Toluene-D8	4-Bromofluorobenzene
		Units	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	%	%	%
		LOR	20	50	100	50	50	20	100	100	100	100	0.1	0.1	0.1
BORE ID	Sample date:	ALS Sample number:													
MB01	15/08/2012	EB1221685001	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	103	94.3	91.2
MB02	14/08/2012	EB1221685002	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	100	95	91.2
MB03	9/08/2012	EB1221685003	<20	<50	<100	<50	<50	<20	<100	<100	<100	<100	104	94.8	97.9
MB04	8/08/2012	EB1221685004	50	<50	<100	<50	<50	50	<100	<100	<100	<100	106	98.5	105

ANZECC 2000 Freshwater 95% Protection Level	Concentration exceeds ANZECC 2000 guidelines for 95% freshwater protection level
ANZECC 2000 Marine Water 95% Protection Level	Concentration exceeds ANZECC 2000 guidelines for 95% marine water protection level
ANZECC 2000 Recreational Water Protection Level	Concentration exceeds ANZECC 2000 guidelines for recreational water protection level
ANZECC 2000 Irrigation and Livestock Watering	Concentration exceeds ANZECC 2000 guidelines for irrigation and livestock

APPENDIX D: DNRM REGISTERED BORES (40KM RADIUS)

ABBREVIATIONS AND CODES.

Office	
DESCRIPTION	**CODE**
AYR	Ayr
BIL	Biloela
BNE	Brisbane
BBG	Bundaberg
CHV	Charleville
EMD	Emerald
GTN	Gatton
GDI	Goondiwindi
LGH	Longreach
MKY	Mackay
MBA	Mareeba
MDB	Mundubbera
RCK	Rockhampton
RMA	Roma
STG	St. George
TBA	Toowoomba
WCK	Warwick
Facility Type	
DESCRIPTION	**CODE**
SF	Sub-artesian Facility
AB	Artesian Bore, Condition Unknown
AF	Artesian Bore, Controlled Flow
AU	Artesian Bore, Uncontrolled Flow
AC	Artesian Bore, Ceased to Flow
AS	Artesian Bore, Seasonal Flow
SW	Surface Water Facility
Facility Status	
DESCRIPTION	**CODE**
PR	Proposed
EX	Existing
AD	Abandoned and Destroyed
AU	Abandoned but still useable
Condition	
DESCRIPTION	**CODE**
Porous Rocks	
UC	Unconsolidated
PS	Consolidated
SC	Semi-Consolidated
Fractured Rocks	
FR	Fractured
VS	Vesicular
CV	Cavernous
WZ	Weathered Zone

DERM	Department of Environment and Resource Management
(shaded)	Non DERM data source

REGISTERED NUMBER	ORIGINAL FACILITY NUMBER OR NAME	PROPERTY NAME	EASTING	NORTHING	OFFICE	BASIN	LOT	PLAN	COUNTY
288		JERICHO SHIRE COUNCIL	411040	7389711	EMD	33	4	J3034	MEXICO
289	JERICHO NO 2 RAILWAY BORE	JERICHO SHIRE COUNCIL	411040	7389732	EMD	33	4	J3034	MEXICO
372	JERICHO TOWN NO 1 BORE	JERICHO SHIRE	411751	7389625	EMD	33	54	MX57	MEXICO
373		JERICHO SHIRE	410994	7388985	EMD	33	54	J3031	MEXICO
1114	SALT BORE	BETANGA	435806	7379434	EMD	1203	31	BF11	BEAUFORT
1115	SALT BORE	CORNTOP	425879	7388605	EMD	1203	7	BF7	BEAUFORT
1116	NO.2 BORE COLARADO	COLARADO	425569	7385634	EMD	1203	2	MX35	MEXICO
1117	TOARBEE BORE	CAVENDISH	420777	7386160	EMD	1203	11	BF25	BEAUFORT
1118	COLORADO WELL NO. 1		432144	7385953	EMD	1203	31	BF11	BEAUFORT
1119	COLORADO WELL NO.2		433620	7385860	EMD	1203	9	BF4	BEAUFORT
1124			467047	7364850	EMD	1203	676	PH12	DRUMMOND
1126	NO.3 BORE	CHESALON	460222	7366014	EMD	1203	3	DM9	DRUMMOND
1128	TWENTY MILE BORE	TARAGO	459157	7358325	EMD	1203	4451	PH561	DRUMMOND
1130	SEDGEFORD NO 7 BORE		469580	7354604	EMD	1203	676	PH12	DRUMMOND
1131	NO.1 BORE	CHESALON	453018	7366495	EMD	1203	1	DM3	DRUMMOND
1132	NO.2 BORE COLARADO	GLENCOE	446998	7370335	EMD	33	2	MX34	MEXICO
1133	COLORADO WELL NO.2	MOSSVALE	452939	7365756	EMD	1203	60	BE20	BELYANDO
1134		KURRAJONG	452844	7362616	EMD	1203	2	DM3	DRUMMOND
1135		KURRAJONG	453019	7356488	EMD	1203	3	DM4	DRUMMOND
1136		KURRAJONG	450379	7355993	EMD	1203	3	DM4	DRUMMOND
1145	OLD RAILWAY WELL	QLD RAILWAYS ALPHA	463663	7384831	EMD	1203	1	RP901125	BELYANDO
1147	SHIRE HALL	ALPHA SHIRE COUNCIL	463360	7384417	EMD	1203	6	A30113	BELYANDO
1148	CONVENT		463236	7384333	EMD	1203	804	A3011	BELYANDO
1161	CRONIN		464757	7385396	EMD	1203	105	BE97	BELYANDO
1163	NO.2 BORE	OAKLEIGH	449641	7390752	EMD	1203	5	BF5	BEAUFORT
1164			452560	7390934	EMD	1203	5	BF5	BEAUFORT
1165	SURPRISE HILL		459983	7382853	EMD	1203	14	BEL1247	BELYANDO
1166	KAHLS		455419	7371256	EMD	1203			BELYANDO
1167	JONES		463569	7384385	EMD	33			BELYANDO
1168	SANDY CREEK BORE	RIVINGTON	455147	7350422	EMD	1203	4	DM5	DRUMMOND
1169	HOUSE BORE	RIVINGTON	446241	7351627	EMD	1203	4	DM5	DRUMMOND
1170	CLEWS BORE	RIVINGTON	456632	7361244	EMD	1203	4451	PH561	DRUMMOND
1172	OLD BEDFORD WELL	BEDFORD	461782	7385457	EMD	1203	86	BE133	BELYANDO
1173	BEDFORD WELL NO2	BEDFORD	458758	7388232	EMD	1203	87	BE34	BELYANDO
1174	NO.1 BORE	DERWENT WATERS	432972	7388298	EMD	1203	10	BE28	BELYANDO
1175	CORN TOP WELL NO.2	CORN TOP	433080	7392181	EMD	1203	7	BF7	BEAUFORT
1176		CORNTOP	432598	7394699	EMD	1203	7	BF7	BEAUFORT
1177	NO.1 BORE	EUREKA	446486	7391215	EMD	1203	6	BF6	BEAUFORT
1179			441492	7392217	EMD	1203	6	BF6	BEAUFORT
3067		LAMBERTON MEADOWS	437031	7400338	EMD	1203	626	MX806585	MEXICO
3110		GLENCOE	410305	7376971	EMD	33	2	MX15	MEXICO
3696		ALLANARD	413419	7357083	EMD	33	1	MX41	MEXICO
5608		LAMBERTON MEADOWS	427421	7393993	EMD	1203	626	MX806585	MEXICO
5609		LAMBERTON MEADOWS	432167	7399465	EMD	1203	626	MX806585	MEXICO
5610		LAMBERTON MEADOWS	424787	7399565	EMD	33	626	MX806585	MEXICO
5716		RIVERIE STATION	414136	7398047	EMD	33	6	MX29	MEXICO
5717		JORDON DOWNS	409287	7397400	EMD	33	5	MX29	MEXICO
5875	INVERURIE A	INVERURIE	411960	7401530	EMD	33	19	MX12	MEXICO
5876	INVERURIE B	INVERURIE	409893	7401233	LGH	33	21	MX12	MEXICO
5877	INVEURIE C	INVERURIE	412438	7409336	EMD	33	2	BF13	BEAUFORT
6000	HOMESTEAD (12 MILE)	TUMBAR	426726	7347198	EMD	33	1196	CP845860	MEXICO
7660		ROSEFIELD	418607	7398476	EMD	33	4	MX54	MEXICO
7661	NO. 2 BORE	ROSEFIELD	419997	7402619	EMD	33	4	MX54	MEXICO
7662	ROSEFIELD NO.3 BORE	ROSEFIELD	419675	7398448	EMD	33	4	MX54	MEXICO
7673	TWENTY MILE BORE	CROA	445478	7386327	EMD	1203	9	BE28	BELYANDO
8090		TRESELLIAN	454378	7419739	EMD	1203	3	CP860083	BEAUFORT
9071	OLD BETANGA BORE	BETANGA	431918	7385101	EMD	1203	31	BF11	BEAUFORT
9856		SUMMERDELL	409654	7369645	EMD	33	9	MX9	MEXICO
9970	JESSDALE NO.3 BORE	CHESALON	454403	7369266	EMD	1203	1	DM3	DRUMMOND
12159	COLORADO WELL NO. 1	ELPHIN	426467	7375674	EMD	1203	7	BEL1243	BELYANDO
12160		ELPHIN	414797	7374158	EMD	1203	30	BEL12417	BELYANDO
12181		ELPHIN	415536	7376876	EMD	1203	38	BEL12417	BELYANDO
12254		ELPHIN	415656	7380860	EMD	1203	34	BEL12417	BELYANDO
13082		ALLANARD	415934	7362844	EMD	33	1	MX41	MEXICO
13852	SUMMERDELL BORE	SUMMERDELL/LAVA	410058	7370090	EMD	33	9	MX9	MEXICO
14194	SEDGEFORD NO 7 BORE	OAKLEIGH	438293	7391693	EMD	1203	5	BF5	BEAUFORT
14512	NO.1 BORE	KURRAJONG	439974	7412792	EMD	1203	3	DM4	DRUMMOND
15405	KIA ORA BORE	CAVENDISH	436422	7418274	EMD	1203	1	BF72	BEAUFORT
15406	JESSDALE NO 2 BORE		443690	7417151	EMD	1203	9	BF4	BEAUFORT
15407		OAKLEIGH	432801	7412761	EMD	1203	5	BF5	BEAUFORT
15408	NO.2 BORE	CAVENDISH	432078	7417623	EMD	1203	11	BF25	BEAUFORT
15591		OAKLEIGH	412859	7382981	EMD	1203	5	BF5	BEAUFORT
16175	JORDON SSRF 1780	STOCK ROUTE	410218	7405248	EMD	33			MEXICO
17020		BURGOYNE	409426	7385038	EMD	33	10	MX24	MEXICO

REGISTERED NUMBER	ORIGINAL FACILITY NUMBER OR NAME	PROPERTY NAME	EASTING	NORTHING	OFFICE	BASIN	LOT	PLAN	COUNTY
17299	NO.3 BORE	OAKLEIGH	412755	7384479	EMD	1203	5	BF5	BEAUFORT
26005	NAMCO BORE	CAVENDISH	432725	7416615	EMD	1203	11	BF25	BEAUFORT
36638	NEW BORE	THE GROVE	459301	7403087	EMD	1203	1	BF45	BEAUFORT
36639	BACK BORE	THE GROVE	459339	7398815	EMD	1203	1	BF45	BEAUFORT
36640	SANDOWN BORE	THE GROVE	462099	7400391	EMD	1203	1	BF45	BEAUFORT
36641	DRY HOLE	THE GROVE	464574	7392929	EMD	1203	25	BE142	BELYANDO
36645		MOSSVALE	459581	7390728	EMD	1203	60	BE20	BELYANDO
36646		MOSSVALE	464756	7390218	EMD	1203	60	BE20	BELYANDO
36647		MOSSVALE	465018	7390599	EMD	1203	60	BE20	BELYANDO
36648		MOSSVALE	465377	7390240	EMD	1203	60	BE20	BELYANDO
36649	BUTLERS BORE	ALPHA HOUSE BORE	463776	7384467	EMD	1203	3	A3017	BELYANDO
36651	BRADYS BORE	ALPHA HOUSE BORE	463854	7384459	EMD	1203	1	A3017	BELYANDO
36652		ALPHA HOUSE BORE	464049	7385513	EMD	1203	106	A3015	BELYANDO
36653		MENTMORE	463691	7384459	EMD	1203	4	BF50	BEAUFORT
36654		ALPHA HOUSE BORE	463426	7384468	EMD	1203	606	A3011	BELYANDO
36655		ALPHA HOUSE BORE	463864	7385609	EMD	1203	108	A3015	BELYANDO
36656	GAYLERS BORE	ALPHA HOUSE BORE	463747	7384596	EMD	1203	7	A3014	BELYANDO
36657	HENDERSONS BORE	ALPHA HOUSE BORE	462375	7384341	EMD	1203	114	BE115	BELYANDO
36658	T MCDONNEL HOUSE BORE		463544	7384339	EMD	1203	703	A3011	BELYANDO
36659	JACKSONS BORE	ALPHA HOUSE BORE	463734	7384419	EMD	1203	7	A3017	BELYANDO
36660		ALPHA HOUSE BORE	463705	7384343	EMD	1203	1	A3018	BELYANDO
36662		LAMORBY	464034	7410373	EMD	1203	1	BF19	BEAUFORT
36671		MYAGH	468578	7383164	EMD	1203	48	BEL12444	BELYANDO
36672	CRONIN	VILLAFIELD	467523	7383285	EMD	1203	19	BEL12410	BELYANDO
36770	THORNES BORE	DERWENT WATERS	466665	7389271	EMD	1203	27	BEL12416	BELYANDO
36771	HOUSE BORE	DERWENT WATERS	473956	7385404	EMD	1203	10	BE28	BELYANDO
36772	TOARBEE BORE	ALPHA HOUSE BORE	464695	7385888	EMD	1203	16	A3017	BELYANDO
36773	DOMESTIC ONLY	NORTHSIDE	464306	7385033	EMD	1203	2	RP604144	BELYANDO
36774		ZETA	471786	7373250	EMD	1203	39	BE23	BELYANDO
36776	RAILWAY CREEK BORE	MYAGAH	471630	7383783	EMD	1203	2	BE29	BELYANDO
36777	HOUSE BORE	MYAGAH	469371	7383646	EMD	1203	53	BE6	BELYANDO
36778	HOUSE BORE	PINE GROVE BORE	464030	7385221	EMD	1203	103	A3015	BELYANDO
36779	PINE GROVE BORE	ALPHA HOUSE BORE	464612	7386367	EMD	1203	49	BEL12449	BELYANDO
36780	HOUSE BORE	ALPHA HOUSE BORE	463510	7386001	EMD	1203	57	K103792	BELYANDO
36781	OLD HOUSE BORE	ALPHA HOUSE BORE	463188	7386612	EMD	1203	12	BEL1245	BELYANDO
36782	NO. 1 BORE	CROA	469349	7389574	EMD	1203	9	BE28	BELYANDO
36783	NO. 2 BORE	CROA	469118	7389823	EMD	1203	9	BE28	BELYANDO
36784		CROA	471147	7397544	EMD	1203	2	BF1	BEAUFORT
36785	HOUSE BORE	ELPHIN	466841	7378754	EMD	1203	7	BEL1243	BELYANDO
36786	NEW HOUSE BORE	ELPHIN	467063	7378721	EMD	1203	7	BEL1243	BELYANDO
36787	ELPHIN BORE	ELPHIN	468136	7378550	EMD	1203	7	BEL1243	BELYANDO
36788	MIDDLE CREEK BORE	ELPHIN	465642	7375191	EMD	1203	30	BEL12417	BELYANDO
36789	PADDOCK BORE	ELPHIN	467592	7375301	EMD	1203	38	BEL12417	BELYANDO
36790	TOP PADDOCK BORE	ELPHIN	469874	7373760	EMD	1203	34	BEL12417	BELYANDO
36816	SALTBUSH BORE	OAKLEIGH	455196	7390564	EMD	1203	5	BF5	BEAUFORT
36817	PALM TREE BORE	OAKLEIGH	453027	7393864	EMD	1203	5	BF5	BEAUFORT
36818	HOUSE BORE	OAKLEIGH	451256	7391619	EMD	1203	5	BF5	BEAUFORT
36819		OAKLEIGH	451603	7392343	EMD	1203	5	BF5	BEAUFORT
36820	SIMPLEX BORE	OAKLEIGH	450618	7392581	EMD	1203	5	BF5	BEAUFORT
36821	IRRIGATION BORE	OAKLEIGH	449672	7390787	EMD	1203	5	BF5	BEAUFORT
36822	HOUSE BORE	GADWELL	462351	7404558	EMD	1203	6	BF16	BEAUFORT
36823	GADWELL BORE	GADWELL	457834	7405989	EMD	1203	6	BF16	BEAUFORT
36824		GADWELL	470544	7403609	EMD	1203	5	BF18	BEAUFORT
36826		TRESSILLION	461387	7418452	EMD	1203	3	CP860083	BEAUFORT
36827		TRESSILLIAN	455114	7418756	EMD	1203	3	CP860083	BEAUFORT
36828		LAMORBY	464170	7411679	EMD	1203	1	BF19	BEAUFORT
36829	BELLROY BORE	BELLROY	463271	7404094	EMD	1203	5	BF18	BEAUFORT
36834		MENTMORE	459514	7411591	EMD	1203	4	BF50	BEAUFORT
36835		MENTMORE	455829	7412158	EMD	1203	4	BF50	BEAUFORT
36836		MENTMORE	459631	7411240	EMD	1203	4	BF50	BEAUFORT
37080	JONES		462592	7396016	EMD	1203	676	PH12	DRUMMOND
37081	BORE NO 2	THE GROVE	463471	7395448	EMD	1203	1	BF45	BEAUFORT
37082	HOUSE BORE	RIVINGTON	462947	7394495	EMD	1203	4451	PH561	DRUMMOND
37258	NO.2 BORE	ALLANARD	456551	7349081	EMD	33	1	MX41	MEXICO
37315		TARAGO	450728	7376837	EMD	1203	4451	PH561	DRUMMOND
38021	HOUSE BORE	CREEK FARM	456949	7378415	EMD	1203	4315	PH720	BEAUFORT
38022	NO.2 BORE	CREEK FARM	452439	7380992	EMD	1203	4315	PH720	BEAUFORT
38023	NO.3 BORE	CREEK FARM	447885	7380903	EMD	1203	4315	PH720	BEAUFORT
38024	NO.4 BORE	CREEK FARM	442490	7382721	EMD	1203	4315	PH720	BEAUFORT
38025	MONKS WELL	CREEK FARM	439109	7381120	EMD	1203	4315	PH720	BEAUFORT
38026	OLD SLAUGHTER YARDS BORE	WOODBROOK	458078	7381996	EMD	1203	88	CP848588	BELYANDO
38027		VILLAFIELD	459189	7381479	EMD	1203	19	BEL12410	BELYANDO
38028		VILLAFIELD	459159	7380215	EMD	1203	9	BEL1244	BELYANDO
38031		CENTRAL WEST ABORIGINAL CORP	463498	7384168	EMD	1203	13	A3017	BELYANDO
38074	PECKETTS BORE	ALPHA HOUSE BORE	463504	7384210	EMD	1203	16	A3017	BELYANDO
38075		ALPHA HOUSE BORE	463369	7384601	EMD	1203	201	A3011	BELYANDO
38087	HOUSE BORE	KURRAJONG	453386	7359691	EMD	1203	3	DM4	DRUMMOND
38088	SHED BORE	KURRAJONG	452670	7365046	EMD	1203	2	DM3	DRUMMOND
38089	DINNER CREEK BORE	ALPHA TOWN BORE	453063	7356276	EMD	1203	39	A30115	BELYANDO

REGISTERED NUMBER	ORIGINAL FACILITY NUMBER OR NAME	PROPERTY NAME	EASTING	NORTHING	OFFICE	BASIN	LOT	PLAN	COUNTY
38090		MONTROSE	463199	7384177	EMD	1203	27	A3017	BELYANDO
38092	HOUSE BORE	BEDFORD	461826	7385433	EMD	1203	86	BE133	BELYANDO
38093	WELL BORE	BEDFORD	462709	7388801	EMD	1203	86	BE133	BELYANDO
38094	BACK BORE	BEDFORD	458777	7387870	EMD	1203	87	BE34	BELYANDO
38095	MENTONE BORE	BEDFORD	457923	7373956	EMD	1203	75	BE144	BELYANDO
38100	HOUSE BORE	SALTBUSH	454330	7402610	EMD	1203	7	BF16	BEAUFORT
38101	BLUE DUCK BORE	SALTBUSH	452542	7398128	EMD	1203	7	BF16	BEAUFORT
38105		BONANZA	458600	7378120	EMD	1203	21	BEL12411	BELYANDO
38106		BONANZA	462961	7384064	EMD	1203	44	A3017	BELYANDO
38107	NO.2 BORE	CHESALON	446996	7369915	EMD	1203	1	DM3	DRUMMOND
38108	NO.3 BORE	CHESALON	449764	7366726	EMD	1203	1	DM3	DRUMMOND
38109	NO 1 BORE	CHESALON	454607	7369030	EMD	1203	1	DM3	DRUMMOND
38110	CLEWS BORE	MYAGAH	462924	7384295	EMD	1203	2	BE29	BELYANDO
38111	NO.2 BORE COLARADO	MYAGAH	463006	7384429	EMD	1203	2	BE29	BELYANDO
38112	OLD BEDFORD WELL	MYAGAH	463003	7384549	EMD	1203	2	BE29	BELYANDO
38113		ALPHA TOWN BORE	462719	7384862	EMD	1203	126	BE103	BELYANDO
38114		ALPA TOWN	461533	7383692	EMD	1203	83	BE49	BELYANDO
38162	ALPHA HOUSE BORE	PORTWINE	462872	7384424	EMD	1203	20	A3013	BELYANDO
44466		MONKLANDS	449295	7415986	EMD	1203	2	BF22	BEAUFORT
44467	OLD BORE	HAZELBUSH	445036	7404829	EMD	1203	3	BF802451	BEAUFORT
44468	NEW BORE	HAZELBUSH	448435	7407327	EMD	1203	3	BF802451	BEAUFORT
44469	CUMBERLAND BORE	CUMBERLAND	444409	7400947	EMD	1203	1	BF17	MEXICO
51050		ARMAGH	430976	7368311	EMD	33	1160	PH286	MEXICO
51051		ARMAGH	424712	7366765	EMD	33	1160	PH286	MEXICO
51097		ZETA	471326	7372185	EMD	1203	35	BE23	BELYANDO
51098		J D	473449	7371067	EMD	1203	12	BE33	BELYANDO
51099	NO.1 BORE	PINE GROVE	462904	7384747	EMD	1203	49	BEL12449	BELYANDO
51102	SHED BORE	CAVENDISH	427101	7409511	EMD	1203	10	RP894235	BEAUFORT
51123		RIVINGTON	462398	7352552	EMD	1203	4451	PH561	DRUMMOND
51126	GAYLORES BORE	TARAGO	462166	7347115	EMD	1203	4451	PH561	DRUMMOND
51127	WILD HORSE BORE	RIVINGTON	452962	7348052	EMD	1203	4	DM5	DRUMMOND
51366		TARAGO	456144	7350425	EMD	1203	4451	PH561	DRUMMOND
51386	OFFICE LICENCE ONLY	FAIRVIEW	471116	7380634	EMD	1203	36	BEL12423	BELYANDO
51401	BEDFORD WELL NO2	EUREKA	462923	7384306	EMD	1203	6	BF6	BEAUFORT
51402	CORN TOP WELL NO.1	ROSEFIELD	463167	7384105	EMD	33	4	MX54	MEXICO
51408	CORN TOP WELL NO.2	ALLANARD	462840	7384874	EMD	33	1	MX41	MEXICO
51458		BONANZA	466958	7379619	EMD	1203	11	BEL1246	BELYANDO
51537	CREEK PADOOCK BORE	ELPHIN	469974	7375205	EMD	1203	38	BEL12417	BELYANDO
51538		ELPHIN	470759	7374562	EMD	1203	38	BEL12417	BELYANDO
51541		ALPHA HOUSE BORE	463330	7384174	EMD	1203	2	RP607989	BELYANDO
51542		ALPHA HOUSE BORE	463319	7384212	EMD	1203	22	A3017	BELYANDO
51594		JERICHO SHIRE TOWN BORE	410989	7388977	EMD	33	54	J3031	MEXICO
51682		CHESALON	433644	7413239	EMD	1203	3	DM9	DRUMMOND
51881		GADWELL	462871	7384873	EMD	1203	6	BF16	BEAUFORT
51968		CHESALON	462997	7384549	EMD	1203	1	DM3	DRUMMOND
51984	JESSDALE NO 2 BORE	OMEGA	469060	7390135	EMD	1203	2	DM16	DRUMMOND
51990		LAMBERTON MEADOWS	463275	7384207	EMD	1203	626	MX806585	MEXICO
69089	OLD BETANGA BORE	ELPHIN	414894	7377315	EMD	1203	7	BEL1243	BELYANDO
69091	HOTEL BORE	JORDAN VALLEY HOTEL	410901	7389412	EMD	33	212	J3031	MEXICO
69235	NEW BORE	OAKLEIGH	413225	7389600	EMD	1203	5	BF5	BEAUFORT
69260		TARAGO	465131	7389236	EMD	1203	4451	PH561	DRUMMOND
69268	JERICHO HOUSE BORE	GLENCOE	412390	7389472	EMD	33	54	MX57	MEXICO
69270	OLD RAILWAY WELL	BEDFORD	454424	7373470	EMD	1203	86	BE133	BELYANDO
69271	CONVENT	TARAGO	453714	7373560	EMD	1203	4451	PH561	DRUMMOND
69285		CHESALON	463132	7380063	EMD	1203	1	DM3	DRUMMOND
69286	CRONIN	MERIDA	458523	7381585	EMD	33	1	MX34	MEXICO
69359	15 MILE BORE	KURRAJONG	453041	7362191	EMD	1203	2	DM3	DRUMMOND
69367		MYAGAH	473310	7383994	EMD	1203	2	BE29	BELYANDO
69368		MYAGAH	472584	7384241	EMD	1203	2	BE29	BELYANDO
69369		MYAGAH	470677	7382911	EMD	1203	2	BE29	BELYANDO
69370		MYAGAH	470677	7382851	EMD	1203	2	BE29	BELYANDO
69371	NO.2 BORE	GADWELL	467512	7383359	EMD	1203	6	BF16	BEAUFORT
69372	SURPRISE HILL	CNR MOORE & DRYDEN ST ALPHA	470848	7382153	EMD	1203	19	A3013	BELYANDO
69428		CROA	440274	7398445	EMD	1203	9	BE28	BELYANDO
69510	JESSDALE NO.3 BORE	TOARBEE	470882	7405601	EMD	1203	5	MX43	MEXICO
69550			473368	7370683	EMD	1203	901	BE166	BELYANDO
69560	KAHLS BORE	ALPHA STATE SCHOOL	465360	7394311	EMD	1203	1	BE165	BELYANDO
69584	OLO TEST HOLE1	LAMBERTON MEADOWS	418368	7407317	EMD	33	626	MX806585	MEXICO
69585	OLO TEST HOLE	LAMBERTON MEADOWS	420523	7407739	EMD	33	626	MX806585	MEXICO
69671	OLD BEDFORD WELL	EUREKA	470743	7374624	EMD	1203	6	BF6	BEAUFORT
69673	BEDFORD WELL NO2	CORN TOP	467700	7384111	EMD	1203	7	BF7	BEAUFORT
69675	CORN TOP WELL NO.1	BETANGA	463848	7384526	EMD	33	31	BF11	BEAUFORT
69676	CORN TOP WELL NO.2	WYCHEPROOF	467164	7380461	EMD	1203	11	BE28	BELYANDO
69677		WYCHEPROOF	463011	7386336	EMD	1203	1	BE18	BELYANDO
69692	NO.1 BORE	COLORADO	466430	7376194	EMD	1203	2	MX35	MEXICO
69696	BACK BORE		467556	7409553	EMD	1203	676	PH12	DRUMMOND
69697		FLORENCE VALE	464581	7386770	EMD	1203	49	BEL12449	BELYANDO
69711		MENTMORE	470680	7387139	EMD	1203	4	BF50	BEAUFORT
69714		LEMBERTON MEADOWS	456364	7374523	EMD	1203	626	MX806585	MEXICO
69715	HENDERSONS BORE	CORNTOP	463074	7384089	EMD	1203	7	BF7	BEAUFORT
69716		ZETA	473639	7370801	EMD	1203	12	BE33	BELYANDO

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69717		CUMBERLAND	469674	7399509	EMD	1203	1	BF17	MEXICO
69720		CREEK FARM	465855	7387915	EMD	1203	4315	PH720	BEAUFORT
69729		COLORADO	466714	7382894	EMD	33	1	MX90	MEXICO
69735		BETANGA	450237	7392580	EMD	1203	31	BF11	BEAUFORT
69744		FLORENCE VALE	415752	7362478	EMD	1203	66	BE22	BELYANDO
69745		EVESTON PARK	423295	7360240	EMD	1203	100	BE58	BELYANDO
69746	BRADYS BORE	GLENCOE	473030	7355552	EMD	33	2	MX34	MEXICO
69749	NO. 2 BORE	KURRAJONG	462920	7384293	EMD	1203	2	DM3	DRUMMOND
89303		FURBERS	412834	7392381	EMD	33	17	MX6	MEXICO
89327		THE GROVE	448027	7403346	EMD	1203	1	BF45	BEAUFORT
89348	CREEK BORE	GADWELL	462932	7406330	EMD	1203	6	BF16	BEAUFORT
89472		CHESALON	453059	7369748	EMD	1203	1	DM3	DRUMMOND
89487		LAMBERTON MEADOWS	441779	7399064	EMD	1203	626	MX806585	MEXICO
90047	TI TREE BORE		466836	7378715	EMD	1203	39	A30115	BELYANDO
90049	NEW SALTBUSH BORE	OAKLEIGH	455195	7390874	EMD	1203	5	BF5	BEAUFORT
90055	18 MILE BORE	TARAGO	456579	7361422	EMD	1203	4451	PH561	DRUMMOND
90056	20 MILE BORE	TARAGO	459045	7358067	EMD	1203	4451	PH561	DRUMMOND
90062		BELYANDO	415695	7381282	EMD	1203	33	A30111	BELYANDO
90084		ALPHA TOWN	426778	7348221	EMD	1203	33	A30111	BELYANDO
90085		ALPHA TOWN	436088	7344227	EMD	1203	132	BEL12415	BELYANDO
90143		GADWELL	467945	7403996	EMD	1203	5	BF18	BEAUFORT
90144		ALPHA TOWN	455357	7406058	EMD	1203	132	BEL12415	BELYANDO
90150	DOMESTIC BORE	CNR MOORE & DRYDEN ST ALPHA	462845	7384450	EMD	1203	19	A3013	BELYANDO
90155	KAHLS	ALLANARD	469002	7390385	EMD	33	6	MX63	MEXICO
90192	OVAL BORE		463013	7384371	EMD	1203	901	BE166	BELYANDO
90193	HOUSE BORE	ARBENE	463504	7384433	EMD	1203	203	A3015	BELYANDO
90199	EUREKA YARDS BORE	EUREKA	445841	7396048	EMD	1203	6	BF6	BEAUFORT
90217	GAYLERS BORE	GLENCO	432275	7377579	EMD	33	2	MX34	MEXICO
90346	DOMESTIC ONLY	GLENCOE	479865	7385698	EMD	33	2	MX34	MEXICO
90347	RAILWAY CREEK BORE		482191	7386830	EMD	1203	626	MX806585	MEXICO
90372			425609	7385301	EMD	1203	6	BF6	BEAUFORT
90453	NO.1 BORE	LAMBERTON MEADOWS	464605	7387031	EMD	1203	626	MX806585	MEXICO
90490	PROPOSED BORE	MENTMORE	456944	7410590	EMD	1203	4	BF50	BEAUFORT
103008		BONANZA	427720	7393488	EMD	1203	18	BEL1249	BELYANDO
103054		ROSEFIELD	432939	7388639	EMD	33	4	MX54	MEXICO
103113	HOUSE BORE	EVESTON PARK	462890	7384873	EMD	1203	100	BE58	BELYANDO
103120	NEW HOUSE BORE	FAIRVIEW	445734	7399351	EMD	1203	3	BE29	BELYANDO
103174	HOUSE BORE	DOUCE FARM	456944	7378548	EMD	1203	1	PER2581	BELYANDO
103175	THORNES BORE	CREEK FARM	422412	7386289	EMD	1203	4315	PH720	BEAUFORT
103181		BETANGA	434551	7381773	EMD	1203	31	BF11	BEAUFORT
103182		GLEN INNES	465181	7386345	EMD	1203	4	BF22	BEAUFORT
103183	PINE GROVE BORE		461747	7384605	EMD	1203	104	A3015	BELYANDO
103184	HOUSE BORE	DURRANDELLA	458197	7381893	EMD	1203	1918	PH2008	DRUMMOND
103185	TEST HOLE FOR 69560	THE GROVE	465748	7395002	EMD	1203	1	BF45	BEAUFORT
103186	P JAQUES	OLD SLAUGHTER YARD BLOCK	459702	7382595	EMD	1203	14	BEL1247	BELYANDO
103194	OLO EA ROGERS		464130	7385567	EMD	1203	1	RP602653	BELYANDO
103198	MOORE ST BORE		462931	7384311	EMD	1203	1	SP104443	BELYANDO
103199			462857	7384873	EMD	1203	39	A30115	BELYANDO
103200			463172	7384101	EMD	1203			BELYANDO
103201			462999	7384551	EMD	1203	316	A3011	BELYANDO
103202	JERICHO TOWN BORE NO 1	JERICHO TOWN	411203	7389458	EMD	33	82	SP108318	MEXICO
103203	JERICHO STANDBY BORE	JERICHO TOWN	410560	7389533	EMD	33	92	SP114674	MEXICO
103214	JERICHO SITE 4	JERICHO TOWN	411702	7389392	EMD	33	54	MX57	MEXICO
103215	JERRICHO SITE 3	JERICHO TOWN	409964	7389747	EMD	33	93	DSN431	MEXICO
103216	JERICHO SITE 2	JERICHO TOWN	410578	7389528	EMD	33	RD RS	IN JERICHO	MEXICO
103217	JERICHO SITE 1	JERICO TOWN	411231	7389450	EMD	33			MEXICO
103218	OLD HOUSE BORE	RIVINGTON	463301	7384811	EMD	1203	4451	PH561	DRUMMOND
103219	ALPHA SITE 2	BELYANDO	463308	7385186	EMD	1203	33	A30111	BELYANDO
103220	ALPHA SITE 3	ALPHA TOWN	462807	7385211	EMD	1203	33	A30111	BELYANDO
103221	ALPHA SITE 4	ALPHA TOWN	462296	7385498	EMD	1203	132	BEL12415	BELYANDO
103222	NO. 1 BORE		463348	7383909	EMD	1203	105	BE97	BELYANDO
103223	ALPHA SITE 6	ALPHA TOWN	461985	7384714	EMD	1203	132	BEL12415	BELYANDO
103224	PADDOCK BORE	COLARADO	461773	7384795	EMD	33	1	MX90	MEXICO
103225	BRIGALOW BORE	RIVINGTON	463342	7384062	EMD	1203	4	DM5	DRUMMOND
103226	SALTBUSH BORE		463279	7383774	EMD	33			BELYANDO
103253		ALLANARD	421464	7358686	EMD	33	6	MX63	MEXICO
103362	NO. 2 BORE	GLEN INNES	430568	7399295	EMD	1203	4	BF22	BEAUFORT
103363	NO. 2 BORE		464338	7385244	EMD	1203	1	BF72	BEAUFORT
103364	HOUSE BORE		412285	7379312	EMD	1203	1	BF72	BEAUFORT
103441	NATIVE BEE BORE	CAVENDISH	421354	7411207	EMD	1203	9	BF28	BEAUFORT
103464	FOUR CORNERS	GLENCO	427711	7374017	EMD	33	2	MX34	MEXICO
103465	TEST HOLE	GLENCOE	427956	7375006	EMD	33	2	MX34	MEXICO
103480	HOUSE BORE	TARAGO	438771	7398870	EMD	1203	4451	PH561	DRUMMOND
103481		LAMBERTON MEADOWS	431353	7399087	EMD	1203	626	MX806585	MEXICO
103492	ELPHIN BORE		437839	7356734	EMD	1203	1	BF72	BEAUFORT
103506			458823	7378948	EMD	1203	1	BF72	BEAUFORT
103667	NO.2 BORE		461675	7384526	EMD	1203	1	BF72	BEAUFORT
103669			457345	7374913	EMD	1203	1	BF72	BEAUFORT
103670		CREEK FARM	457286	7378284	EMD	1203	4315	PH720	BEAUFORT
103671	NO.4 BORE	ZETA	439763	7407217	LGH	1203	12	BE33	BELYANDO

REGISTERED NUMBER	ORIGINAL FACILITY NUMBER OR NAME	PROPERTY NAME	EASTING	NORTHING	OFFICE	BASIN	LOT	PLAN	COUNTY
103672		ZETA	436089	7404723	LGH	1203	12	BE33	BELYANDO
103674	PALM TREE BORE	ZETA	464090	7385167	LGH	1203	12	BE33	BELYANDO
103678	SIMPLEX BORE		458892	7345468	EMD	1203	1	PER206832	BEAUFORT
103679			451108	7341384	EMD	1203	31	BF11	BEAUFORT
103787	HOUSE BORE	ZETA	447664	7369512	LGH	1203	35	SP136838	BELYANDO
103801	BLACK BOY NUMBER 1	COLORADO	422187	7414823	EMD	1203	9	BF28	BEAUFORT
103873	MURPHYS BORE		413091	7413970	EMD	33	2	BF13	BEAUFORT
103874	JOHNOS YARD BORE	INVERURIE	412025	7401479	EMD	33	19	SP167251	MEXICO
118232	NEW HOUSE BORE	INVERURIE	409793	7401233	LGH	33	21	MX12	MEXICO
118257	IRRIGATION BORE	TOARBEE	423806	7353279	LGH	1203	5	MX43	MEXICO
132308		TOARBEE	456813	7351496	LGH	33	5	MX43	MEXICO
132355	CORN TOP BORE	CREEK FARM	470798	7388548	LGH	1203	4315	PH720	BEAUFORT
132597		CREEK FARM	437007	7384238	LGH	1203	4315	PH720	BEAUFORT
132598		CREEK FARM	451122	7365741	LGH	1203	4315	PH720	BEAUFORT
132599	BELLROY BORE	BETANGA	450455	7369269	LGH	1203	31	BF11	BEAUFORT
132743	CORELLA MINE BORE	GLEN INNES	436290	7404895	EMD	1203	4	BF22	BEAUFORT
132744	MILKY BORE	GLEN INNES	433574	7407244	EMD	1203	4	BF22	BEAUFORT
132745	BACK BORE	GLEN INNES	437714	7411893	EMD	1203	4	BF22	BEAUFORT
132746	REIDS BORE	GLEN INNES	443677	7411097	EMD	1203	4	BF22	BEAUFORT
132790			442104	7413143	EMD	1203	132	BEL12415	BELYANDO
132791			444105	7415170	EMD	1203	132	BEL12415	BELYANDO
132792	BACK BORE		438040	7415054	EMD	1203	3	SP136857	BELYANDO
132820	WAR38-15(40)		438017	7415027	EMD	1203	1	BF72	BEAUFORT
132821	WAR42-13(50)		442074	7413136	EMD	1203	1	BF72	BEAUFORT
132822	WAR44-15(RETRO)		444093	7415172	EMD	1203	1	BF72	BEAUFORT
132823	WAR38-15(63)		438037	7415043	EMD	1203	1	BF72	BEAUFORT
132824	WAR42-13(65)		442087	7413142	EMD	1203	1	BF72	BEAUFORT
132825	WAR44-15(MONITOR)		444095	7415165	EMD	1203	1	BF72	BEAUFORT
132826	WAR42-13(80)		442090	7413147	EMD	1203	1	BF72	BEAUFORT
132829	KANAAN BORE	LOT 12 CAPRICORN HWY	412304	7389149	EMD	33	12	SP210342	MEXICO
146458		ZETA	473401	7370759	LGH	1203	12	BE33	BELYANDO
146459	YARDS BORE	ZETA	473401	7370704	LGH	1203	12	BE33	BELYANDO
146460		ZETA	473384	7370582	LGH	1203	12	BE33	BELYANDO
146461	CREEK BORE	ZETA	472335	7372186	LGH	1203	35	SP136838	BELYANDO
146462	RILEYS BORE	TOARBEE	425715	7388271	LGH	1203	5	MX43	MEXICO
146463		TOARBEE	424577	7388863	LGH	33	5	MX43	MEXICO
146473			413831	7361446	LGH	33	1	MX41	MEXICO
146484	MB04	CREEK FARM	448405	7379881	LGH	1203	4315	PH720	BEAUFORT
146485	MB03	CREEK FARM	447518	7379280	LGH	1203	4315	PH720	BEAUFORT
146486	MONITORING BORE	CREEK FARM	441755	7377477	LGH	1203	4315	PH720	BEAUFORT
146487			437505	7378773	EMD	1203			MEXICO
12030028			470401	7384516	EMD	1203	14	BEL1247	BELYANDO
12030029	SANDOWN BORE		470216	7384516	EMD	1203			BELYANDO
12030030	BUTLERS BORE	RIVINGTON	470012	7384536	EMD	1203	4	DM5	DRUMMOND
12030036	T MCDONNEL HOUSE BORE	QLD RAILWAYS ALPHA	464808	7383722	EMD	1203	1	RP901125	BELYANDO
12030037	BORE NO 1	CORN TOP	464178	7383566	EMD	1203	7	BF7	BEAUFORT
12030038	BORE NO 3		463411	7383841	EMD	1203	5	BF5	BEAUFORT
12030039	MENTONE BORE	KURRAJONG	463426	7383872	EMD	1203	3	DM4	DRUMMOND
12030040	HOUSE BORE		463182	7384105	EMD	1203	804	A3011	BELYANDO
12030041	BLUE DUCK BORE	ALPHA SHIRE COUNCIL	463196	7384101	EMD	1203	6	A30113	BELYANDO
12030042	MONKS WELL	BETANGA	454704	7358401	EMD	1203	31	BF11	BEAUFORT
12030043		CHESALON	454758	7358404	EMD	1203	1	DM3	DRUMMOND
12030044		TUMBAR	454897	7358396	EMD	33	1196	CP845860	MEXICO
12030045	HOUSE BORE	LAMBERTON MEADOWS	454630	7368942	EMD	1203	626	MX806585	MEXICO
12030046	BREAKAWAY BORE	LAMBERTON MEADOWS	454686	7368888	EMD	1203	626	MX806585	MEXICO
12030047	OLD RAILWAY WELL	LAMBERTON MEADOWS	454721	7368846	EMD	33	626	MX806585	MEXICO
12030048		LAMBERTON MEADOWS	454804	7368802	EMD	1203	626	MX806585	MEXICO
12030051	JESSDALE NO.3 BORE		462583	7415657	EMD	1203			MEXICO
12030052		COLARADO	462383	7416057	EMD	1203	2	MX35	MEXICO
12030067			455886	7350061	EMD	1203	4315	PH720	BEAUFORT
12030068		GLENCOE	455970	7350062	EMD	33	2	MX15	MEXICO
12030069	R3		455689	7350071	EMD	1203	4	DM5	DRUMMOND
12030070	MIDDLE CREEK BORE	SOUTH JD	464054	7405913	EMD	1203	1	DM16	DRUMMOND
12030071	TOP PADDOCK BORE		463686	7405727	EMD	1203	3	BE29	BELYANDO
12030076		MERIDA	445752	7414375	EMD	33	1	MX34	MEXICO
12030077	NO.2 BORE	CORN TOP	445299	7413783	EMD	1203	7	BF7	BEAUFORT
12030144	HOUSE BORE		444309	7386028	EMD	1203	1	DM3	DRUMMOND
12030145	NAP BELYANDO SITE 20		444449	7386195	EMD	1203	4315	PH720	BEAUFORT
12030146	SHIRE HALL		480366	7384611	EMD	1203			BELYANDO
12030148		BETANGA	461051	7410650	EMD	1203	31	BF11	BEAUFORT
12030183			473083	7370197	EMD	1203	4	BF50	BEAUFORT
12030184	BE-07		459961	7402356	EMD	1203	4	BF50	BEAUFORT
12030186	CONVENT	BEDFORD	455844	7385759	EMD	1203	87	BE34	BELYANDO

HYDROGEOLOGICAL INFORMATION FOR BORES IN SOUTH GALILEE (DbRM)

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer			Field Parameters		CONDITION	FACILITY TYPE	FACILITY STATUS
						FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)			
288	01/01/1886											SF	AD
289	1/05/1903	349.5		-17.37			527.3			0	PS	SF	AD
372	25/06/1887										PS	SF	AD
373	1/08/1944											SF	AD
1115	1/01/1912	408.7	432	-60.96	347.74	WINTON FORMATION	33.53	102.11	BRACKISH	0	SC	SF	AD
1117	20/10/1948		412	-76.2	335.79	ORALLO FORMATION	106.68		POTABLE	0.1	PS	SF	AD
1132	22/11/1952	411	414	-30.48	355.22	COLINLEA SANDSTONE	91.44		GOOD	0.06	PS	SF	EX
1133	1/01/1900		379	-23.7	355.50	WINTON FORMATION	126	147	SUITABLE	0.76	PS	SF	EX
1174	1/01/1920		405	-24.38			0				PS	SF	EX
3110	24/03/1927											SF	EX
3696												SF	AD
5716												SF	EX
5717	18/09/1930											SF	AD
5875	10/07/1937					TERTIARY - UNDEFINED					SC	SF	EX
5876	10/07/1937											SF	EX
5877	10/07/1937					TERTIARY - UNDEFINED					SC	SF	EX
6000	28/03/1937											SF	AD
7673			382	-49.99			77.72	80.77			PS	SF	EX
8090	15/01/1940	382		-45.11		TERTIARY - UNDEFINED	77.72				PS	SF	AD
9856	21/04/1944						134	137			PS	SF	AD
12159	1/01/1968		427	-93.88	333.26	CLEMATIS GROUP	96.01	99.36	GOOD HAS IRON	0.91	PS	SF	EX
12160	1/01/1966		367	-44.5	322.50	CLEMATIS GROUP	48.16	48.77	SALTY	0.17	FR	SF	EX
12181	1/01/1926		368	-40.23	327.78	MOOLAYEMBR	44.2	48.77	POTABLE	0.82	PS	SF	EX
12254	1/01/1969		365	-40.5	324.27	INJUNE CREEK GROUP	44.1	44.8	POTABLE	0.75	PS	SF	AD
13852	1/04/1959											SF	EX
14194	1/01/1900		381	-27	326.17	NOT RECORDED	120.5	123.2	SLIGHT BRACKISH	0.88	PS	SF	AD
14512		351.25	344	-18.3	332.95	COLINLEA SANDSTONE	38.1	42.7		2.58	FR	SF	AD
15405	30/11/1952			-30.5		TERTIARY - UNDEFINED	36.6	39.6		0.27	PS	SF	EX
15406	1/01/1900	333	336	-18.3	314.70	COLINLEA SANDSTONE	65.2	66.8		1.07	PS	SF	AD
15407	1/01/1919	378.66	377	-37.8	340.86	COLINLEA SANDSTONE	85.9	86.6		0.16	PS	SF	AD
15408	19/10/1962											SF	EX

HYDROGEOLOGICAL INFORMATION FOR BORES IN SOUTH GALILEE (DERM)

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer			Field Parameters		CONDITION	FACILITY TYPE	FACILITY STATUS
						FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)			
15591	1/06/1971		357	-21.34	335.37	TERTIARY - UNDEFINED	24.99		TDS 143 MG/L		UC	SF	EX
16175	10/02/1965			-42.98		TERTIARY - UNDEFINED	53.64	54.56	GOOD	0.78	SC	SF	EX
17020	29/11/1966			-40.5		TERTIARY - UNDEFINED	68	72	POTABLE	1.3	WZ	SF	EX
17299	1/06/1971		363	-38.71	324.21	MOOLAYEMBR	89	98.15	COND 800	9.34	PS	SF	EX
26005	1/01/1963											SF	EX
36653	22/01/1971		355	-10.67	344.44		23.77	24.38	GOOD	0	UC	SF	EX
36672			359	-15.2	343.66	SAND	39	44	SUITABLE	0.6	PS	SF	EX
36772	5/09/1972		355	-19.5	335.18	NOT RECORDED	43	44	SUITABLE	0.3	UC	SF	EX
36826	1/06/1971											SF	EX
37080		362	363	-34.44	327.56	CONGLOMERATE (35.05-38.1)SAND	50.9	51.08	POTABLE	0.01	PS	SF	AD
37082	8/08/1968		365	-35.97	328.96	SAND	42.06	42.98	POTABLE	0.09	UC	SF	AD
37258	14/02/1959	397.41	396	-40.84	356.57	JOE JOE GROUP	68.6	71.7			PS	SF	AD
37315	8/08/1968		409	-84		COLINLEA SANDSTONE	156	160	POTABLE	0.86	PS	SF	EX
38089	29/12/1983		386	-17.3	369.02	BLACKWATER GROUP	0	32		0.5	FR	SF	AD
38110	19/05/1986		354	-15.1	339.27	TERTIARY SEDIMENTS	22.6	24.1		2.8	UC	SF	AD
38111	19/05/1986		352	-17.98	333.99	ALPHA CREEK ALLUVIUM	21.34	21.64	SUITABLE	1	UC	SF	AD
38112	19/05/1986		352	-15.54	336.36	TERTIARY SEDIMENTS	19.81	22.56		1.5	UC	SF	AD
51099	11/05/1991	350.4		-17.6	332.80							SF	EX
51401	1/12/1974	350.8	354	-17	353.30	ALPHA CREEK ALLUVIUM/TERTIARY SEDIMENTS >12.4m	21	24	1260 US/CM	2.5	UC	AC	AU
51402	1/01/1917	351.5	354	-17.2	367.90	UNDIFF TERT	36	39	POTABLE	16.4	SC	SF	AD
51408	7/01/1992		352	-16.4	335.99	TERTIARY SEDIMENTS	18	32	POTABLE	3.4	UC	SF	EX
51594	29/01/1980			-35.82		TERTIARY - UNDEFINED	68.88	69.19	MINERALY	5.6	PS	SF	EX
51682	1/01/1913	374.04	375	-51.82	322.22	NOT RECORDED	73.2	76.2	POTABLE	0.91	PS	SF	AD
51881	5/10/1992	348.91	352	-15.72	333.19	TERTIARY SEDIMENTS	19	32	POTABLE	6.4	UC	SF	EX
51968	15/12/1992	349.63	352	-16.51	333.12	TERTIARY SEDIMENTS	20	35	SUITABLE	5	UC	SF	EX

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer			Field Parameters		CONDITION	FACILITY TYPE	FACILITY STATUS
						FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)			
51984	9/06/1993		347	-16.7	329.88	NATIVE COMPANION ALLUVIUM	24	32	POTABLE	4	UC	SF	EX
51990	25/11/1992		355	-17.4	338.03	ALPHA CREEK ALLUVIUM	20	23	POTABLE	0.9	UC	SF	EX
69089	3/08/1993		365	-44	321.05	TERTIARY - UNDEFINED (20-22 SALTY, 60-62 POTABLE)	82.5	90	POTABLE	1.89	PS	SF	EX
69091	1/10/1985			-28.96		CLEMATIS GROUP	35.05	67.06	COND 820	4.55	PS	SF	EX
69235	22/07/1993		352	-36.5	315.87	NOT RECORDED	45.5	51.5	POTABLE	1.34	PS	SF	EX
69260	17/08/1993		349	-15.85	333.30		21.95	28.04	POTABLE	0	UC	SF	EX
69268	14/06/1986			-30.48		TERTIARY - UNDEFINED	62.48	67.06	COND 980	1.64	FR	SF	EX
69270		367.75	369	-24	343.75	ALPHA CREEK ALLUVIUM	32	36	POTABLE	0.25	UC	SF	AD
69271	1/08/1993		379	-24	354.81	ALPHA CREEK ALLUVIUM	31	35	POTABLE	1.26	UC	SF	EX
69285	1/01/1914	378.13	382	-49	329.13	TERT.ALLUVIUM	50	57	SALTY	0.95	UC	SF	AD
69286	14/09/1993		360	-39	321.32	NOT RECORDED	27	43	POTABLE	3.78	UC	SF	EX
69371	25/03/1994		358	-16	342.09		18	32		2.5	UC	SF	EX
69372	7/04/1994		356	-18	337.51	NATIVE COMPANION ALLUVIUM	28	32.5	POTABLE	2.5	UC	SF	EX
69428	10/04/1994		353	-35.5	317.28	NOT RECORDED	50	51	21500 US/CM	0.5	UC	SF	EX
69510	1/06/1944	341.7	343	-39	302.70	COLINLEA SANDSTONE	49	56	POTABLE	1.8	PS	SF	AD
69550	21/03/1995		372	-16.46	355.67	SAND	28.96	35.05	POTABLE	0.82	UC	SF	EX
69560	20/03/1995		357	-19.8	336.93	JOE JOE GROUP	42.7	76.2	BRACKISH	4.6	SC	SF	EX
69584	28/01/1989											SF	AU
69585	28/01/1989											SF	AU
69671			366	-18	348.20	NATIVE COMPANION ALLUVIUM	23	25	POTABLE	1	UC	SF	EX
69673	1/01/1912	355.48	362	-11	344.48	NATIVE COMPANION ALLUVIUM	38	43			UC	SF	EX
69675	24/05/1993		354	-12.5	341.28	ALPHA CREEK ALLUVIUM	26	29.5	POTABLE	2	UC	SF	EX
69676	4/11/1994		356	-27	329.48	ALPHA CREEK ALLUVIUM	27	34	POTABLE	1.8	UC	SF	EX
69677	4/11/1994		352	-20	332.17	ALPHA CREEK ALLUVIUM	20	26		1.8	UC	SF	EX
69692	14/10/1995		363	-12	351.01	NATIVE COMPANION ALLUVIUM	20	26		0.9	UC	SF	EX
69696	1/01/1900	336.99	336	-20	316.99	JOE JOE GROUP	85	107	COND 1230	1.5	FR	SF	AD
69697	9/05/1996		354	-16	337.50	ALLUVIUM	16	27	POTABLE	1	UC	SF	EX

HYDROGEOLOGICAL INFORMATION FOR BORES IN SOUTH GALILEE (DERM)

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer: FORMATION DESCRIPTION	Aquifer: TOP (mbgl)	Aquifer: BOTTOM (mbgl)	Field Parameters: QUALITY	Field Parameters: YIELD (L/S)	CONDITION	FACILITY TYPE	FACILITY STATUS
69711	4/05/1996		351	-5	345.87	NATIVE COMPANION ALLUVIUM	6	9	POTABLE	0.26	UC	SF	EX
69714	30/09/1999		371	-22.5	348.12	ALPHA CREEK ALLUVIUM	22	31	POTABLE	1.5	UC	SF	EX
69715	10/09/1997		354	-18.29	335.71	TERTIARY SEDIMENTS	18.9	26.5	COND 1550		UC	SF	EX
69717	9/12/1997		343	-19	323.83	JOE JOE GROUP	47	114	POTABLE	1.8	FR	SF	EX
69720	5/06/1998		351	-32	319.22	ALPHA CREEK ALLUVIUM	38	59	6220 US/CM	0.75	UC	SF	EX
69729	22/10/2001		365	-18	346.63	NATIVE COMPANION ALLUVIUM	18	56	POTABLE	0.75	UC	SF	EX
69735	24/05/1993		385	-39.6	345.22	NOT RECORDED	42.7	45.8	228 US/CM	0.6	WZ	SF	AD
69744	1/01/1900		389	-25.9	363.34	UNDIFF	56	65.6	SALTY	0.76	PS	AS	AD
69745	18/02/1991		385	-55	330.35	UNDIFF	97.6	109.8	GOOD		PS	SF	EX
69746	1/01/1952	399.77	403	-10.67	389.10	JOE JOE GROUP	16.8	32	GOOD	0.76	FR	SF	EX
69749	1/01/1900	350.8	355	-18	332.80	ALPHA CREEK ALLUVIUM	12	52	1250 US/CM	5.2	UC	SF	AD
89303	27/12/1991			-41.15		TERTIARY - UNDEFINED	62.48	64.01	GOOD	1.52	PS	SF	EX
89327	24/11/1984		354	-27	326.65	COLINLEA SANDSTONE	52	59		0.88	WZ	AS	AD
89472	1/01/1921	377	383	-46		UNDIFF	73	74	POTABLE	1.6	UC	SF	AD
90047			362	-15	346.98	NATIVE COMPANION ALLUVIUM	23	27	POTABLE	1.7	UC	SF	EX
90062	12/08/1999		360	-41	319.04	UNDIFF	40	52.7	1200 US/CM	1.5	FR	SF	AD
90084	13/08/1999		405	-57.6	347.81	MOOLAYEMBER FORMATION/CLEMATIS GROUP	140	169	COND 1180	1.2	PS	SF	AD
90085	14/08/1999		430	-80.7	349.64	CLEMATIS GROUP	124	154.6	COND 900	2.2	PS	SF	AD
90144	14/09/1999		362	-33	328.69	ALLUVIUM ?????	71	77		1.52	UC	SF	EX
90155	9/12/1998		344	-13	331.36	NATIVE COMPANION ALLUVIUM	23	31	9490 US/CM	2.5	UC	SF	EX
90193	8/09/2000		355	-15	339.99	TERTIARY SEDIMENTS	18.3	22.9	COND 1550 7/95	2.27	UC	SF	EX
90217	24/10/1998		484	-30		UNDIFF.	139	143	POTABLE	0.5	PS	SF	EX
90346	22/10/1998		387	-30.48	356.80	TERT.SEDIMENTS	64.01	70.1	POTABLE	0.45	UC	SF	AD
90347	12/04/2000		390	-30.48	359.35	TERT.SEDIMENTS	69.19	80.16	GOOD	1.52	UC	SF	EX
90372		440.49	445	-85.34	355.15	CLEMATIS GROUP	169.16	170.69	GOOD	0.61	FR	SF	AD
90453	29/09/1999		353	-12.2	340.80	SAND	20.42	30.18	1350 US/CM	2.2	UC	SF	EX
103008	2/11/2001		393	-45.72	347.52	DUNDA BEDS	48.77	90.83	2600US/CM	0.38	PS	SF	EX
103054	1/01/1931	400.02	405	-30.48			46.63	54.86	GOOD	0.76	PS	SF	EX

HYDROGEOLOGICAL INFORMATION FOR BORES IN SOUTH GALILEE (DERM)

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer			Field Parameters		CONDITION	FACILITY TYPE	FACILITY STATUS
						FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)			
103113	19/01/2003		352	-15	337.07	TERTIARY - UNDEFINED	21	26	1000 US/CM	4.1	UC	SF	EX
103120	1/01/1916	352	355	-36.58		COLINLEA SANDSTONE	45.72	54.86	GOOD	0.76	PS	SF	AD
103174	8/11/2002		373	-24.38	348.49	TERTIARY - UNDEFINED	45.72	64.01	GOOD	1.52	UC	SF	EX
103175	6/11/2002		427	-77.72	348.81	CLEMATIS GROUP	88.39	93.88	636 US/CM	1.82	PS	SF	EX
103182	17/11/2002		355	-18.2	336.49	SAND	28.6	29.2	BRACKISH	0.01	UC	SF	AD
103183	3/11/2002		382	-47	334.56	TERTIARY - UNDEFINED	65	68	COND 770 4/97	1	UC	SF	EX
103184	4/12/2002		371	-36.58	334.72	TERTIARY - UNDEFINED	39.62	47.24	COND 480	11.49	UC	SF	EX
103202	9/05/2000			-36.5		TERTIARY - UNDEFINED	116.3	119.3	COND 830	16.2	PS	SF	EX
103203	11/06/2000			-36.6		TERTIARY - UNDEFINED	110	123		23	PS	SF	EX
103214	5/08/1999			-99.99		CLEMATIS GROUP	94	109	COND 1124	1.9	PS	SF	AD
103215	25/06/1999			-99.99		TERTIARY - UNDEFINED	84	92	COND 975	1.2	PS	SF	AD
103216	8/07/1999	345		-36.84		TERTIARY - UNDEFINED	101	119	COND 708	2.5	PS	SF	EX
103217	16/07/1999	346		-99.99		TERTIARY - UNDEFINED	108	119	COND 870	2.5	SC	SF	EX
103218	1/01/1912	360.13	353.05	-16.65	336.40	TERTIARY - UNDEFINED	26	35.5	COND 2090, 2340	0.1	WZ	SF	AD
103222		360.45	354.69	-20.8	333.89	TERTIARY - UNDEFINED	62	66	COND 1203	1	UC	SF	AD
103224	1/01/1914	356.96	379.69	-44.05	335.64	TERTIARY - UNDEFINED	56	72	COND 1576	0.5	UC	SF	EX
103225	1/01/1912	360.45	354.52	-18.18	336.34	(21-45) TERTIARY - UNDEFINED	21	70	COND 1704, 1563, 1305	1	UC	SF	EX
103226		360.45	355.51	-18.4	337.11	(23-31) TERTIARY - UNDEFINED	23	68	COND 1740, 1415, 1460	1	UC	SF	AD
103362			364	-30.48	333.51	CLEMATIS GROUP	103.63	121.92	2700US/CM	1.26	PS	SF	EX
103363	1/01/2010		356	-19.81	336.19	SEDIMENTARY - UNDIFF.	35.36	37.49	1850 US/CM	0.57	SC	SF	EX
103364	1/01/2010		364	-45.72	317.87	MOOLAYEMBER FORMATION (63.4-71.93) /TERTIARY	63.4	71.93	2300, 1774 US/CM	2.27	PS	SF	EX
103441	22/09/2001			-97.54		CLEMATIS GROUP	103.63	115.82	210 US/CM	0.57	PS	SF	EX
103480	1/01/1914	356	357	-32	324.00	COLINLEA SANDSTONE	60.96	121.92	5900US/CM	1.64	PS	SF	AD
103492	1/01/2010		471	-13		CLEMATIS GROUP	35.9	38	400US/CM	3.7	UC	SF	EX
103506	1/01/2010		365	-24.38	340.23	SEDIMENTARY - UNDIFF.	32.92	35.36	1508US/CM	1.52	UC	SF	EX
103667	1/01/2010		382	-47.75	333.92	TERTIARY - UNDEFINED	65.2	68.2	620 PPM T.D.S	0.3	UC	SF	EX
103669	1/01/2010		369	-24.52	344.55	SAND	22	33		0.4	PS	SF	EX
103671	15/11/2009		350	-23.95	325.85	TERTIARY - UNDEFINED	25	35		0.5	UC	SF	AD
103672	18/11/2009		362	-48.6	313.00	TERTIARY - UNDEFINED	25	46			UC	SF	EX
103674	19/11/2009		354	-29	325.31	SEDIMENTARY - UNDIFF.	19	26		0.2	SC	SF	AU
103678	10/10/1939	409	417	-36.5	372.50	COLINLEA SANDSTONE	60.3	100.1	POTABLE	1.05	CV	SF	AD

						Aquifer			Field Parameters				
REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)	CONDITION	FACILITY TYPE	FACILITY STATUS
103679	1/01/1900	412	411			DUNDA BEDS	62	80		0.3	PS	SF	AD
103787	21/11/2009		402	-66		BLACKWATER GROUP	68	120	COND 1980 US/CM	2.19	PS	SF	EX
103801	28/08/2003	438		-85.34		CLEMATIS GROUP	112.78	118.87	GOOD	0.76	FR	SF	EX
103873	29/01/2005			-109			111	125	295 US/CM	1.9	SC	SF	EX
103874	18/11/2004			-40		TERTIARY - UNDEFINED	48	65	"POTABLE"	5.7	PS	SF	EX
118232	23/02/2003			-34			59	61	"POTABLE"	2.9	PS	SF	EX
118257	3/04/2009		402	-64.01	337.99	MOOLAYEMBER FORMATION	88.39	91.44	GOOD	3.03	PS	SF	EX
132308	6/04/2009		408	-36	372.30	BLACKWATER GROUP	55	86	1147, 663 PPM	6.29	FR	SF	AU
132355	6/06/2010		346	-16	329.79	NATIVE COMPANION ALLUVIUM	14.33	16	4.54MS	0.72	UC	SF	EX
132597	11/06/2010		415	-48	366.63	COLINLEA SANDSTONE	46	90	POTABLE	1.39	PS	SF	EX
132598	14/06/2010		390	-33	356.62		29	66	POTABLE	4.62	PS	SF	EX
132599	2/07/2010		385	-42	342.96		66	72	POTABLE	1.52	PS	SF	EX
132790	19/05/1974		336	-17	318.95	TERTIARY (15-47) COLINLEA SANDSTONE	47	80			FR	SF	AU
132791	16/05/1974		329	-11	317.72	COLINLEA SANDSTONE	33	62			FR	SF	AU
132792	16/05/1974		375	-51	323.63	BANDANNA FORMATION (44-57.4) COLINLEA SANDSTONE	57.4	66			PS	SF	EX
132829	6/03/2011											SF	EX
146473	8/11/1998											SF	EX
146487	31/05/1974		435	-86.5	348.84	127-230 POTABLE	244	253	B	4.48	PS	SF	EX
12030028		347.32	350	-6.05	341.27	COMPANION CREEK ALLUVIUM	3.7	12.8	COND 770		UC	SF	AD
12030029		348.32	353	-6.73	341.59	COMPANION CREEK ALLUVIUM	5.8	8.5	COND 820 11/78		UC	SF	AD
12030030	1/01/1912	348.06	351	-5.63	342.43	COMPANION CREEK ALLUVIUM	6.1	8.2	COND 510 11/78		UC	SF	EX
12030036		349.36	363	-15	334.36	ALPHA CREEK ALLUVIUM / GRANITES	12.8	17.1	COND 310 8/77		WZ	SF	AD
12030037	1/01/1900	350.3	355	-6	344.30	ALPHA CREEK ALLUVIUM	6.1	7.9			UC	SF	EX
12030038		350.07	358	-9.2	340.87	ALPHA CREEK ALLUVIUM	7.6	10.4			UC	SF	AD
12030039		350.07	357	-16.1	333.97	TERTIARY SEDIMENTS	29	30.2	POTABLE		UC	SF	AD
12030040		350.64	354	-11.7	338.94	ALPHA CREEK ALLUVIUM	4	13.1	COND 1850 8/77		UC	SF	AD

REGISTERED NUMBER	DRILLED DATE	GROUND (mAHD) ELEVATION	GROUND ELEVATION (mAHD) GIS ACQUIRED	SWL (mbgl)	SWL ELEVATION (mAHD)	Aquifer			Field Parameters		CONDITION	FACILITY TYPE	FACILITY STATUS
						FORMATION DESCRIPTION	TOP (mbgl)	BOTTOM (mbgl)	QUALITY	YIELD (L/S)			
12030041		350.64	354	-15.7	334.94	UNDIFF TERT	13.1	24.4	COND 2050		PS	SF	AD
12030042	31/03/1942	376.15	387	-3.15	373.00	ALPHA CREEK ALLUVIUM	1	4.5	COND 110 8/77		UC	SF	AD
12030043	1/09/1944	377.71	387	-4.49	373.22	ALPHA CREEK ALLUVIUM	3.1	5.5	COND 167 8/77		UC	SF	AD
12030044	1/01/1937	380.17	386	-7.02	373.15	ALPHA CREEK ALLUVIUM	5.5	9.3	COND 350		UC	SF	AD
12030045	1/01/1900	369.04	373	-7.7	361.34	ALPHA CREEK ALLUVIUM	5.5	7.9			UC	SF	AD
12030046	17/05/1937	369.12	372	-6.88	362.24	ALPHA CREEK ALLUVIUM	6.1	7.9	COND 600 8/77		UC	SF	EX
12030047	17/05/1937	369.7	374	-7.23	362.47	ALPHA CREEK ALLUVIUM	4.6	10.7	COND 570		UC	SF	AD
12030048	17/05/1937	369.77	376	-11.02	358.75	UNDIFF TERT	7.9	19.8	COND 970 11/78		PS	SF	AD
12030051	31/05/1974	318.13	322	-14.01	304.12	COMPANION CREEK ALLUVIUM	12.5	13.4		0	UC	SF	EX
12030052	1/01/1912	318.42	321	-8.84	309.58	COMPANION CREEK ALLUVIUM	7.6	10.4	COND 790 11/78		UC	SF	EX
12030067	1/10/2003	391.02	398	-8.41	382.61	ALPHA CREEK ALLUVIUM	6.1	8.2		0	UC	SF	AU
12030068	4/12/1952	390.19	398	-8.94	381.25	ALPHA CREEK ALLUVIUM	5.3	10.1			UC	SF	AD
12030070		328.97	332	-10.1	318.87	NATIVE COMPANION ALLUVIUM	7	12.5			UC	SF	AD
12030071	2/10/2003	329.15	330	-15.58	313.57	COMPANION CREEK ALLUVIUM	8.2	16.8		0	UC	SF	AU
12030076	20/01/1953	399.38	328	-9.3	318.69	COLINLEA SANDSTONE	22.9	28.3	COND 2270011/78		PS	SF	AD
12030077	22/06/1960	400	333	-1.86	330.82	TERTIARY - UNDEFINED	4	8.2	COND 190		WZ	SF	AD
12030144	1/01/1900	380.47	390	-49.36	340.46	QUATERNARY - UNDEFINED / TERTIARY - UNDEFINED /BLACKWATER GROUP (62-70)	62	70	COND 11620		FR	SF	AD
12030146	24/08/2010	287.25	390	-8.04	381.96	TERTIARY - UNDEFINED /JOE JOE GROUP (58-80)						SF	AD
12030148	1/06/1944	320.84	324	-26.6	294.24	SEDIMENTARY - UNDIFF / JOE JOE GROUP	25	27			UC	SF	AD
12030183	27/08/2010		378	0	378.00	DUCABROOK FORMATION	190	250	12300 MS/CM	1.5	SC	SF	AD
12030186	1/01/1919	388.6	380	-44.8	343.80	TERTIARY - UNDEFINED /JOE JOE FORMATION (90-252)	59.5	65	770US/CM	0.1	SC	SF	AD

APPENDIX E: BORE CENSUS MATRIXPLUS REPORTS

LANDHOLDER BORE CENSUS - Betanga
for
ALPHA COAL PROJECT
June 2009

matrixplus

Document History and Status

Issue	Revision	Issued to	Qty	Date	Reviewed by
1	1 (Draft)	Matrixplus	1	22/5/2009	Tim Armstrong
2	2 (Draft)	AMCI	1	25/5/2009	Mark Bouffler
3	3 (Draft)	Matrixplus	1	28/5/2009	Bonny O'Neal
4	4 (Draft)	AMCI	1	28/5/2009	Mark Bouffler
5	5 (Draft)	Matrixplus	1	05/6/2009	Bonny O'Neal
6	6 (Final)	AMCI	1	09/6/2009	Mark Bouffler

Matrixplus Project Delivery System

Printed: **10 June 2009**

Last saved: **10 June 2009**

File Name: **p:\projects\amci\amc801_alpha coal\wip\groundwater\wip\landholder report\matrixplus_20090610_landholder_bore_census_report_betanga.doc**

Project Manager: **Bonny O'Neal**

Name of Organisation: **Matrixplus**

Name of Project: **Landholder bore census - Betanga**

Name of Document: **Final**

Document Version: **Ver 6.0**

Project Number: **AMC801**

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GLOSSARY OF TERMS

mAHD	Metres above Australian Height Datum (approximately mean sea level).
Alluvium	A general term for clay, silt, sand, gravel or similar unconsolidated detrital material, deposited by a stream or other body of running water, in the bed of the stream or on its floodplain or delta.
Aquifer	A water bearing rock or sediment in a formation, group of formations, or part of a formation that is capable of yielding sufficient water to satisfy a particular demand.
Casing	A tube used as temporary or permanent lining for a bore.
Coal	A black rock formed from prehistoric plant material which has been unable to breakdown and subsequently compressed over time, composed largely of carbon and burned as a fuel.
DERM	Queensland Department of Environmental Resource Management.
Dewatering	Is the removal of groundwater from geological units by pumping or draining. This is often done during the development phase of mine construction and/or production due to a high water table. It usually involves the use of dewatering bores.
Electrical conductivity (EC)	The measure of a solution's ability to conduct electricity. EC units are used to express salinity levels in water. When salt is dissolved in water the conductivity increases, so the more salt, the higher the EC value. Usually expressed in micro Siemens per centimetre (µS/cm) at 25°C.
Groundwater	The water contained within the joints, vesicles, fractures or interconnected pores of an aquifer.
Groundwater flow	The movement of water through openings in sediment and rock; occurs in the zone of saturation.
Licensed production bores	Groundwater bores that are licensed by the DERM under the *Water Act 2000* and/or *Integrated Planning Act 1997*.
Lithology	The description of rocks on the basis of such characteristics as colour, mineralogy and grain size.
Mudstone	A fine-grained detrital sedimentary rock consisting mainly of clay size particles. Mudstone has low capacity to transmit water.
Registered bores	Groundwater bores that are registered by the DERM under the *Water Act 2000* and/or *Integrated Planning Act 1997*.
Sandstone	A clastic sedimentary rock composed of sand sized particles. Has potential to transmit significant quantities of water depending on the size of sand particles and the proportion of fines between the sand grains.
Screen	A tubular device with slots, holes, gauze, or continuous-wire wrap; used at the end of a bore casing to allow entry of water while withhold the aquifer material.
Siltstone	A fine-grained detrital sedimentary rock composed of silt-sized particles. Siltstone has a low capacity to transmit water.
Standing water level	The depth from ground level (or other stated reference point) to the water level in a bore which is not influenced by pumping.
Total Dissolved Solids (TDS)	The sum of all inorganic and organic particulate matter (including salts) in a sample of water, usually expressed in milligrams per litre (mg/L) or parts per million (ppm).
Yield	The volume of water discharged from a bore in gallons per hour (GPH) or litres per second (l/s).

1 INTRODUCTION

AMCI (Alpha) Pty Ltd is currently undertaking a feasibility study with the aim of establishing a new coal mine (Alpha Coal Project). The proposed Alpha Coal Project (ACP) will involve the development of an underground and/or open-cut coal mining and processing operation. The project is located immediately south-west of the township of Alpha, which is approximately 160 km to the west of Emerald. ACP mining tenements include four exploration permits (EPC1048, EPC1049, EPC1179, and EPC1180) which cover an area of 2,580 m^2 (**Figure 1-1**). Exploration drilling to date has concentrated on EPC1049.

The primary land use within the vicinity of the proposed mine site is agriculture; the area covered by the EPC's is made up of a number of cattle grazing properties. The majority of these properties utilise groundwater for stock and domestic supplies.

The proposed ACP will most likely intersect aquifers during mining operations. The intersection of aquifers will cause groundwater inflows into the underground and/or open-cut coal mine. A degree of aquifer dewatering by the mining operation will be required to allow for safe mining operations.

The removal of groundwater may potentially impact the surrounding hydrogeological regime including affecting water levels in nearby landholder bores.

Matrixplus on behalf of AMCI recently completed a bore census of proximal properties as an initial investigation into the groundwater resources of the region. The bore census allows Matrixplus/AMCI to assess surrounding landholder's groundwater resources prior to mining so that the potential impact of the mine can be assessed, monitored and mitigated. The objectives of the bore census included:

- identifying all bores located on the selected properties; and
- providing further information on groundwater use, current state of each bore, target aquifer, and water quality.

Data collected during the census will assist AMCI/Matrixplus in conceptualising the regional hydrogeological regime and assess the potential impact of the proposed mine on the surrounding groundwater environment. The increased understanding gained through the bore census will allow Matrixplus to better mitigate potential groundwater related impacts to surrounding landholders.

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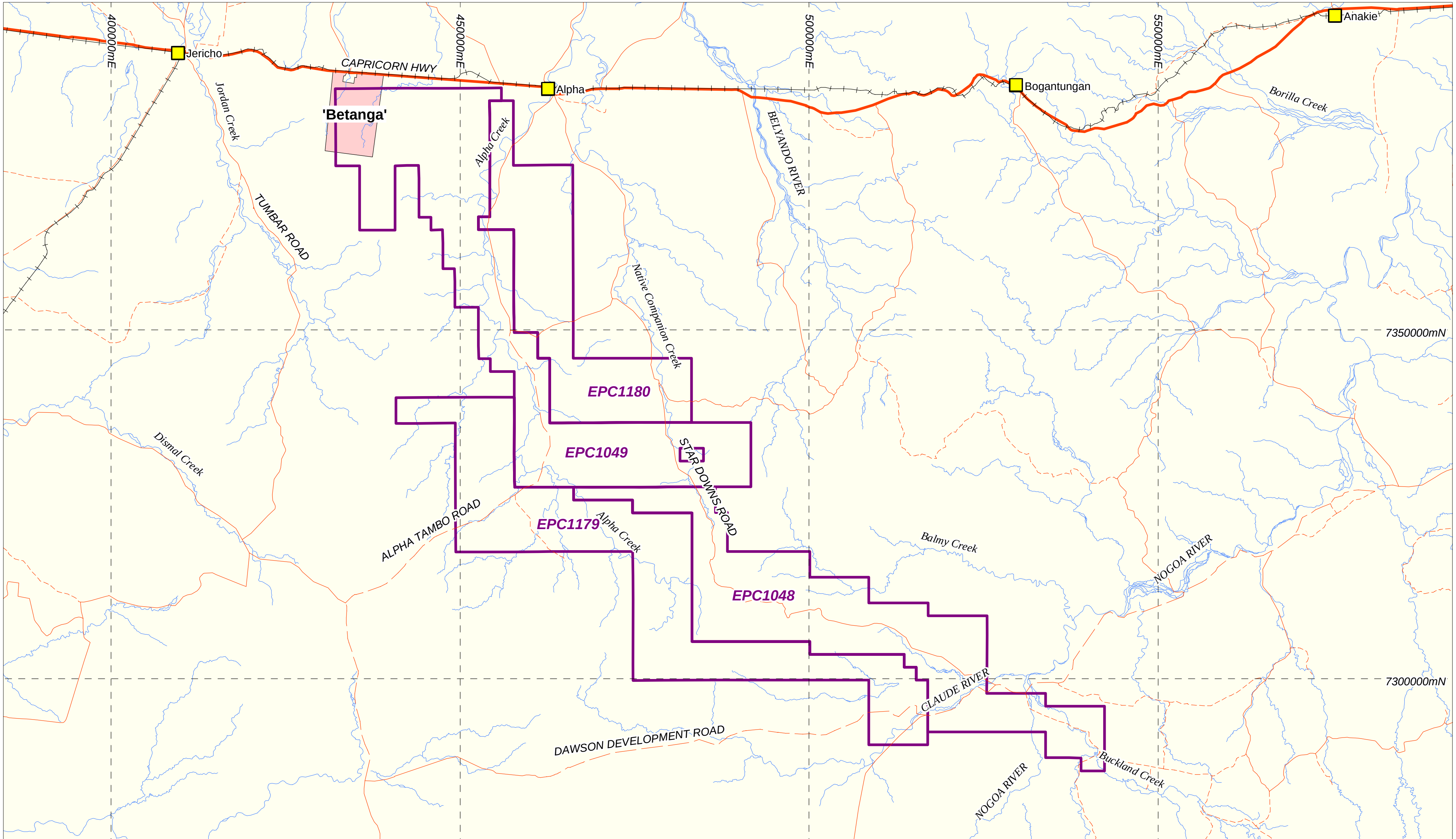


matrixplus

0 15

Kilometres

Scale: 1:750,000 (A4)

LEGEND

Project Tenement	Railway
Highway	Watercourse
Road	Town
Track	

Data Source: Cadastral (DCDB2005) - ERM. Topography - Geoscience Australia. Tenement - EEDI

Alpha Coal Project

Landholder Bore Census - 'Betanga'

Location of Current Exploration Permits

12/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 1-1

2 EXISTING ENVIRONMENT

2.1 TOPOGRAPHY

The proposed ACP is located on a gently undulating landscape with a typical elevation of 380-420 mAHD. The western margins of the EPC are flanked by the Great Dividing Range.

Large sections of the proposed mine area have been cleared of vegetation for the purposes of low intensity cattle grazing. The majority of the ACP is traversed by minor creek systems including Alpha and Tallarenha Creeks.

2.2 GEOLOGY

The proposed ACP lies within the Late Carboniferous to Middle Triassic Galilee Basin. The Galilee Basin strata comes to outcrop on the eastern edge of the basin along the margins of the overlying Eromanga Basin sediments which form the Great Dividing Range and Great Artesian Basin (GAB) (refer to **Figure 2-1**). The ACP EPC's follow this outcrop along the Great Dividing Ranga and GAB margin targeting coal seams associated with the Permian Bandanna Formation.

Table 2-1 shows a generalised stratigraphic section of the region surrounding the ACP including a brief lithologic description of each unit. The ACP geology typically comprises of Tertiary sediments unconformably overlying gently dipping Permian sedimentary deposits (**Figure 2-1**).

Table 2-1 Generalised ACP stratigraphy

Period	Formation	Rock type
Quaternary		Alluvium, some sand and gravel
Tertiary	Undefined	Sand, clay and gravel
Lower? to Middle Triassic	Clematis Sandstone	Quartzose sandstone, siltstone and mudstone
Lower Triassic	Dunda Beds	Lithic to quartzose sandstone, siltstone and mudstone
	Rewan Formation	Mudstone, siltstone and sandstone
Upper Permian	Blackwater Group (including the Bandanna Formation)	Sandstone, siltstone, mudstone, conglomerate and coal
Lower Permian	Colinlea Sandstone	Labile and quartz sandstone, minor siltstone and coal
Upper Carboniferous to Lower Permian	Joe Joe Formation	Mudstone, labile sandstone, siltstone and shale

2.2.1 Quaternary

Alluvial deposits occur along the creek courses, the most significant of these alluviums exist along the courses of Alpha Creek, Tallarenha Creek and Beta Creek. Deposits are narrow and limited in extent, consisting of silts, clays, and sands and are generally less than 10 metres thick.

2.2.2 Tertiary

The ACP is covered by a thin veneer of unconsolidated Tertiary sediments which unconformably overlie the Permian strata and are generally less than 30 metres thick. The Tertiary sediments consist of sand plain deposits of residual alluvium, predominantly a mixture of sand and clay units, iron-cemented in places, commonly ferruginised (duricrust) with occasional basal sand and gravel.

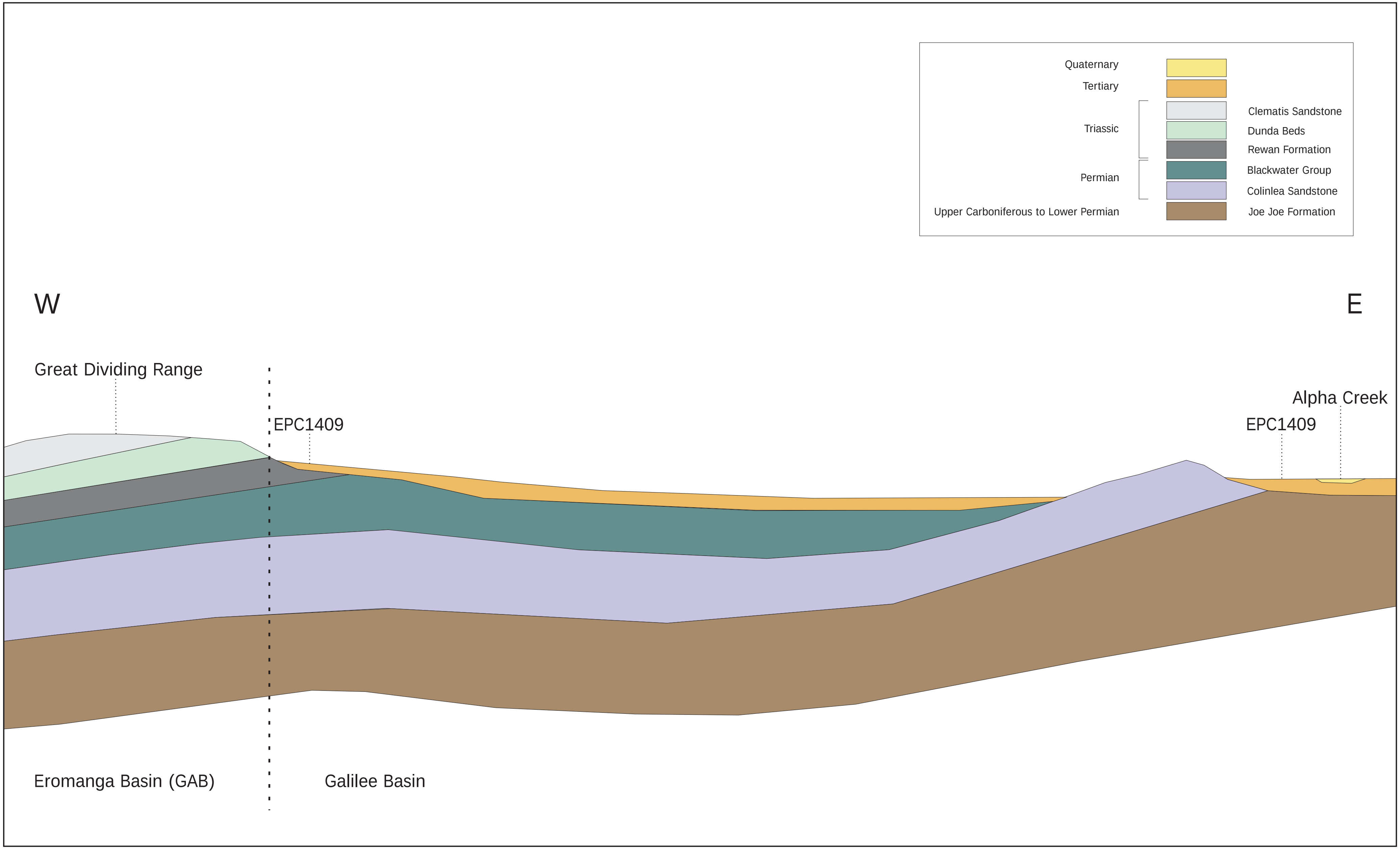
2.2.3 Triassic

This unit is not present across the ACP, but is believed to unconformably overlie the Permian strata to the west along the Great Dividing Range. The Triassic unit is related to the Eromanga Basin and the GAB sequence and consists of sandstones, siltstones and mudstones including the Clematis sandstone and Rewan Formation.

2.2.4 Permian

The Permian stratigraphic sequence strikes north-south and dips to the west. The uppermost unit, the Blackwater Group including the Bandanna Formation, subcrops within EPC1049 and along the area of the Alpha/Tambo road following the eastern margin of the Galilee Basin. Significant coal seams up to 5 metres thick are present in the Bandanna Formation.

To the east the Lower Permian Colinlea Sandstone outcrops to form a range of low rounded hills creating a topographic rise between the ACP and the township of Alpha (**Figure 2-1**).



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Alpha Coal Project

Schematic geological cross-section - Figure 2-1

2.3 Groundwater Occurrence

A review of the Department of Environment and Resource Management (DERM) groundwater database along with exploration logs from recent exploration drilling reveal that five aquifers occur proximal to the proposed ACP. These aquifers are:

- Quaternary alluvial aquifer;
- Tertiary undefined aquifer;
- Triassic Dunda Beds (a formation associated with the Great Artesian Basin);
- Permian Bandanna Formation aquifer; and
- Permian Colinlea Sandstone aquifer.

The DERM groundwater database indicates there are a number of registered bores located within and surrounding the ACP. Locations of registered bores are shown in **Figure 2-2**. Because domestic and stock bores (located within the Burdekin Basin) do not require formal licensing, the total number of bores within this area may actually exceed the bores identified in the DERM database.

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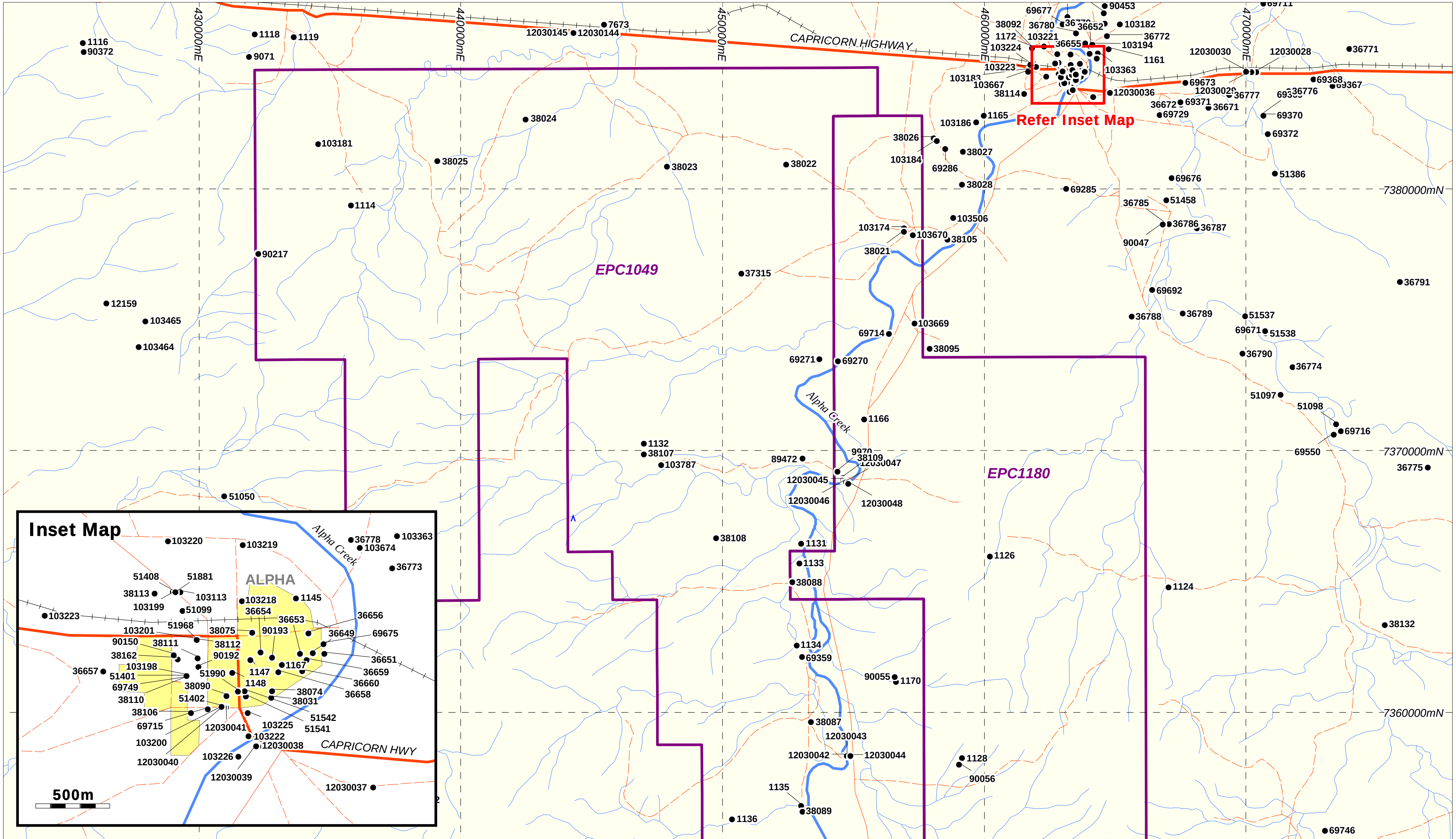

LEGEND

- Project Tenement
- Highway
- Road
- Road
- Railway
- Watercourse
- Alpha Creek

Data Source: Topography - Geoscience Australia. Tenement - EEDI.

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Kilometres
Scale: 1:200,000 (A4)

Alpha Coal Project

Landholder Bore Census - 'Betanga'

DERM Registered Bore Locations

22/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 2-2

3 BORE CENSUS METHODOLOGY

AMCI contacted landholders in the vicinity of the ACP exploration permits advising them of the proposed census and invited them to participate. A property would not be surveyed without the prior consent of the landholder. Each landholder participated in the survey of the property, escorting a Matrixplus hydrogeologist to bore locations.

A hand held global position system (GPS) was used to map the location of each bore visited. Anecdotal information on bore usage, aquifer type, pumping rates, and bore yield was collected. Groundwater levels were determined using a water level dip meter (dipper) unless headworks impeded access to the bore casing. Where possible, groundwater quality parameters of pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Temperature were measured in the field. Bore information such as drill logs were recorded from property owners if available.

Field collected data was supplemented by historical data extracted from the DERM groundwater database. Both sets of data were collated to summarise the property's groundwater occurrence and use.

4 BORE CENSUS RESULTS

The Betanga property runs approximately 450 head of cattle and relies on a mixture of groundwater and surface water (i.e. dams). During the 2009 bore census, 12 groundwater bores were identified on the Betanga property. **Figure 4-1** illustrates the bore locations and **Table 4-1** shows bore information compiled from the bore census and DERM groundwater database.

Of the 12 bores, 3 are currently available for use:

- House bore is utilised for domestic supplies;
- Solar bore has recently been installed and once equipped will be used for stock watering purposes; and
- Hills bore is used sporadically for stock watering.

The 9 remaining bores are abandoned due to age deterioration (<1950) and subsequent collapse, casing collapse due to poor bore construction and insufficient water supply.

Standing water level for Solar bore was measured at 40.2 mBGL; all other bores on the Betanga property were unable to be measured due to collapsed casing or pumps precluding measurement. At the time of the bore census no bores could be tested for water quality. Anecdotal evidence suggests that House bore is potable and Hills bore is acceptable as stock water for cattle.

The bore census has shown that four distinct aquifers exist across the Betanga property, including the:

- Quaternary alluvial aquifer;
- Tertiary undefined aquifer;
- Triassic Dunda Beds (formation associated with the Great Artesian Basin); and
- Permian Bandanna Formation aquifer.

At the time of the census two of the four aquifers were being utilised for domestic and stock water supplies, the; Tertiary undefined and Triassic Dunda Beds aquifers.

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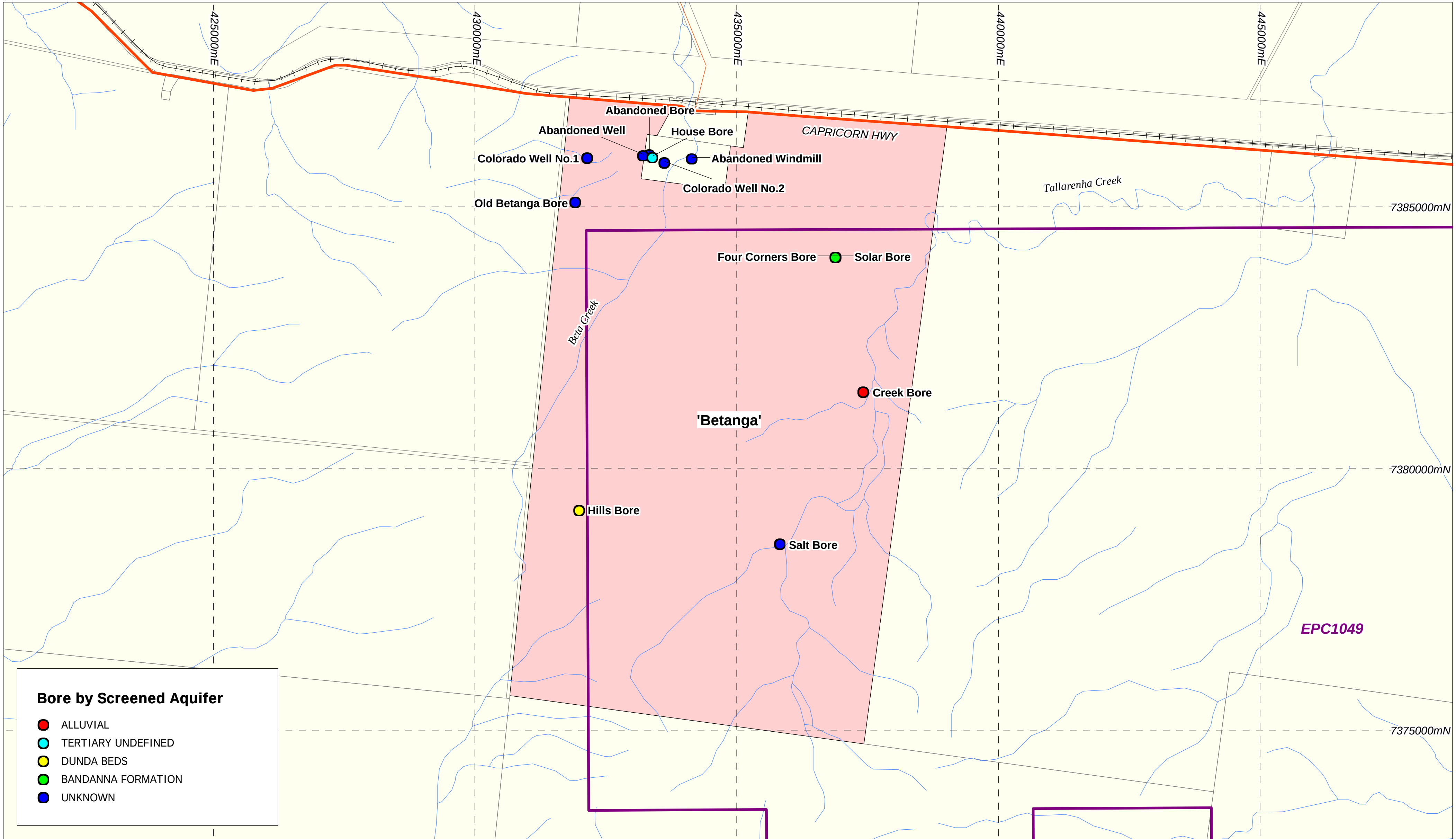

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Kilometres

Scale: 1:100,000 (A4)

LEGEND

- Project Tenement
- Property Boundary
- Highway
- Road
- Track
- Railway
- Watercourse

Data Source: Cadastral (DCDB2005) - ERM. Topography - Geoscience Australia. Tenement - EEDI.

Alpha Coal Project

Landholder Bore Census - 'Betanga'

Bore Locations

28/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 4-1

Table 4-1 Bore detail summary

	Bore name	Colorado well No. 1	Colorado well No. 2	House bore	Abandoned windmill	Old Betanga bore	Abandoned bore	Abandoned well	Solar bore	Four corners bore	Creek bore	Hills bore	Salt bore
Bore Details	RN	1118	1119			9071				103181		90217	1114
	Date drilled	1/01/1900	1/01/1900	1992		31/3/1942*			2009	24/05/1993*		24/05/1993*	1/06/1944*
	Easting (GDA94)	432144*	433620*	433394	434141	431918*	433334	433210	436892	436887	437422	431991	435826
	Northing (GDA94)	7385953*	7385860*	7385958	7385934	7385101*	7386009	7385991	7384057	7384055	7381485	7379221	7378577
	Elevation (mAHD)						385		413	451	416	475	435
	Bore depth (mBGL)	38.4*	38.4*	70		44.2*			90	152.4*		170*	187.2*
	Screened interval (m)					32.9-44.2*						139-143*	
	Aquifer lithology	unknown	unknown	Tertiary undefined	unknown	unknown	unknown	unknown	Permian Bandanna Formation - sandstone	Permian Bandanna Formation - sandstone	Quaternary - alluvial	Triassic Dunda Beds - sandstone	unknown
	Casing (mm)			152.4 steel					PVC	125 PVC		125 steel	125 steel
Bore use details	Bore use	abandoned	abandoned	domestic	abandoned	abandoned	abandoned	abandoned	not in use	abandoned	abandoned	stock water	abandoned
	Approximate usage			3-4 times a week								sporadically	
	Bore equipment			submersible								submersible	
	Depth to pump intake											100	
Groundwater Details	SWL (mBGL)					22.8*			40.2			30*	
	Yield (L/s)			0.63						0.6	0.1	0.63	
	pH												
	EC (µS/cm)												
	TDS (ppm)												
	Temperature												
Comments		Bore not located during the census	Bore not located during the census	potable		Bore not located during the census			Installed by AMCI will be equipped shortly	Bore collapsed in 2002	Abandoned prior to 1996 due to poor casing condition and insufficient yield to warrant pumping	Bore used as sole water supply during last drought	Bore is collapsed at ~ 5 m and has never been used during the current landholders ownership of the property

* denotes DERM data

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LANDHOLDER BORE CENSUS - Creek Farm
for
ALPHA COAL PROJECT
June 2009

matrixplus

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Document History and Status

Issue	Revision	Issued to	Qty	Date	Reviewed by
1	1 (Draft)	Matrixplus	1	22/5/2009	Tim Armstrong
2	2 (Draft)	AMCI	1	25/5/2009	Mark Bouffler
3	3 (Draft)	Matrixplus	1	28/5/2009	Bonny O'Neal
4	4 (Draft)	AMCI	1	28/5/2009	Mark Bouffler
5	5 (Draft)	Matrixplus	1	05/6/2009	Bonny O'Neal
6	6 (Final)	AMCI	1	09/6/2009	Mark Bouffler

Matrixplus Project Delivery System

Printed: **10 June 2009**

Last saved: **10 June 2009**

File Name: **p:\projects\amci\amc801_alpha coal\wip\groundwater\wip\landholder report\matrixplus_20090610_landholder_bore_census_report_creek_farm.doc**

Project Manager: **Bonny O'Neal**

Name of Organisation: **Matrixplus**

Name of Project: **Landholder bore census – Creek Farm**

Name of Document: **Final**

Document Version: **Ver 6.0**

Project Number: **AMC801**

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GLOSSARY OF TERMS

mAHD	Metres above Australian Height Datum (approximately mean sea level).
Alluvium	A general term for clay, silt, sand, gravel or similar unconsolidated detrital material, deposited by a stream or other body of running water, in the bed of the stream or on its floodplain or delta.
Aquifer	A water bearing rock or sediment in a formation, group of formations, or part of a formation that is capable of yielding sufficient water to satisfy a particular demand.
Casing	A tube used as temporary or permanent lining for a bore.
Coal	A black rock formed from prehistoric plant material which has been unable to breakdown and subsequently compressed over time, composed largely of carbon and burned as a fuel.
DERM	Queensland Department of Environmental Resource Management.
Dewatering	Is the removal of groundwater from geological units by pumping or draining. This is often done during the development phase of mine construction and/or production due to a high water table. It usually involves the use of dewatering bores.
Electrical conductivity (EC)	The measure of a solution's ability to conduct electricity. EC units are used to express salinity levels in water. When salt is dissolved in water the conductivity increases, so the more salt, the higher the EC value. Usually expressed in micro Siemens per centimetre (µS/cm) at 25°C.
Groundwater	The water contained within the joints, vesicles, fractures or interconnected pores of an aquifer.
Groundwater flow	The movement of water through openings in sediment and rock; occurs in the zone of saturation.
Licensed production bores	Groundwater bores that are licensed by the DERM under the *Water Act 2000* and/or *Integrated Planning Act 1997*.
Lithology	The description of rocks on the basis of such characteristics as colour, mineralogy and grain size.
Mudstone	A fine-grained detrital sedimentary rock consisting mainly of clay size particles. Mudstone has low capacity to transmit water.
Registered bores	Groundwater bores that are registered by the DERM under the *Water Act 2000* and/or *Integrated Planning Act 1997*.
Sandstone	A clastic sedimentary rock composed of sand sized particles. Has potential to transmit significant quantities of water depending on the size of sand particles and the proportion of fines between the sand grains.
Screen	A tubular device with slots, holes, gauze, or continuous-wire wrap; used at the end of a bore casing to allow entry of water while withhold the aquifer material.
Siltstone	A fine-grained detrital sedimentary rock composed of silt-sized particles. Siltstone has a low capacity to transmit water.
Standing water level	The depth from ground level (or other stated reference point) to the water level in a bore which is not influenced by pumping.
Total Dissolved Solids (TDS)	The sum of all inorganic and organic particulate matter (including salts) in a sample of water, usually expressed in milligrams per litre (mg/L) or parts per million (ppm).
Yield	The volume of water discharged from a bore in gallons per hour (GPH) or litres per second (l/s).

1 INTRODUCTION

AMCI (Alpha) Pty Ltd is currently undertaking a feasibility study with the aim of establishing a new coal mine (Alpha Coal Project). The proposed Alpha Coal Project (ACP) will involve the development of an underground and/or open-cut coal mining and processing operation. The project is located immediately south-west of the township of Alpha, which is approximately 160 km to the west of Emerald. ACP mining tenements include four exploration permits (EPC1048, EPC1049, EPC1179, and EPC1180) which cover an area of 2,580 m^2 (**Figure 1-1**). Exploration drilling to date has concentrated on EPC1049.

The primary land use within the vicinity of the proposed mine site is agriculture; the area covered by the EPC's is made up of a number of cattle grazing properties. The majority of these properties utilise groundwater for stock and domestic supplies.

The proposed ACP will most likely intersect aquifers during mining operations. The intersection of aquifers will cause groundwater inflows into the underground and/or open-cut coal mine. A degree of aquifer dewatering by the mining operation will be required to allow for safe mining operations.

The removal of groundwater may potentially impact the surrounding hydrogeological regime including affecting water levels in nearby landholder bores.

Matrixplus on behalf of AMCI recently completed a bore census of proximal properties as an initial investigation into the groundwater resources of the region. The bore census allows Matrixplus/AMCI to assess surrounding landholder's groundwater resources prior to mining so that the potential impact of the mine can be assessed, monitored and mitigated. The objectives of the bore census included:

- identifying all bores located on the selected properties; and
- providing further information on groundwater use, current state of each bore, target aquifer, and water quality.

Data collected during the census will assist AMCI/Matrixplus in conceptualising the regional hydrogeological regime and assess the potential impact of the proposed mine on the surrounding groundwater environment. The increased understanding gained through the bore census will allow Matrixplus to better mitigate potential groundwater related impacts to surrounding landholders.

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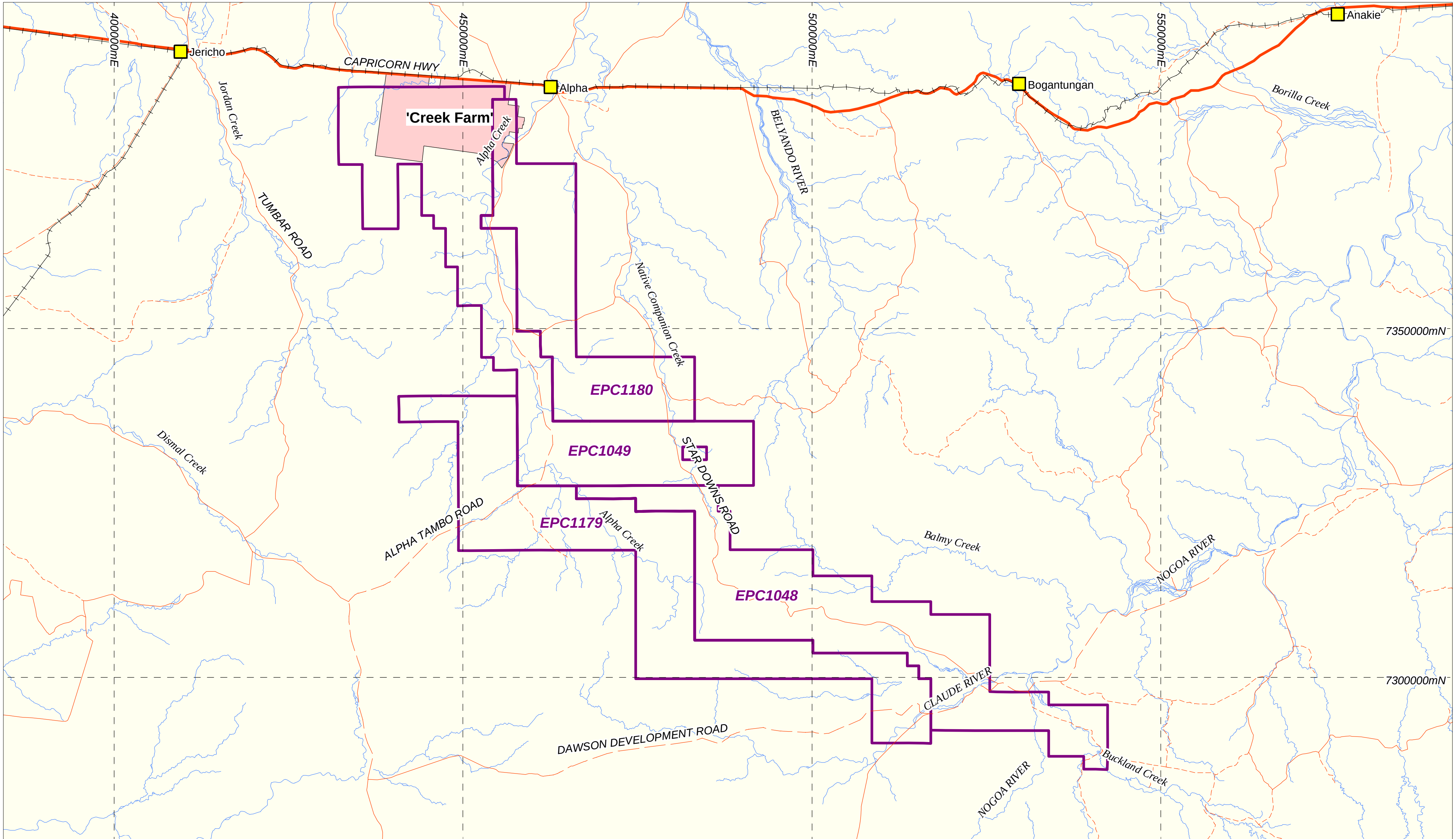

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LEGEND

Project Tenement
Highway
Road
Track
Railway
Watercourse
Town

Data Source: Cadastral (DCDB2005) - ERM. Topography - Geoscience Australia. Tenement - EEDI

Alpha Coal Project

Landholder Bore Census - 'Creek Farm'

Location of Current Exploration Permits

12/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 1-1

2 EXISTING ENVIRONMENT

2.1 TOPOGRAPHY

The proposed ACP is located on a gently undulating landscape with a typical elevation of 380-420 mAHD. The western margins of the EPC are flanked by the Great Dividing Range.

Large sections of the proposed mine area have been cleared of vegetation for the purposes of low intensity cattle grazing. The majority of the ACP is traversed by minor creek systems including Alpha and Tallarenha Creeks.

2.2 GEOLOGY

The proposed ACP lies within the Late Carboniferous to Middle Triassic Galilee Basin. The Galilee Basin strata comes to outcrop on the eastern edge of the basin along the margins of the overlying Eromanga Basin sediments which form the Great Dividing Range and Great Artesian Basin (GAB) (refer to **Figure 2-1**). The ACP EPC's follow this outcrop along the Great Dividing Ranga and GAB margin targeting coal seams associated with the Permian Bandanna Formation.

Table 2-1 shows a generalised stratigraphic section of the region surrounding the ACP including a brief lithologic description of each unit. The ACP geology typically comprises of Tertiary sediments unconformably overlying gently dipping Permian sedimentary deposits (**Figure 2-1**).

Table 2-1 Generalised ACP stratigraphy

Period	Formation	Rock type
Quaternary		Alluvium, some sand and gravel
Tertiary	Undefined	Sand, clay and gravel
Lower? to Middle Triassic	Clematis Sandstone	Quartzose sandstone, siltstone and mudstone
Lower Triassic	Dunda Beds	Lithic to quartzose sandstone, siltstone and mudstone
	Rewan Formation	Mudstone, siltstone and sandstone
Upper Permian	Blackwater Group (including the Bandanna Formation)	Sandstone, siltstone, mudstone, conglomerate and coal
Lower Permian	Colinlea Sandstone	Labile and quartz sandstone, minor siltstone and coal
Upper Carboniferous to Lower Permian	Joe Joe Formation	Mudstone, labile sandstone, siltstone and shale

2.2.1 Quaternary

Alluvial deposits occur along the creek courses, the most significant of these alluviums exist along the courses of Alpha Creek, Tallarenha Creek and Beta Creek. Deposits are narrow and limited in extent, consisting of silts, clays, and sands and are generally less than 10 metres thick.

2.2.2 Tertiary

The ACP is covered by a thin veneer of unconsolidated Tertiary sediments which unconformably overlie the Permian strata and are generally less than 30 metres thick. The Tertiary sediments consist of sand plain deposits of residual alluvium, predominantly a mixture of sand and clay units, iron-cemented in places, commonly ferruginised (duricrust) with occasional basal sand and gravel.

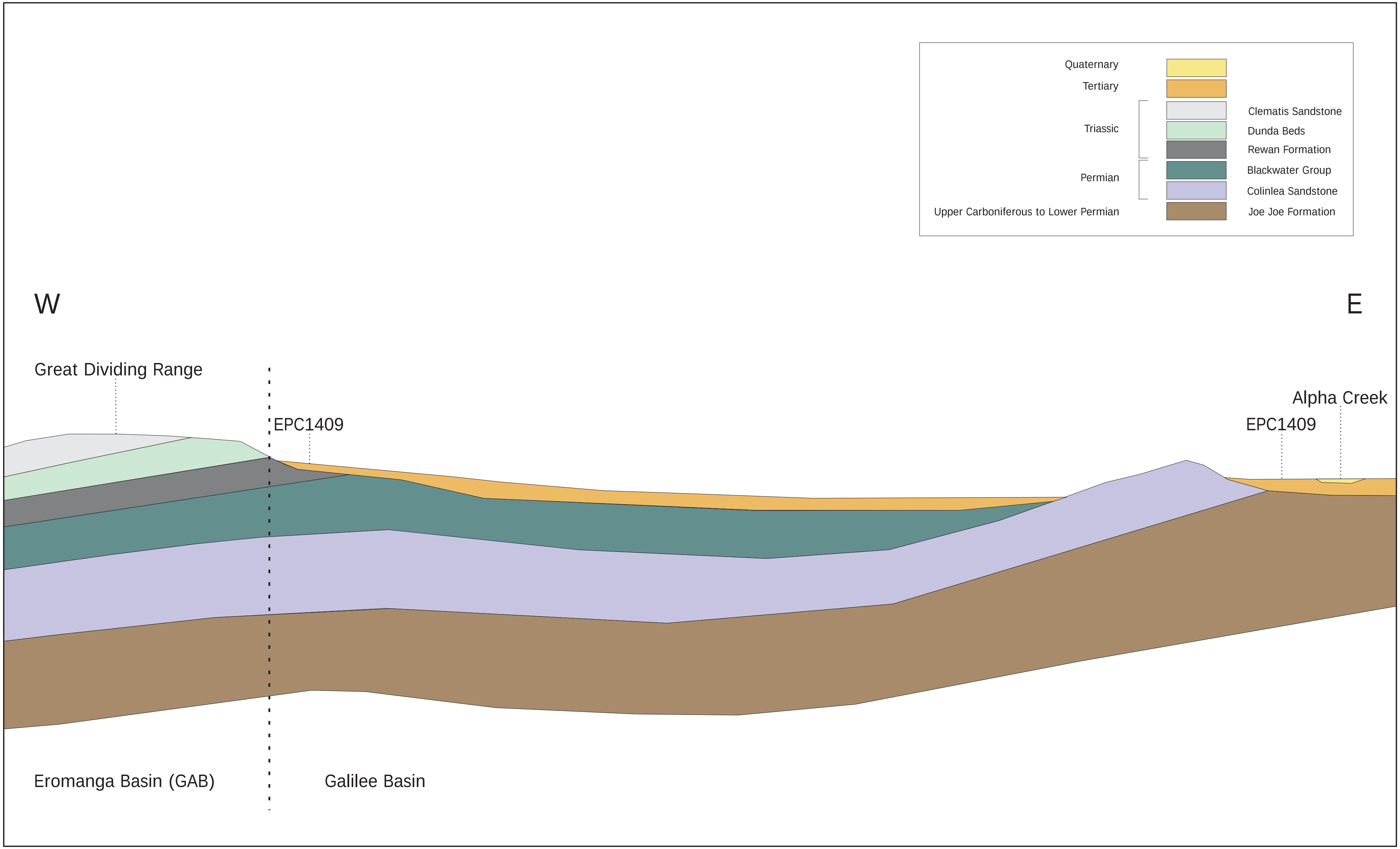
2.2.3 Triassic

This unit is not present across the ACP, but is believed to unconformably overlie the Permian strata to the west along the Great Dividing Range. The Triassic unit is related to the Eromanga Basin and the GAB sequence and consists of sandstones, siltstones and mudstones including the Clematis sandstone and Rewan Formation.

2.2.4 Permian

The Permian stratigraphic sequence strikes north-south and dips to the west. The uppermost unit, the Blackwater Group including the Bandanna Formation, subcrops within EPC1049 and along the area of the Alpha/Tambo road following the eastern margin of the Galilee Basin. Significant coal seams up to 5 metres thick are present in the Bandanna Formation.

To the east the Lower Permian Colinlea Sandstone outcrops to form a range of low rounded hills creating a topographic rise between the ACP and the township of Alpha (**Figure 2-1**).



Alpha Coal Project

Schematic geological cross-section - Figure 2-1

2.3 GROUNDWATER OCCURRENCE

A review of the Department of Environment and Resource Management (DERM) groundwater database along with exploration logs from recent exploration drilling reveal that five aquifers occur proximal to the proposed ACP. These aquifers are:

- Quaternary alluvial aquifer;
- Tertiary undefined aquifer;
- Triassic Dunda Beds (a formation associated with the Great Artesian Basin);
- Permian Bandanna Formation aquifer; and
- Permian Colinlea Sandstone aquifer.

The DERM groundwater database indicates there are a number of registered bores located within and surrounding the ACP. Locations of registered bores are shown in **Figure 2-2**. Because domestic and stock bores (located within the Burdekin Basin) do not require formal licensing, the total number of bores within this area may actually exceed the bores identified in the DERM database.

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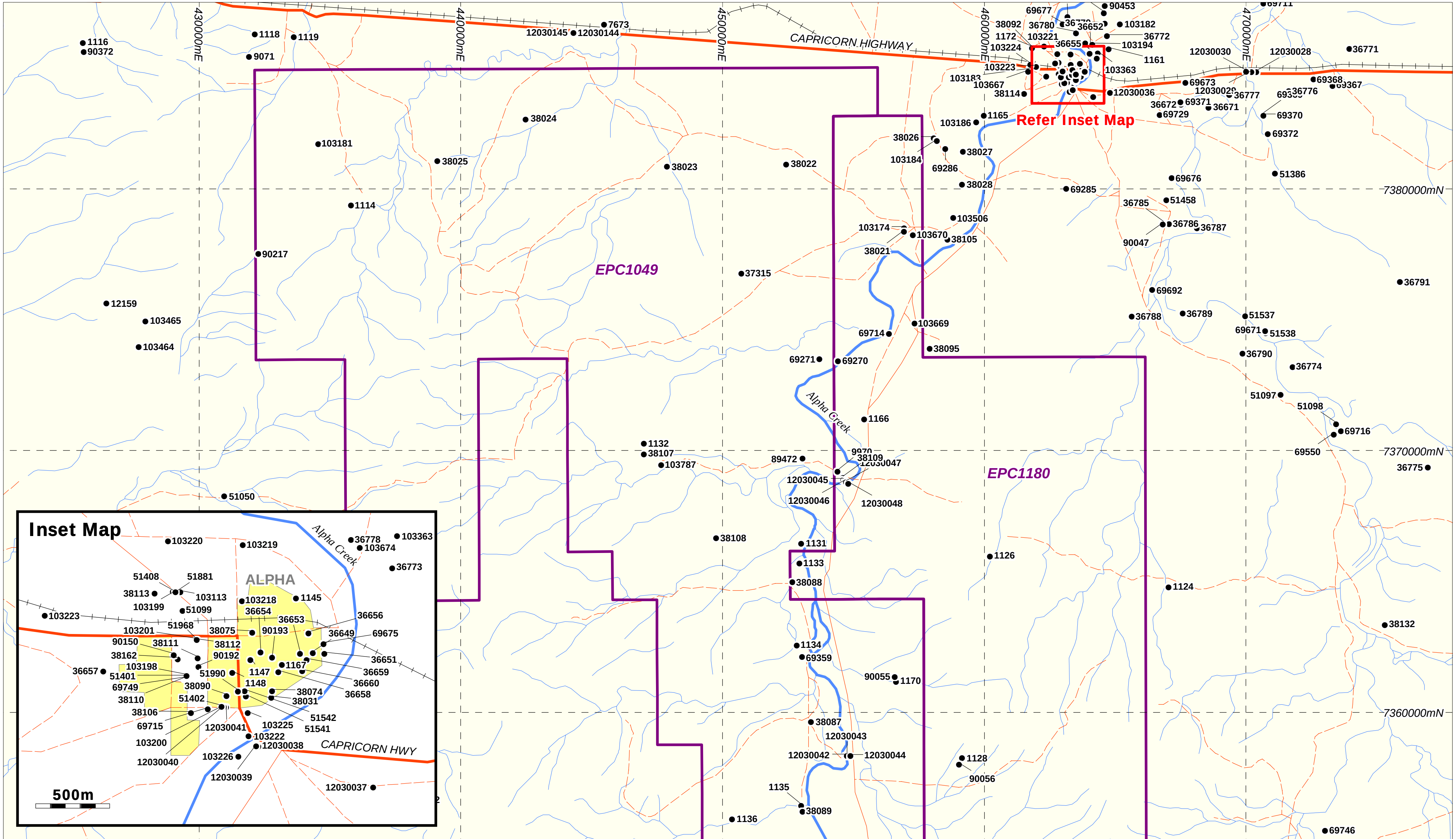

LEGEND

- Project Tenement
- Highway
- Road
- Road
- Railway
- Watercourse
- Alpha Creek

Data Source: Topography - Geoscience Australia. Tenement - EEDI.

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Kilometres
Scale: 1:200,000 (A4)

Alpha Coal Project

Landholder Bore Census - 'Betanga'

DERM Registered Bore Locations

22/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 2-2

3 BORE CENSUS METHODOLOGY

AMCI contacted landholders in the vicinity of the ACP exploration permits advising them of the proposed census and invited them to participate. A property would not be surveyed without the prior consent of the landholder. Each landholder participated in the survey of the property, escorting a Matrixplus hydrogeologist to bore locations.

A hand held global position system (GPS) was used to map the location of each bore visited. Anecdotal information on bore usage, aquifer type, pumping rates, and bore yield was collected. Groundwater levels were determined using a water level dip meter (dipper) unless headworks impeded access to the bore casing. Where possible, groundwater quality parameters of pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Temperature were measured in the field. Bore information such as drill logs were recorded from property owners if available.

Field collected data was supplemented by historical data extracted from the DERM groundwater database. Both sets of data were collated to summarise the property's groundwater occurrence and use.

4 BORE CENSUS RESULTS

The Creek Farm property runs approximately 5000 head of cattle and relies on groundwater and a small portion of surface water (i.e. dams). During the 2009 bore census, 16 groundwater bores were identified on the Creek Farm property. **Figure 4-1** illustrates the bore locations and **Table 4-1** shows bore information compiled from the bore census and DERM groundwater database.

Of the 16 bores, 5 are currently available for use:

- 7 mile bore is used daily for stock water;
- Four corners bore is used daily for stock water;
- AFRAC bore is utilised daily for domestic and stock supplies;
- Hamilton bore is used daily for stock water; and
- Main roads bore is used for stock water.

Two bores are not in use currently, but are available for stock watering if necessary. Two DERM monitoring bores were also located along the Capricorn Highway easement in front of the Creek farm property.

The 7 remaining bores are abandoned due to age deterioration (<1950) and subsequent collapse and poor bore construction.

Standing water levels were measured in four bores; all other bores on the Creek Farm property were unable to be measured due to collapsed casing or pumps precluding measurement. At the time of the bore census physicochemical field measurements were taken from the three aquifers from which extraction was occurring (**Table 4-1**). Measurements indicate that the Tertiary undefined aquifer produces water of good quality (705 µS/cm); anecdotal evidence suggests that AFRAC bore is potable. Groundwater from the Permian Colinlea Sandstone aquifer is fresh (1,322 µS/cm) while water from the Permian Bandanna Formation aquifer is more saline and exhibits brackish levels (4,535 µS/cm). Water from both of the Permian aquifers is acceptable as stock water for cattle.

The bore census has shown that four distinct aquifers exist across the Creek Farm property, including the:

- Quaternary alluvial aquifer;
- Tertiary undefined aquifer;
- Permian Bandanna Formation aquifer; and
- Permian Colinlea Sandstone aquifer.

At the time of the census three of the four aquifers were being utilised for domestic and stock water supplies, the; Tertiary undefined, Permian Bandanna Formation and Permian Colinlea Sandstone aquifers.

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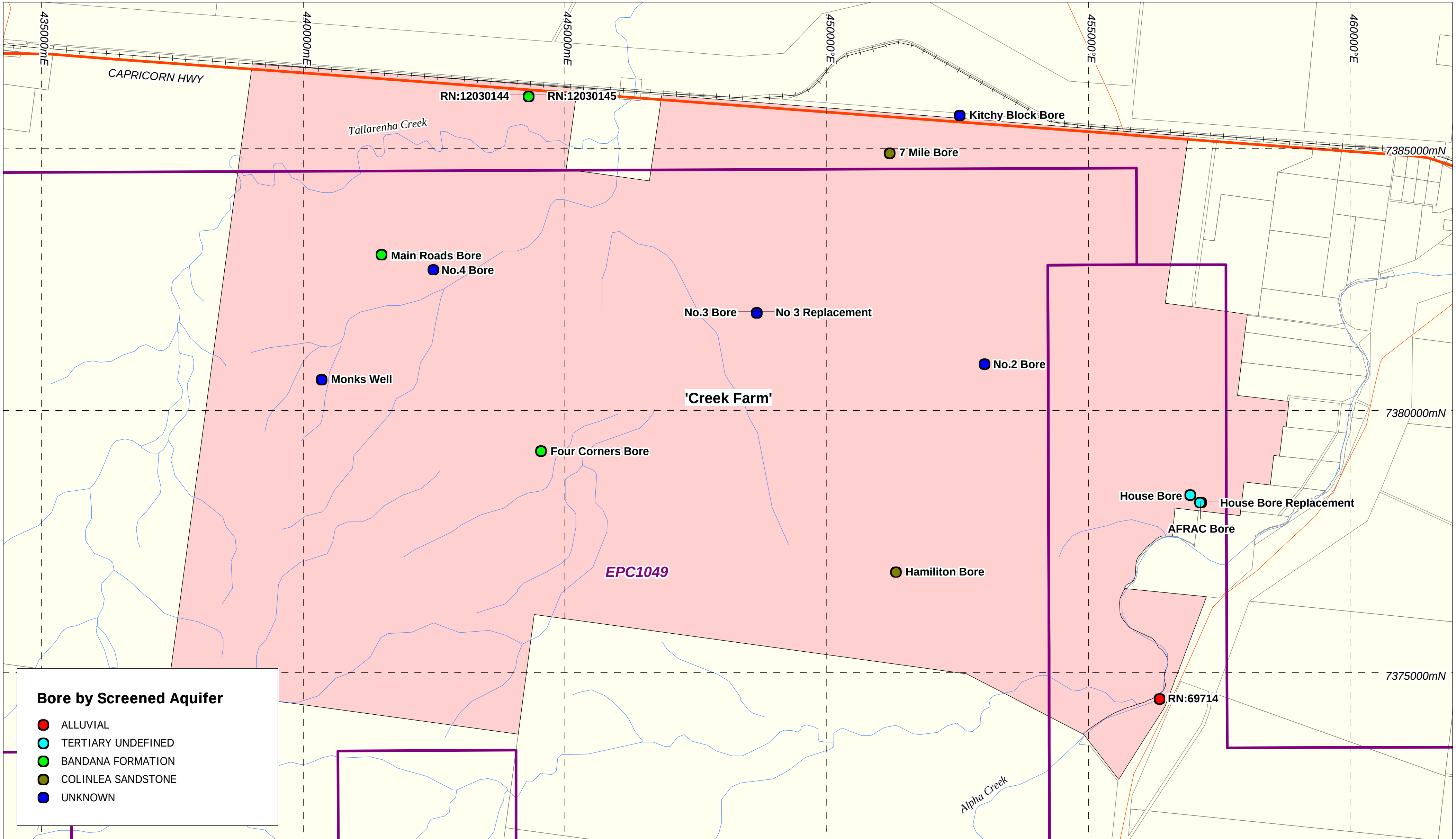

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LEGEND

- Project Tenement
- Property Boundary
- Highway
- Road
- Track
- Railway
- Watercourse

Data Source: Cadastral (DCDB2005) - ERM. Topography - Geoscience Australia. Tenement - EEDI.

Alpha Coal Project

Landholder Bore Census - 'Creek Farm'

Bore Locations

19/05/2009

Datum: GDA94
Projection: MGA55

FIGURE 4-1

Table 4-1 Bore detail summary

	Bore Name	Nap belyando site 20	Nap belyando site 20	Kitchy block bore	7 mile bore	Main roads bore	No 4	No 3	No 3 replacement	No 2	Monks well	Four corners	House bore	House bore replacement	AFRAC bore	Hamilton bore	
Bore Details	RN	12030144	12030145				38024	38023		38022	38025		38021	103174	103670	37315	69714
	Date Drilled	1/10/2003*	1/10/2003*		20/01/2003	21/01/2009	1/10/1940*		1974			19/01/2003		5/06/1998	6/11/2002	19/1/1972*	26/03/1991*
	Easting (GDA94)	444309*	444309*	452551	451209	441503	442490*	448668	448671	453026	440363	444550	456949*	457159	457135	451329	456364*
	Northing (GDA94)	7386028*	7386028*	7385665	7384945	7383004	7382721*	7381899	7381899	7380917	7380617	7379257	7378415*	7378276	7378276	7376942	7374523*
	Elevation (mAHD)			417	422	401		386	386			400		368	375		
	Bore depth (mBGL)	70*	24.2*	30.5	137.6	75	152.5*	76.3		117.4*	38.1*	145.9	38.1*	67.06*	75	168.86	32.5*
	Screened interval (m)	67.49-68.49*	16-17*		116-134	60-66					6.7-38*	103-109, 126-143		45.72-64.01	67.6-70.6	156-161	24-30*
	Aquifer lithology	Permian Bandanna Formation - sandstone	Tertiary undefined	unknown	Permian Colinlea Sandstone - sandstone/shale	Permian Bandanna Formation - ST/CO	unknown	unknown	unknown	unknown	unknown	Permian Bandanna Formation - SS/SH/CO	Tertiary undefined	Tertiary undefined	Tertiary undefined	Permian Colinlea Sandstone	Quaternary - alluvium
	Casing (mm)	50 PVC	50 PVC	152 steel	125 PVC	125 PVC	127 steel	152 steel				125 PVC		127 PVC	150 PVC	152 steel	
Bore use details	Bore use	monitoring	monitoring	not in use	stock water	stock water	abandoned	abandoned	abandoned	abandoned	abandoned	stock water	abandoned	not in use	domestic/stock water	stock water	abandoned
	Approximate usage				pumped daily 6-8 hours	daily 10 hours						daily 10-20 hours			daily 6-10 hours	daily 10 hours	
	Bore equipment			mono	submersible	submersible						submersible		submersible	submersible	submersible	
	Depth to pump intake			29	120									30	70	120	
Groundwater Details	SWL (mBGL)	49.36*	17.56*		75	54		28.47		30.01		65*		24.38*	31.05*	84*	
	Yield (L/s)			1.1	1.8	1.51						1.8		1.5	2.103	0.7	
	pH				7.05							6.31			6.12	7.18	
	EC (µS/cm)	11,600*			1,407							4,535			705.2	1,322	
	TDS (ppm)				965.1							3,461			476.8	917.1	
	Temperature				35.9							26.2			24.7	26.9	
Comments		Departmental monitoring bore	Departmental monitoring bore	Maybe an old seismic hole converted into a bore. Bore only used when stock in this block. Water use to be piped across to Creek Farm however water supply replaced with 7 mile bore	Anecdotal evidence suggests the water is potable	Installed by AMCI	Not located during the census	Original No 3 bore	Hole blew out in 1997, 0.4 L/s. Bore deemed unsuitable for use				Original water supply for the homestead	Not used at present, it can be used if needed however due to poor construction the bores pumps sand also	Replacement for house bores		Not located during the census

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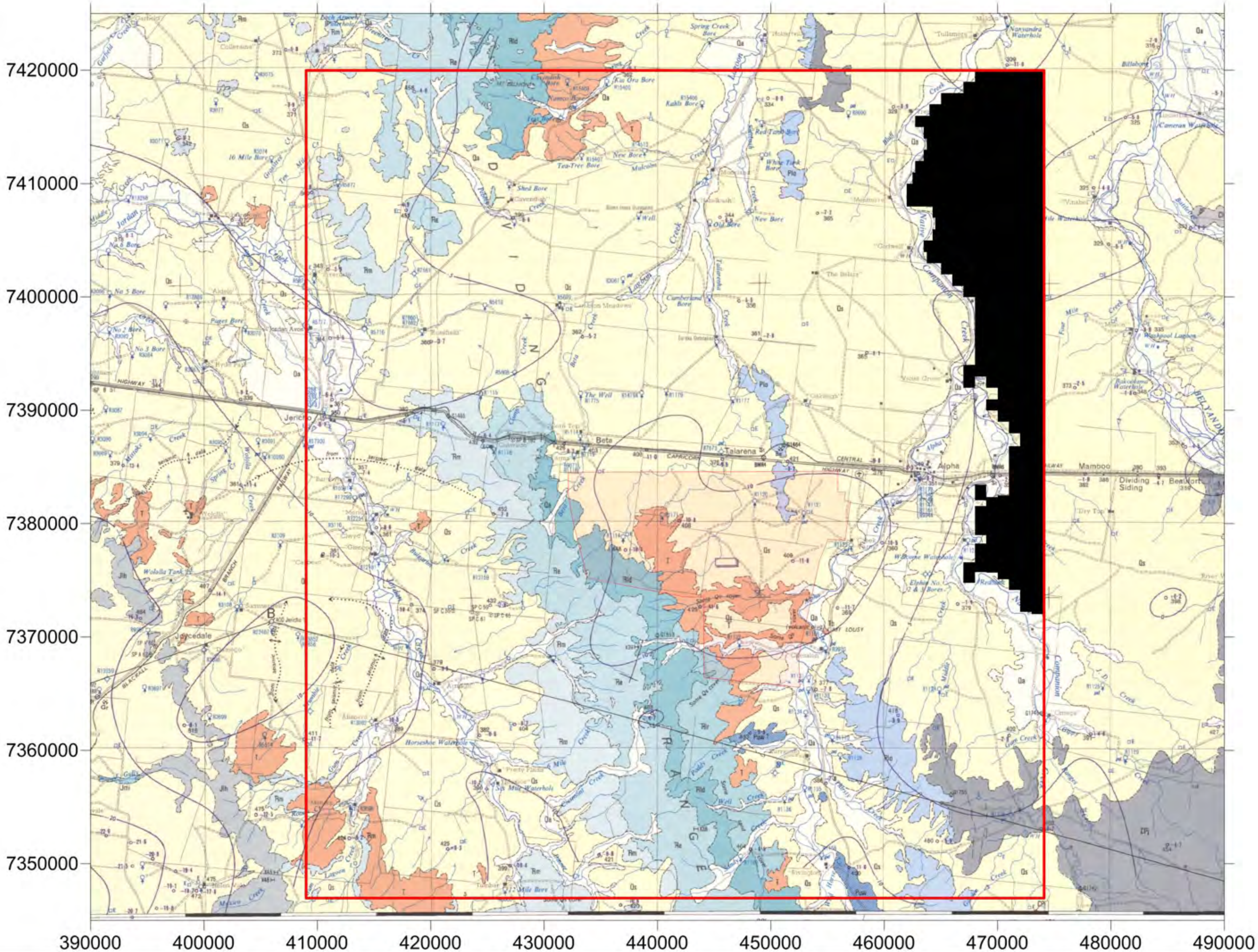
APPENDIX F: MODEL SETUP



RPS Aquaterra

SOUTH GALILEE - MODEL DOMAIN FIGURE F.01

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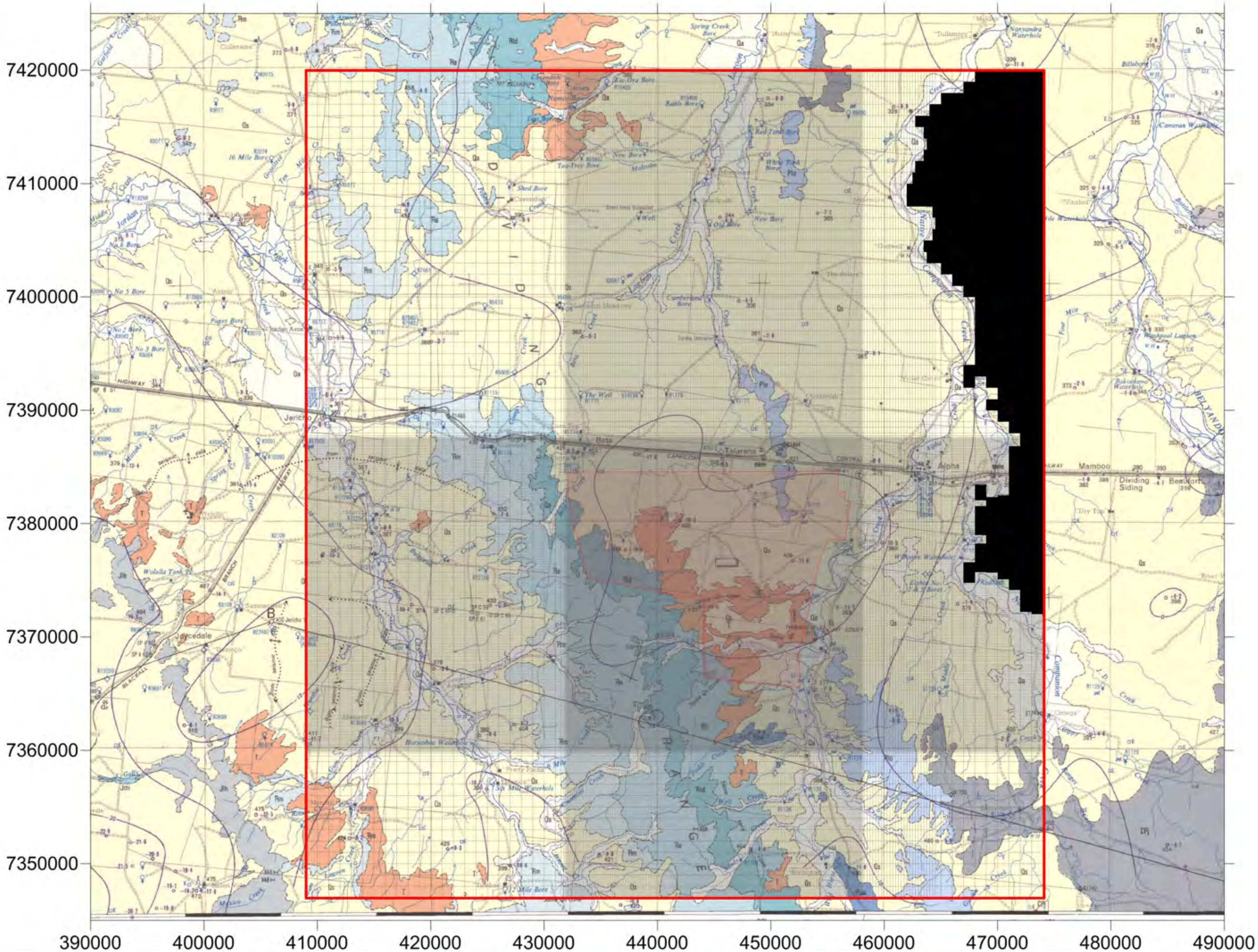
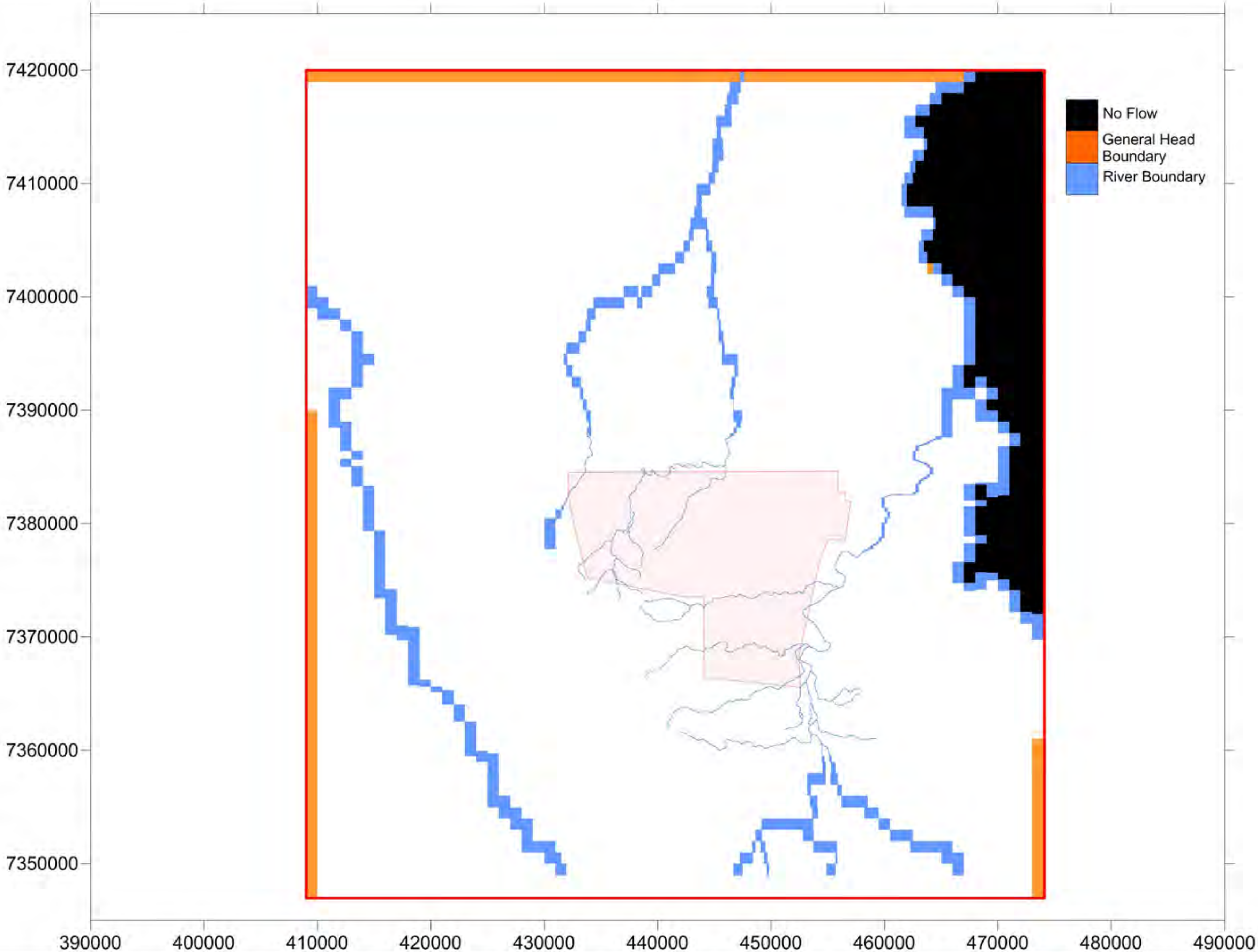


RPS Aquaterra

SOUTH GALILEE - MODEL GRID FIGURE F.02

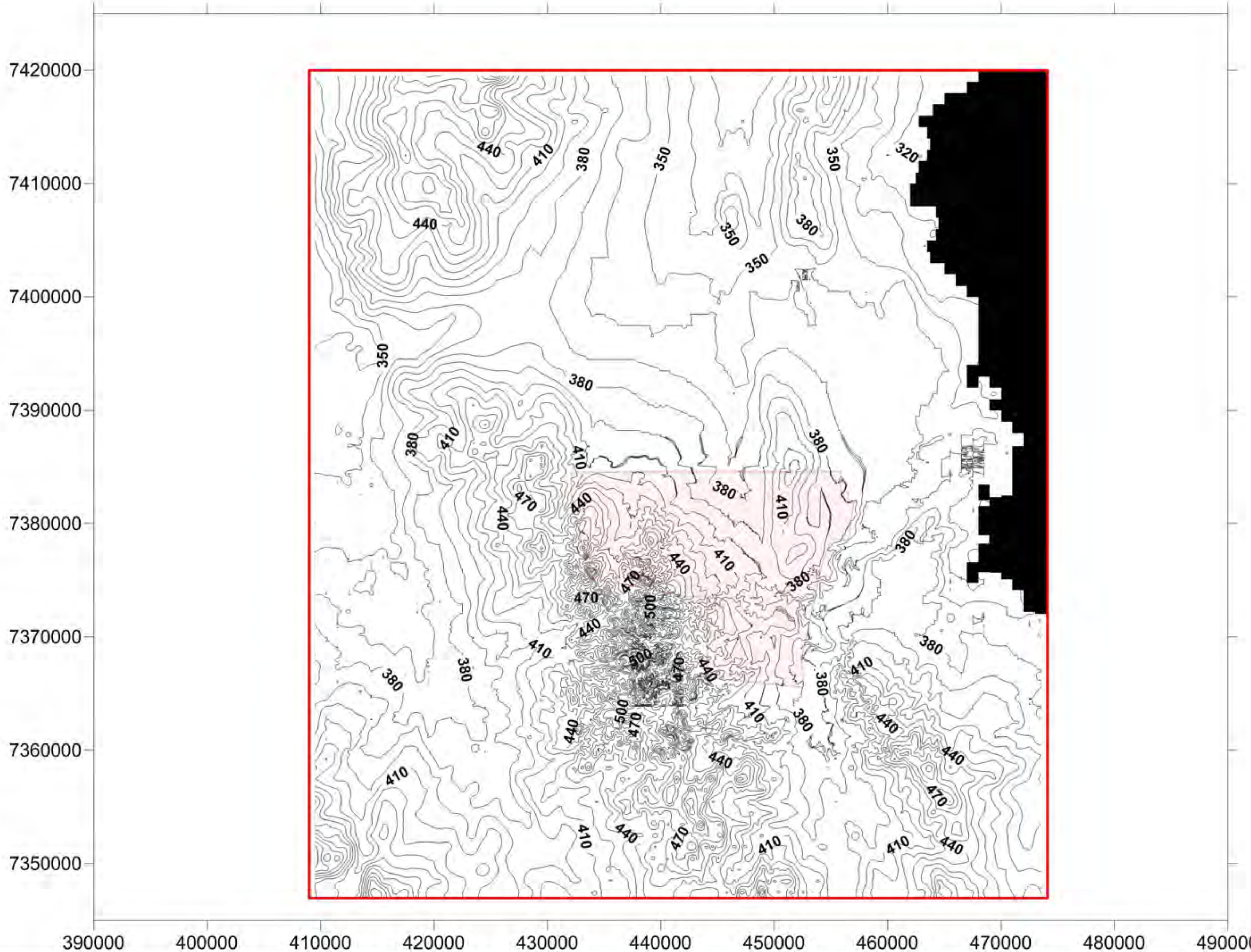
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - BOUNDARY CONDITIONS FIGURE F.03

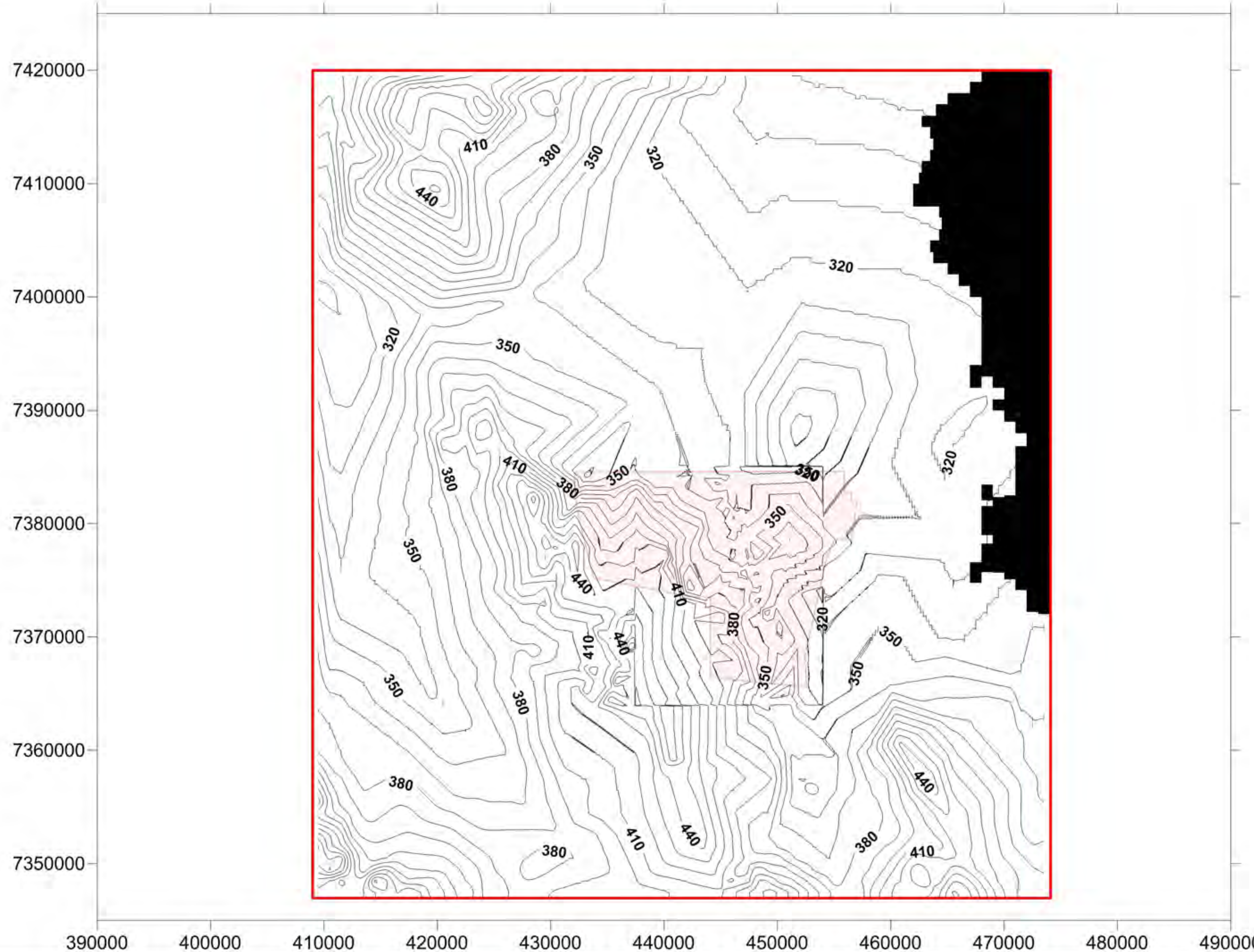
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 01 TOP FIGURE F.04

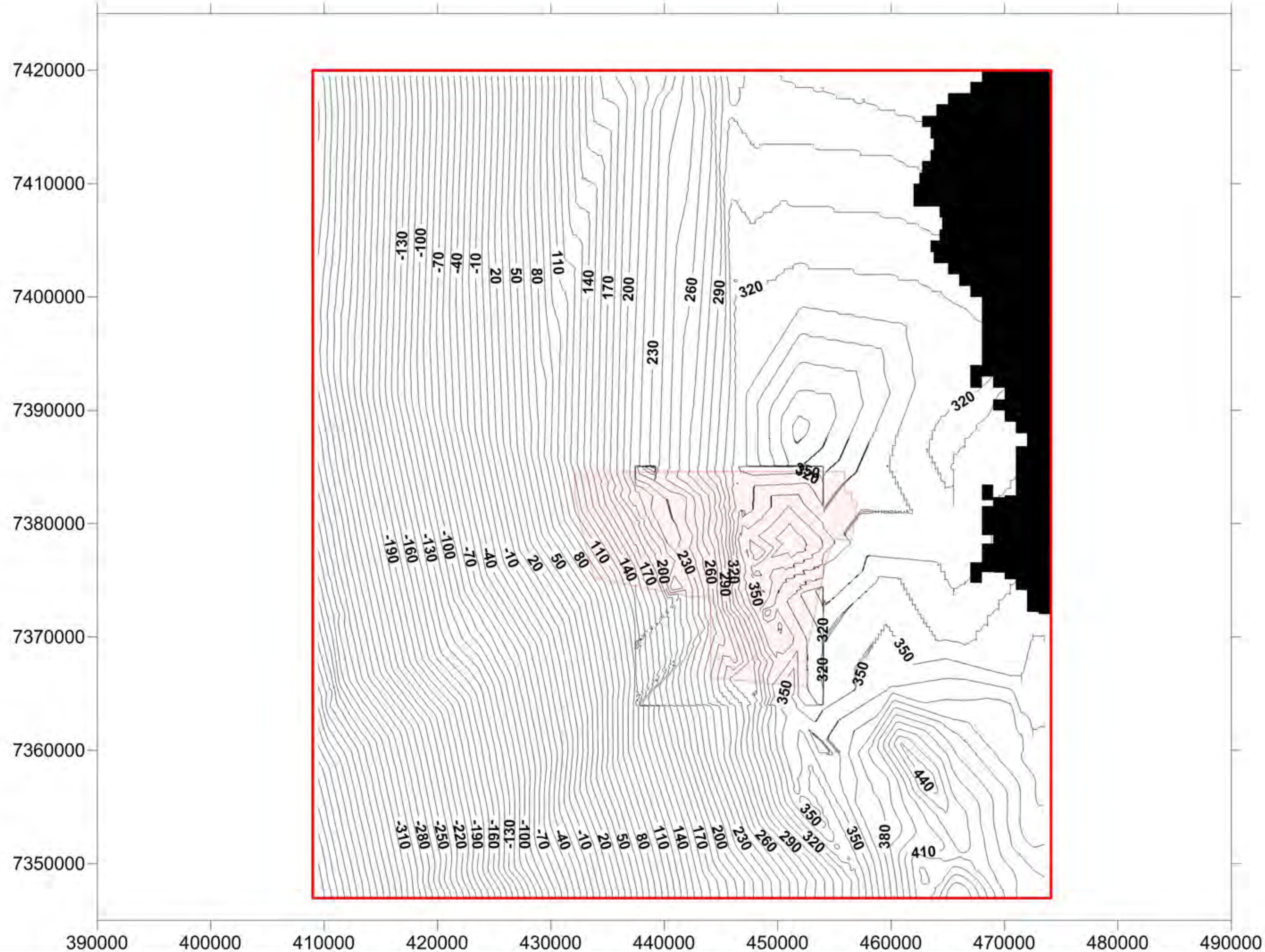
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 01 BASE FIGURE F.05

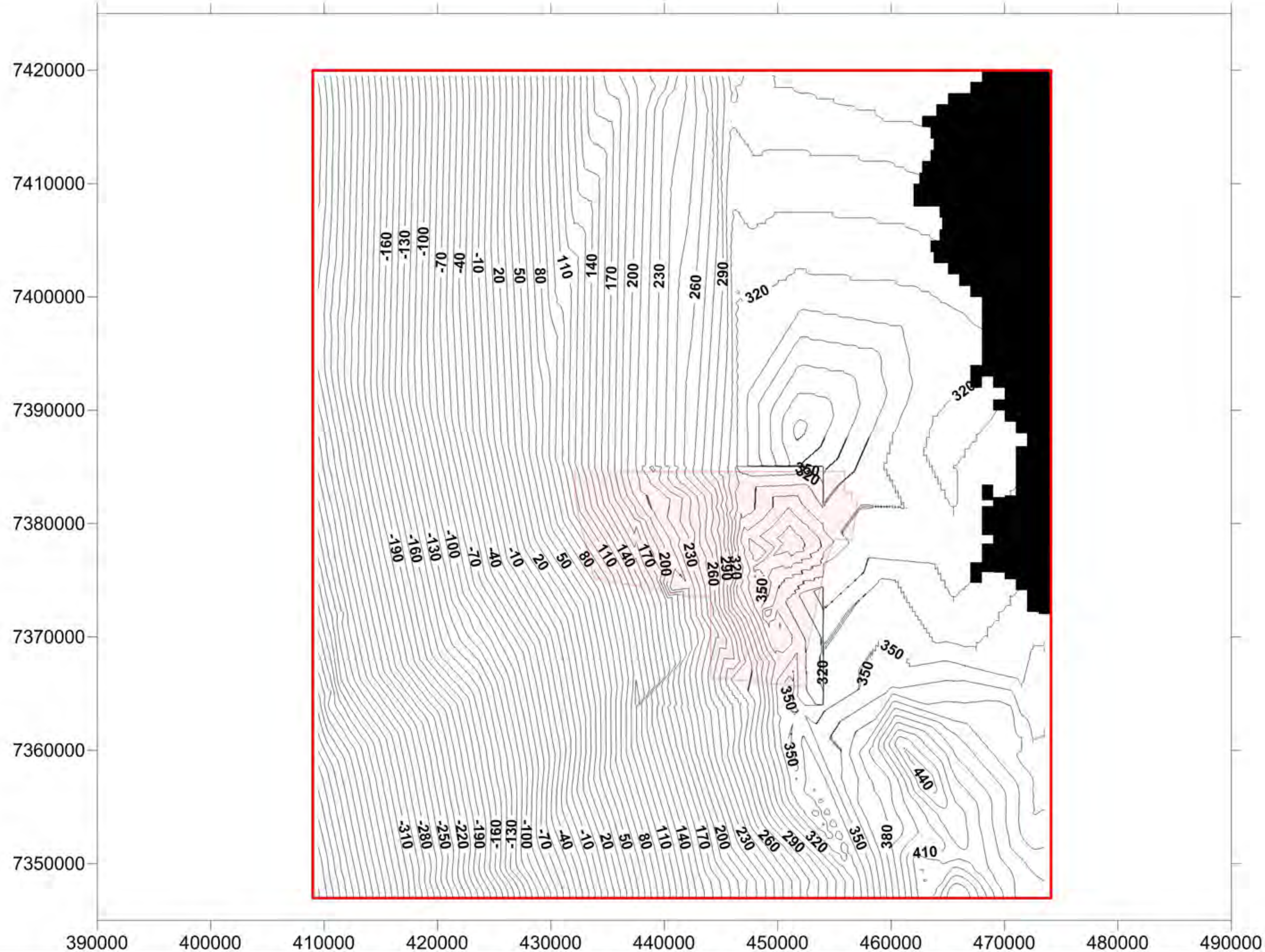
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 02 BASE FIGURE F.06

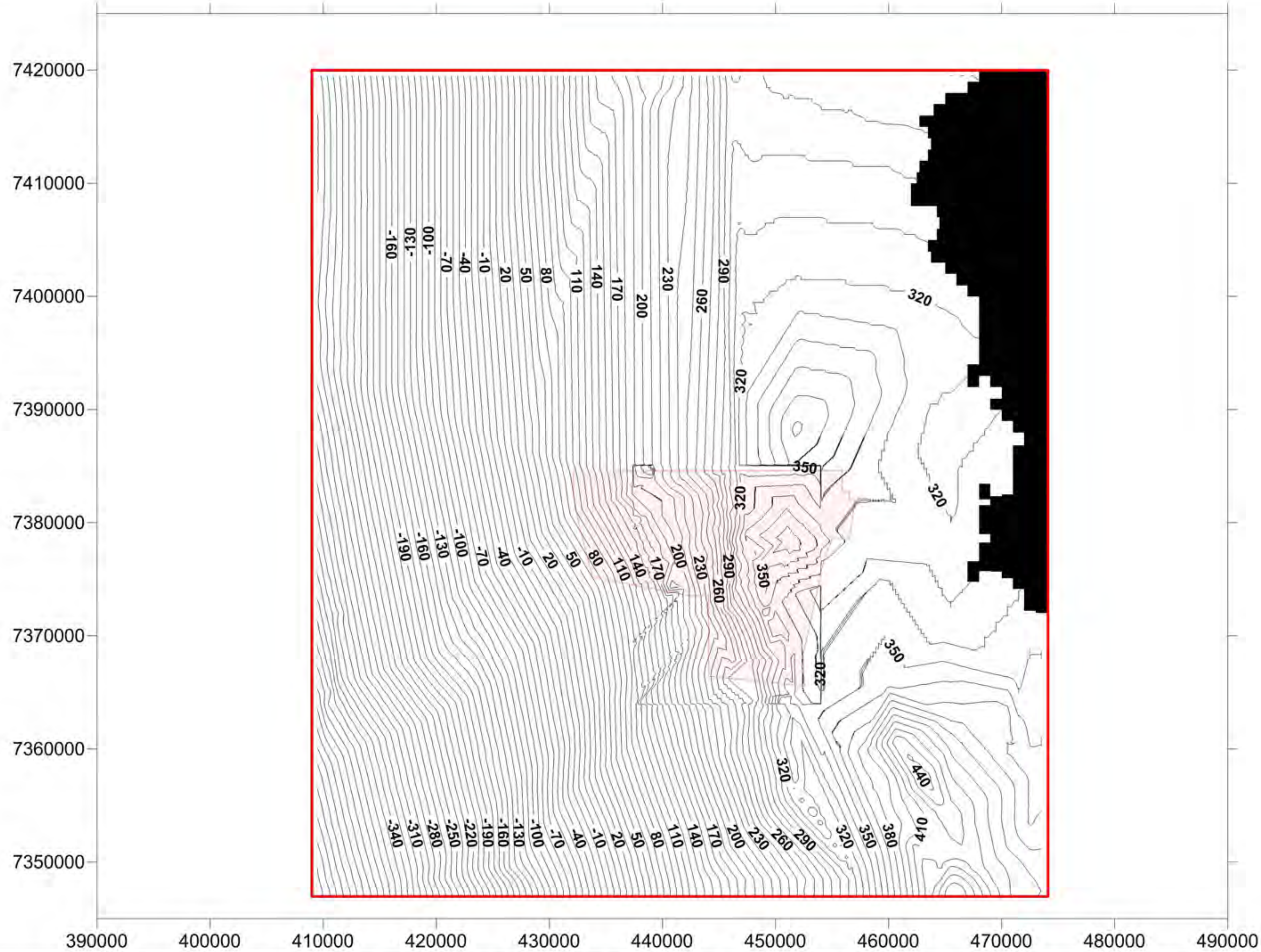
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 03 BASE FIGURE F.07

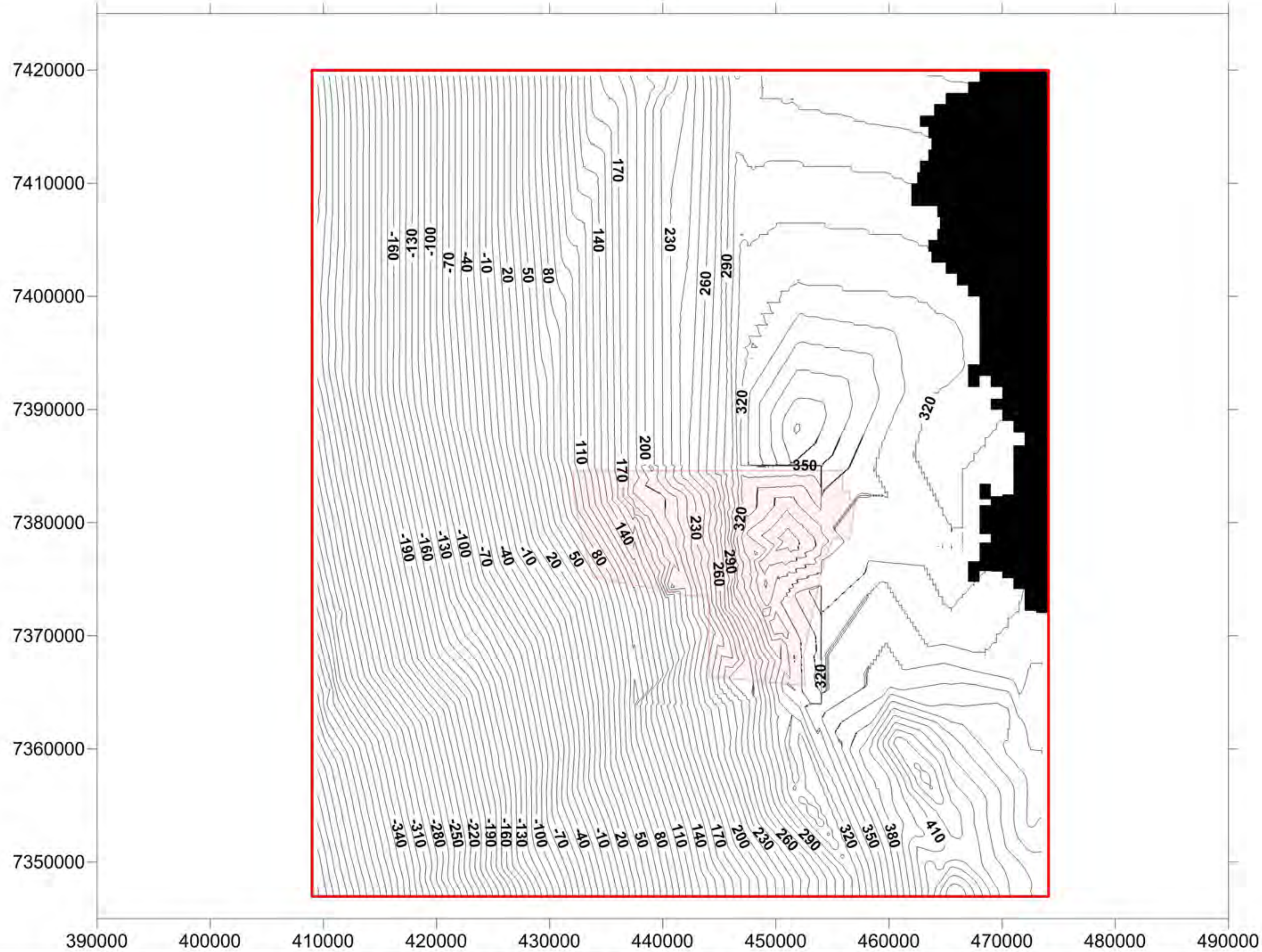
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 04 BASE FIGURE F.08

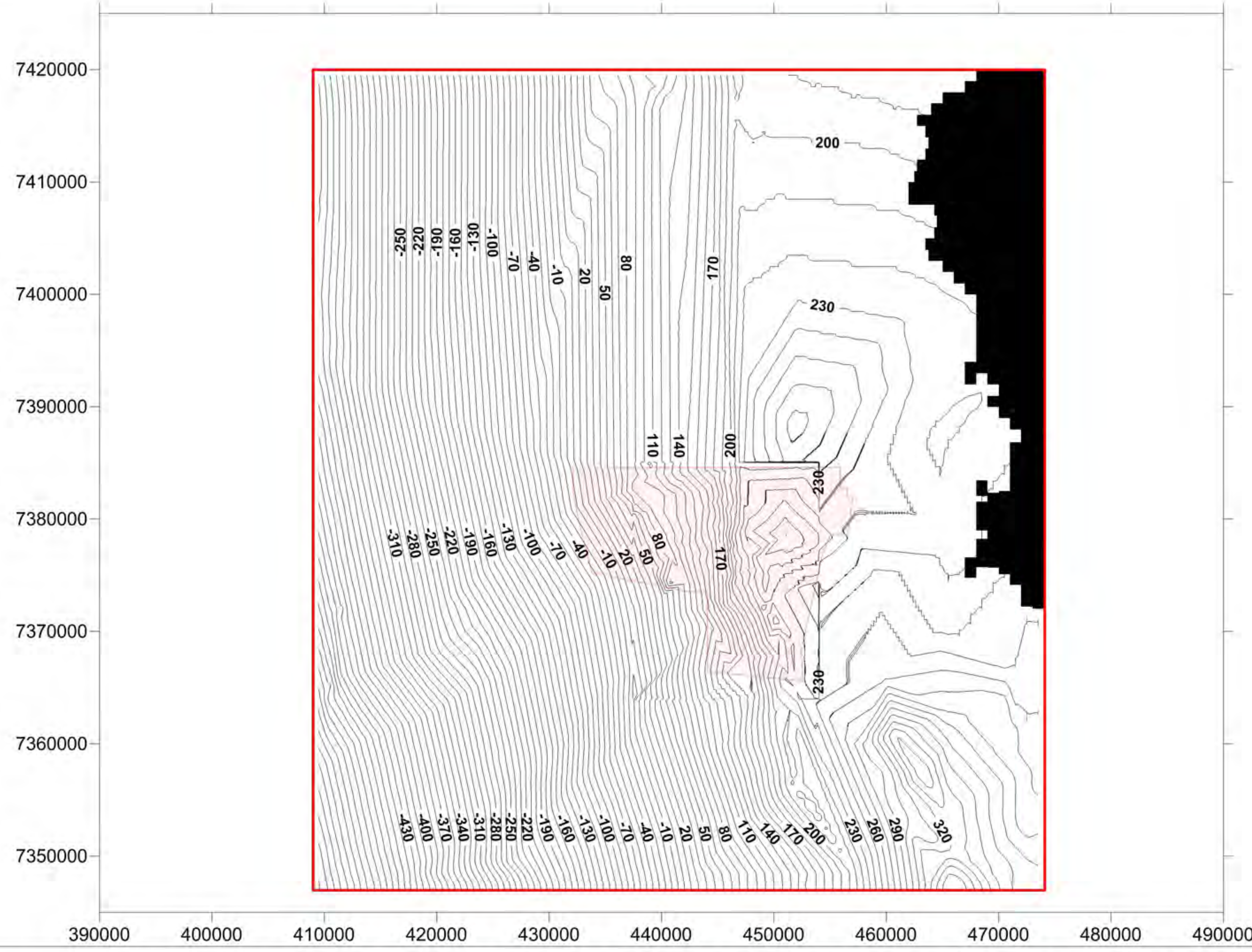
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - LAYER ELEVATION - LAYER 05 BASE FIGURE F.09

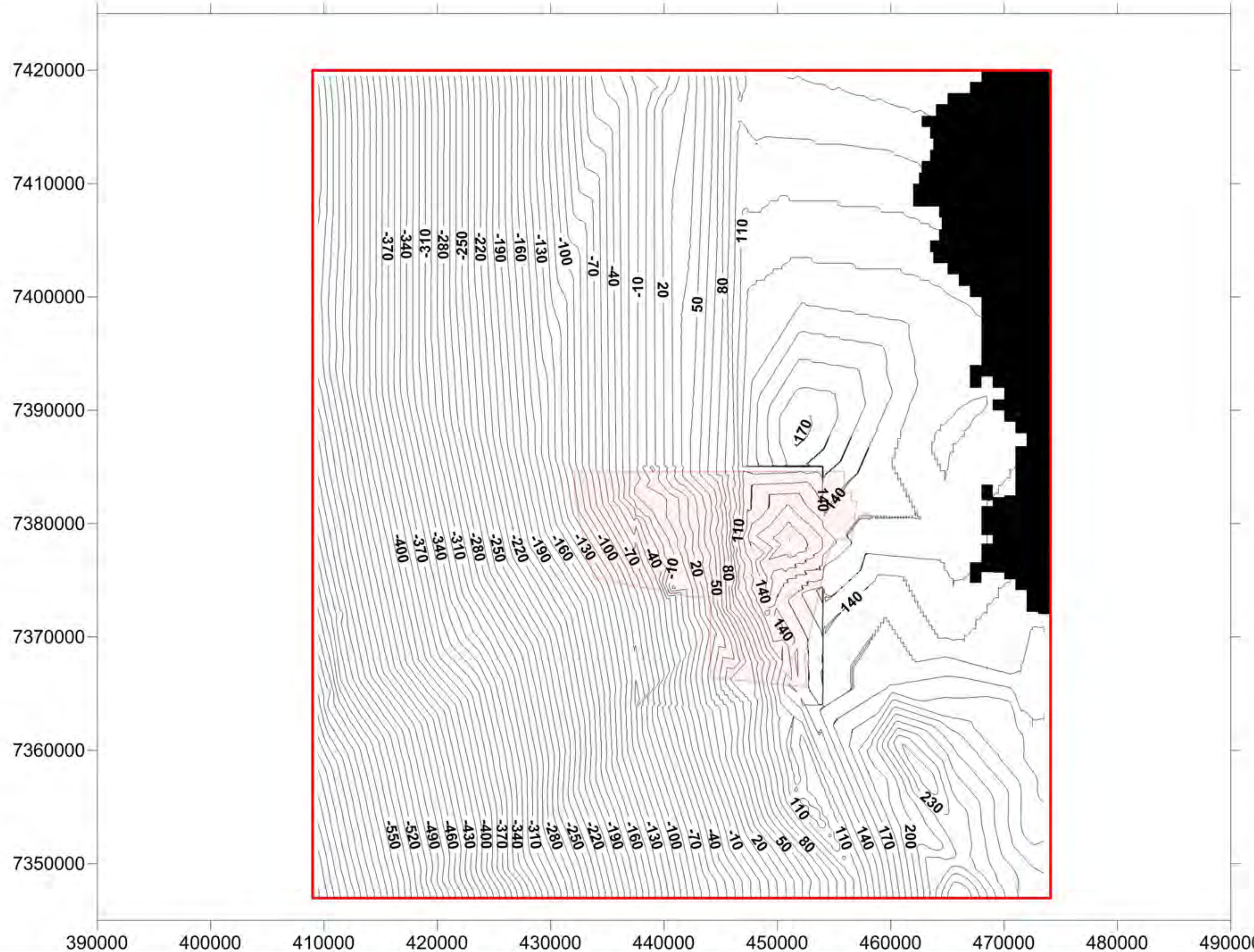
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

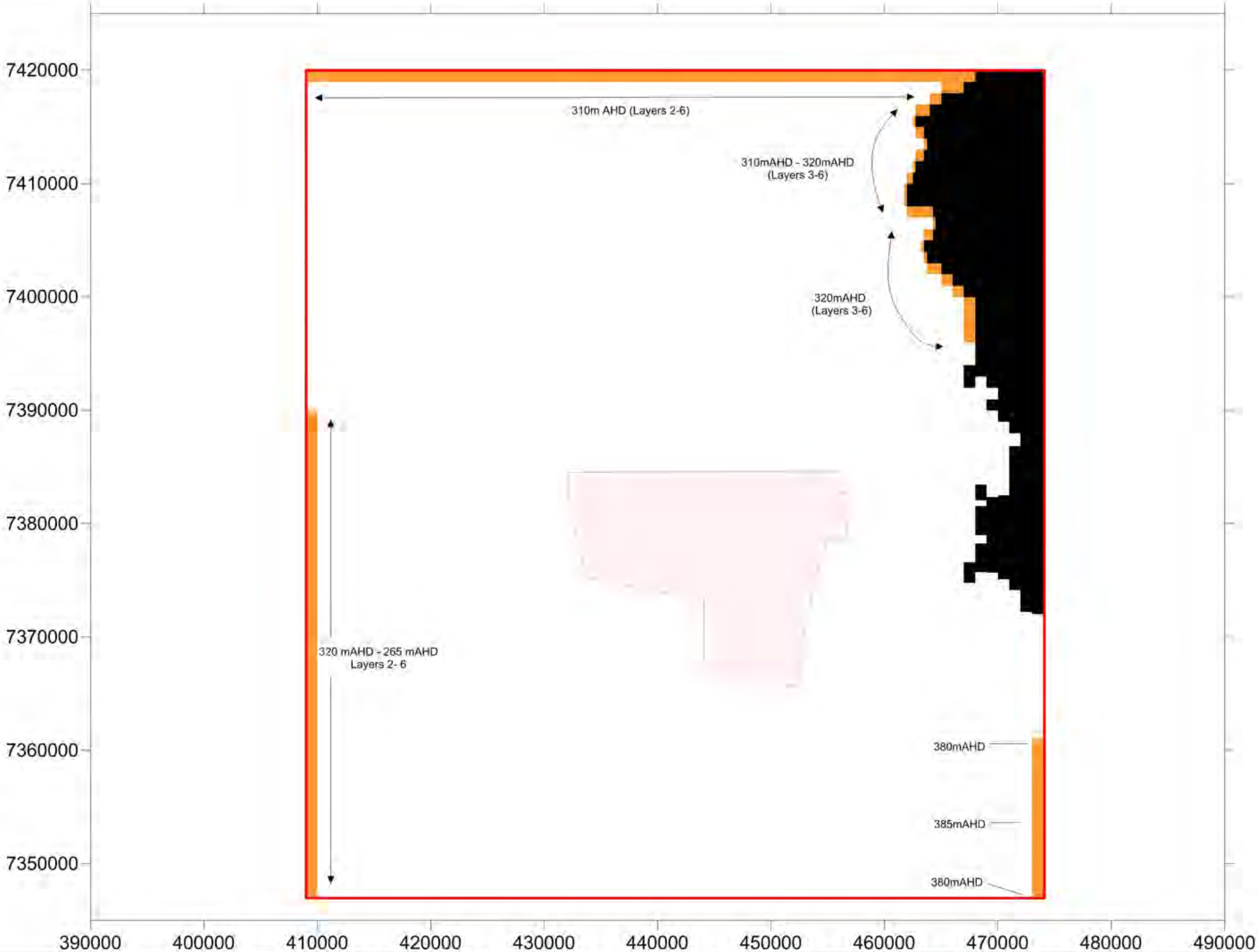
SOUTH GALILEE - LAYER ELEVATION - LAYER 06 BASE FIGURE F.10

F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



SOUTH GALILEE - LAYER ELEVATION - LAYER 07 BASE FIGURE F.11

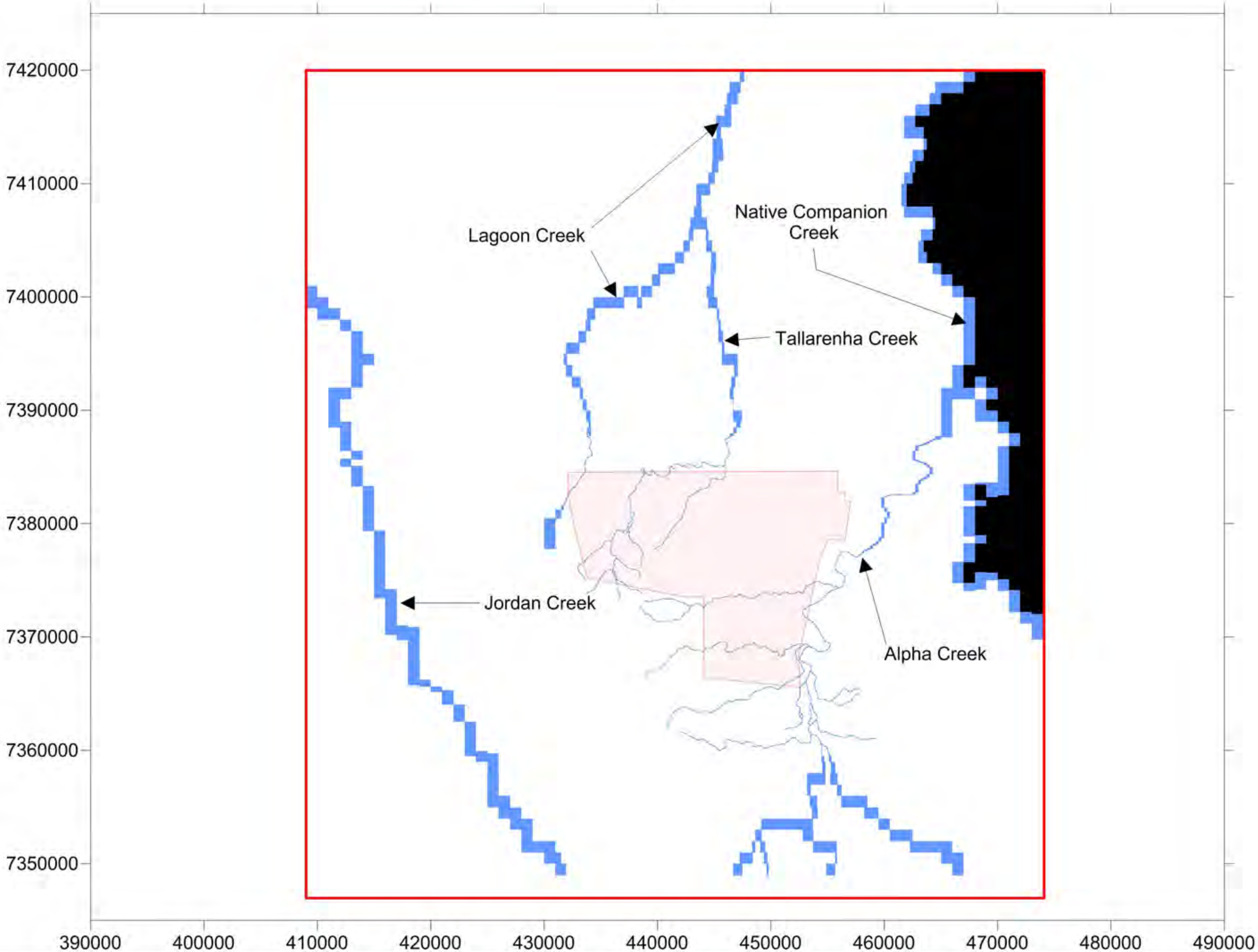
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



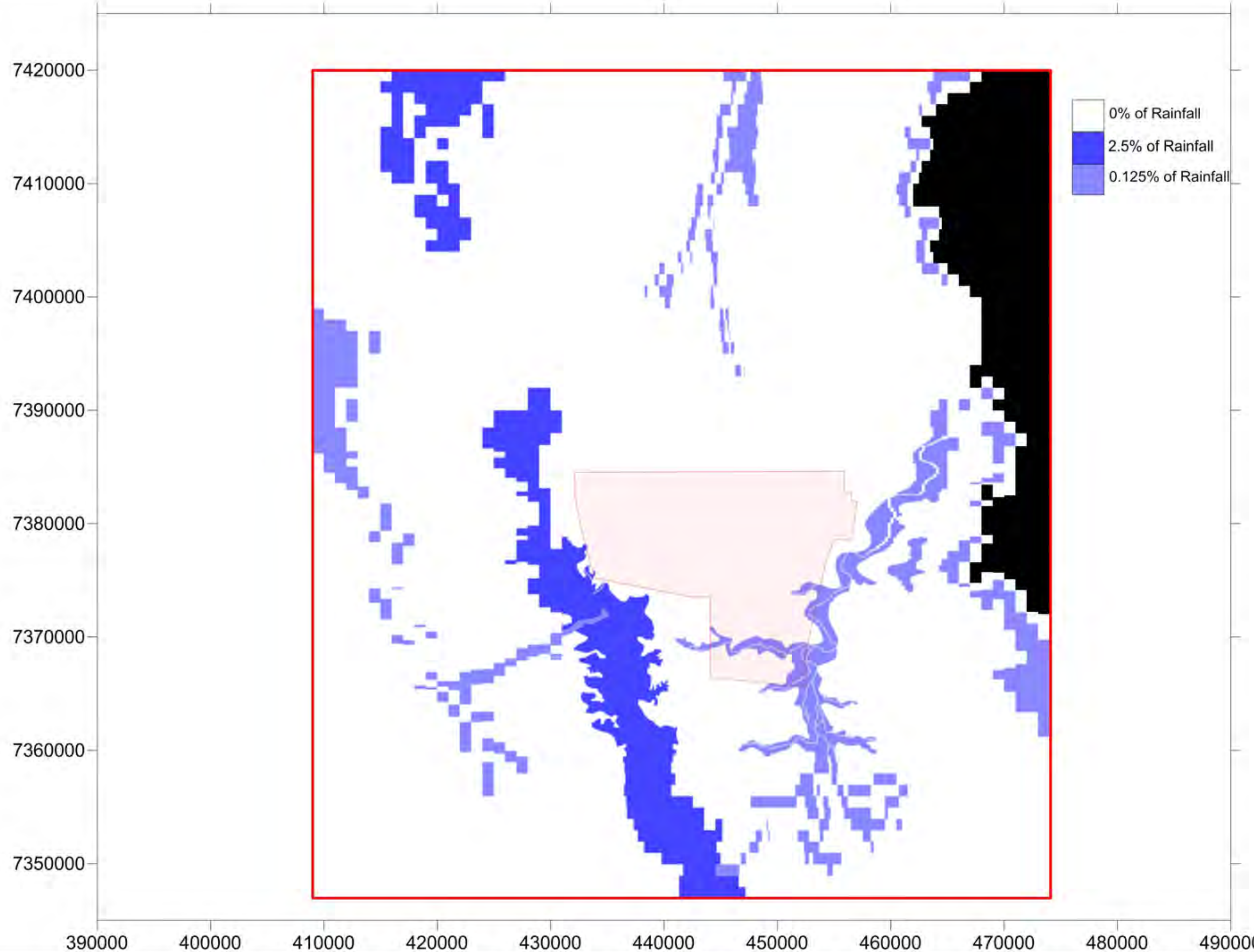
RPS Aquaterra

SOUTH GALILEE - GENERAL HEAD BOUNDARIES FIGURE F.12

F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



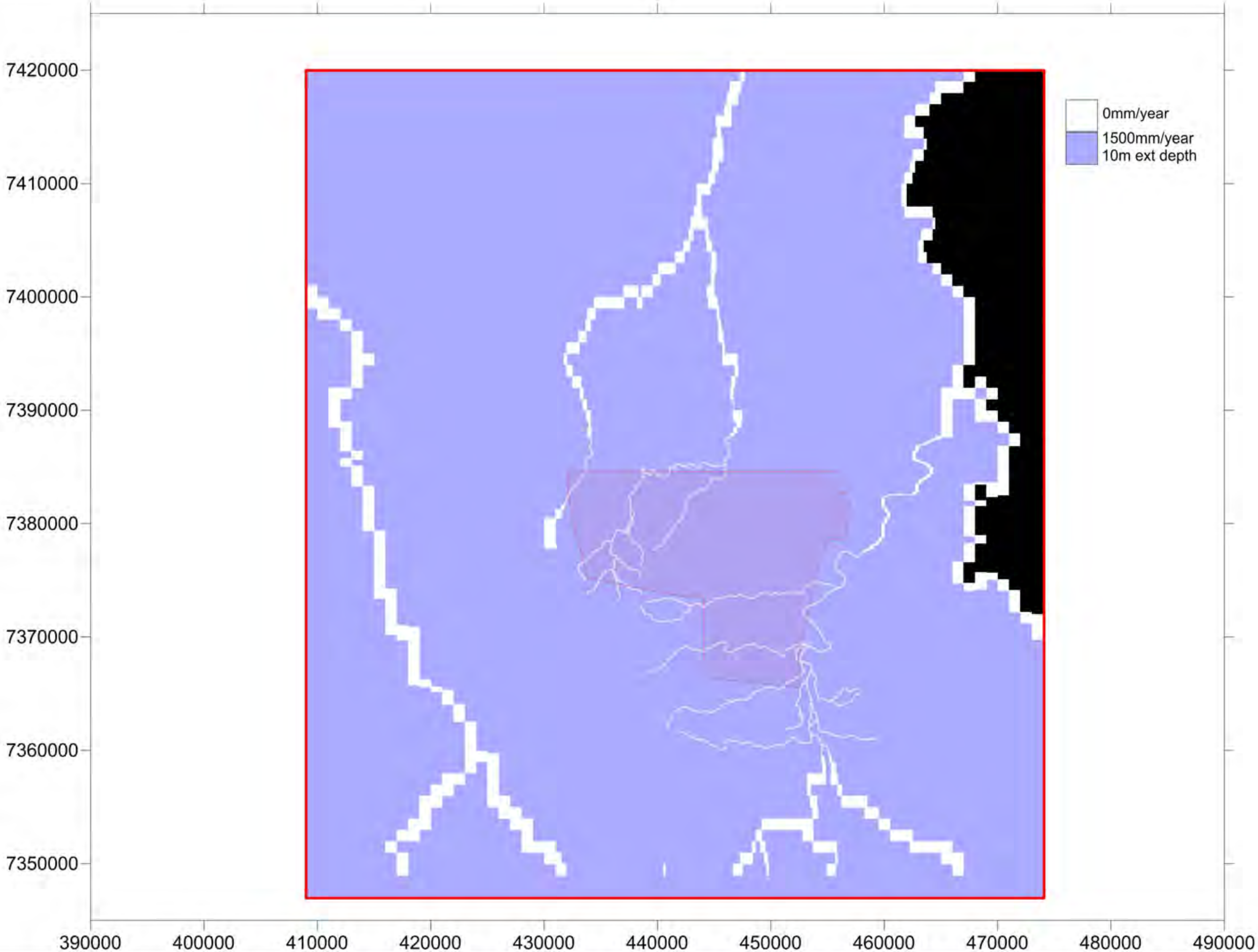
SOUTH GALILEE - RIVER BOUNDARY CONDITIONS FIGURE F.13



RPS Aquaterra

SOUTH GALILEE - RECHARGE DISTRIBUTION FIGURE F.14

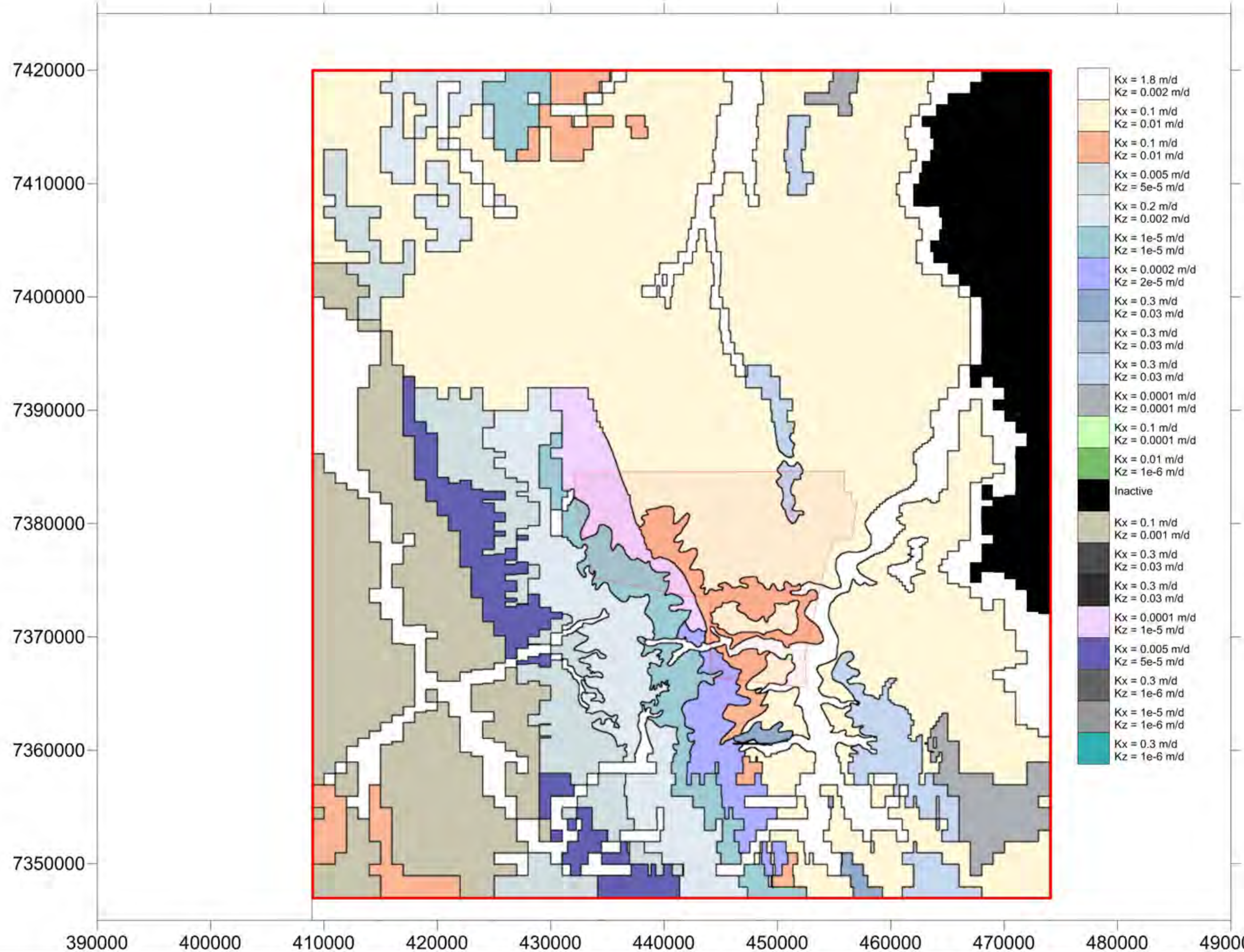
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - EVAPOTRANSPIRATION DISTRIBUTION FIGURE F.15

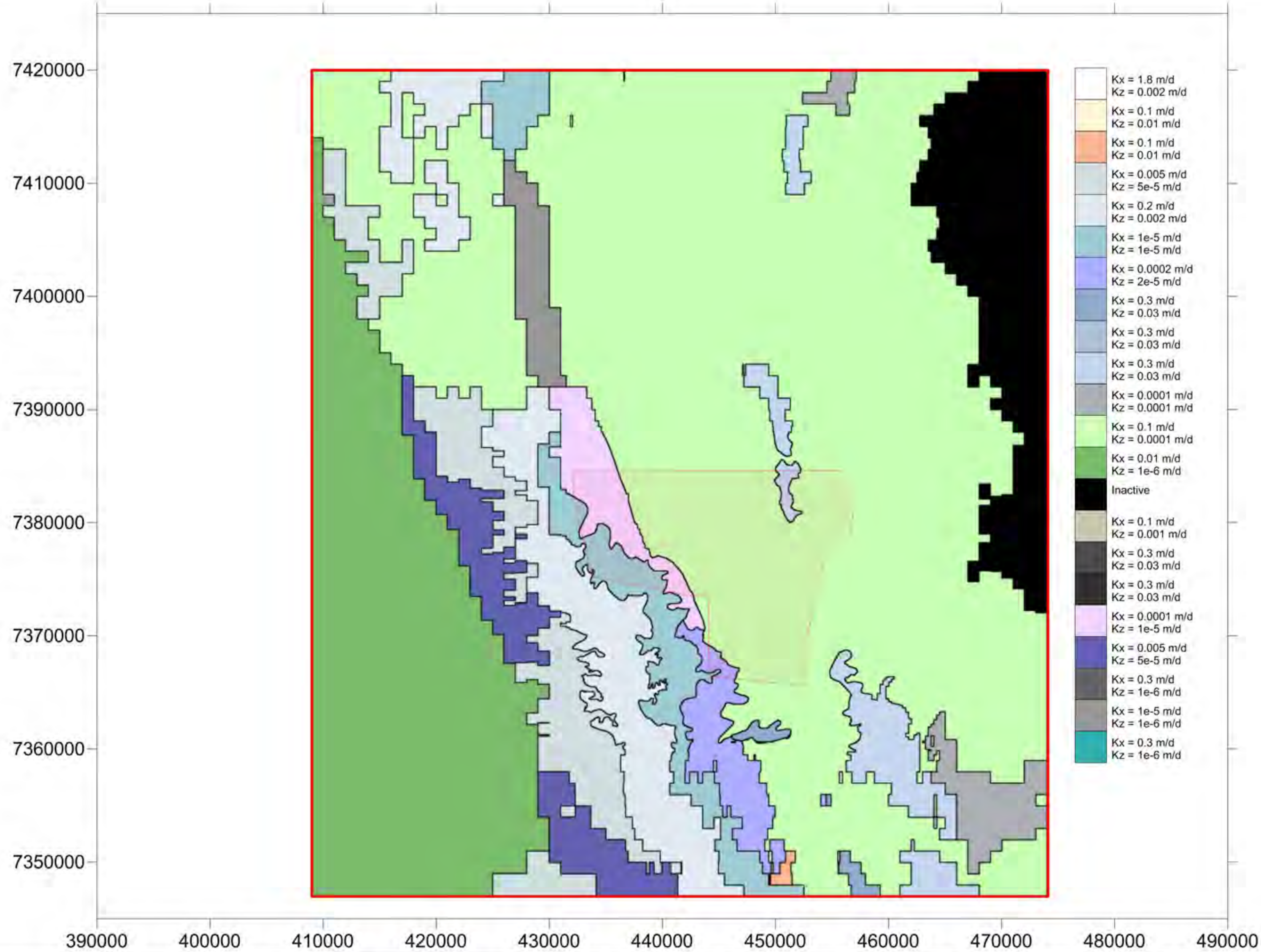
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 01 FIGURE F.16

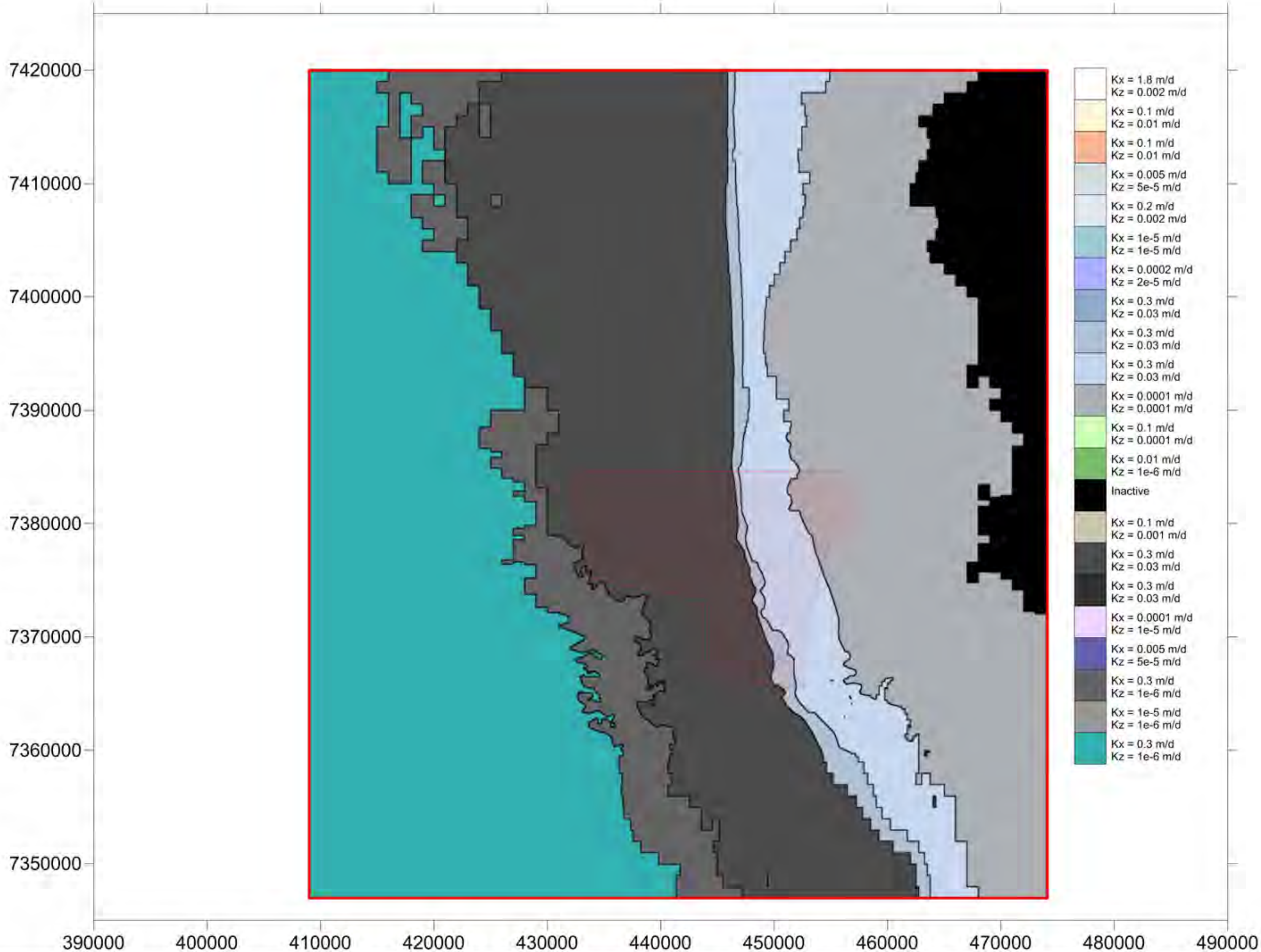
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 02 FIGURE F.17

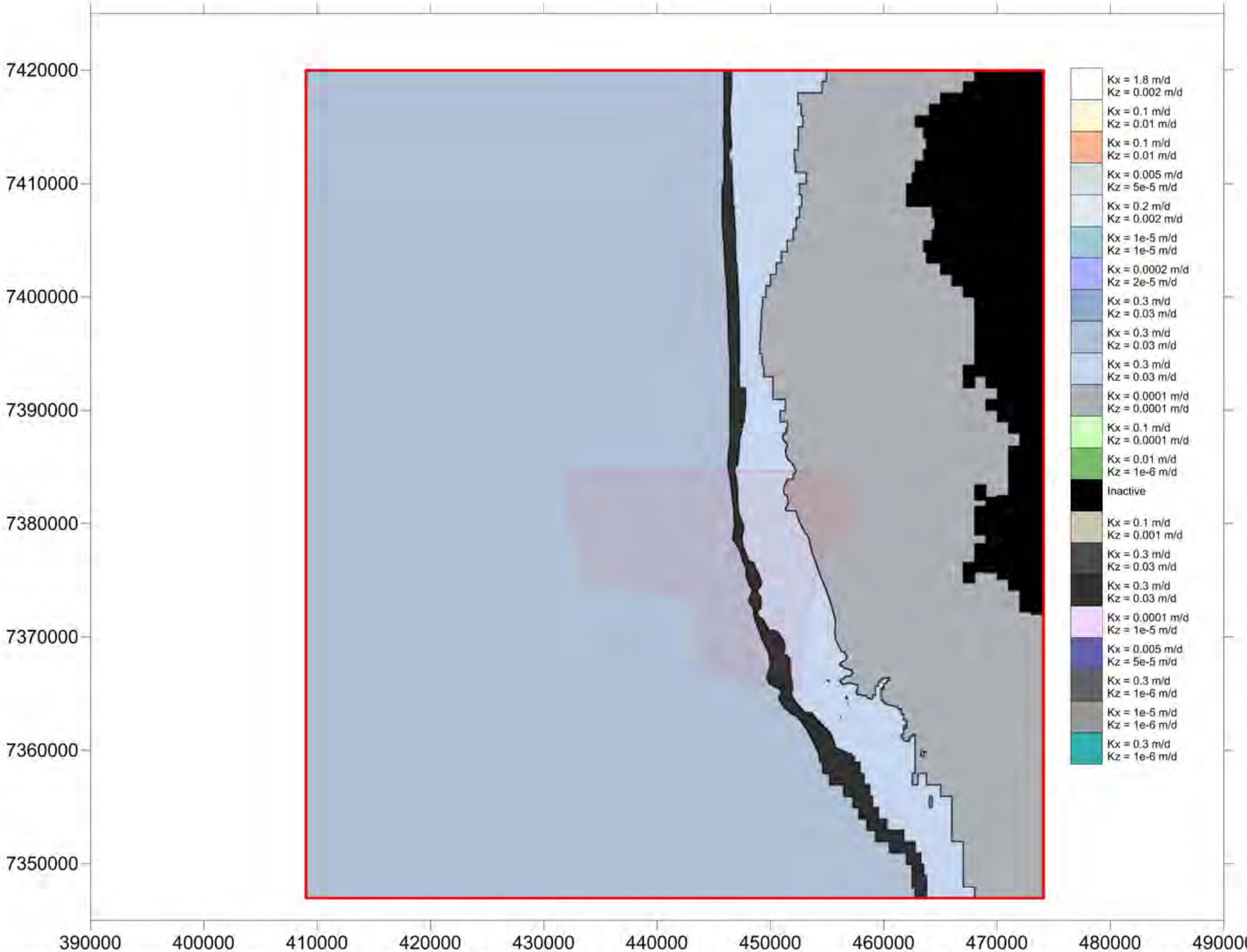
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 03 FIGURE F.18

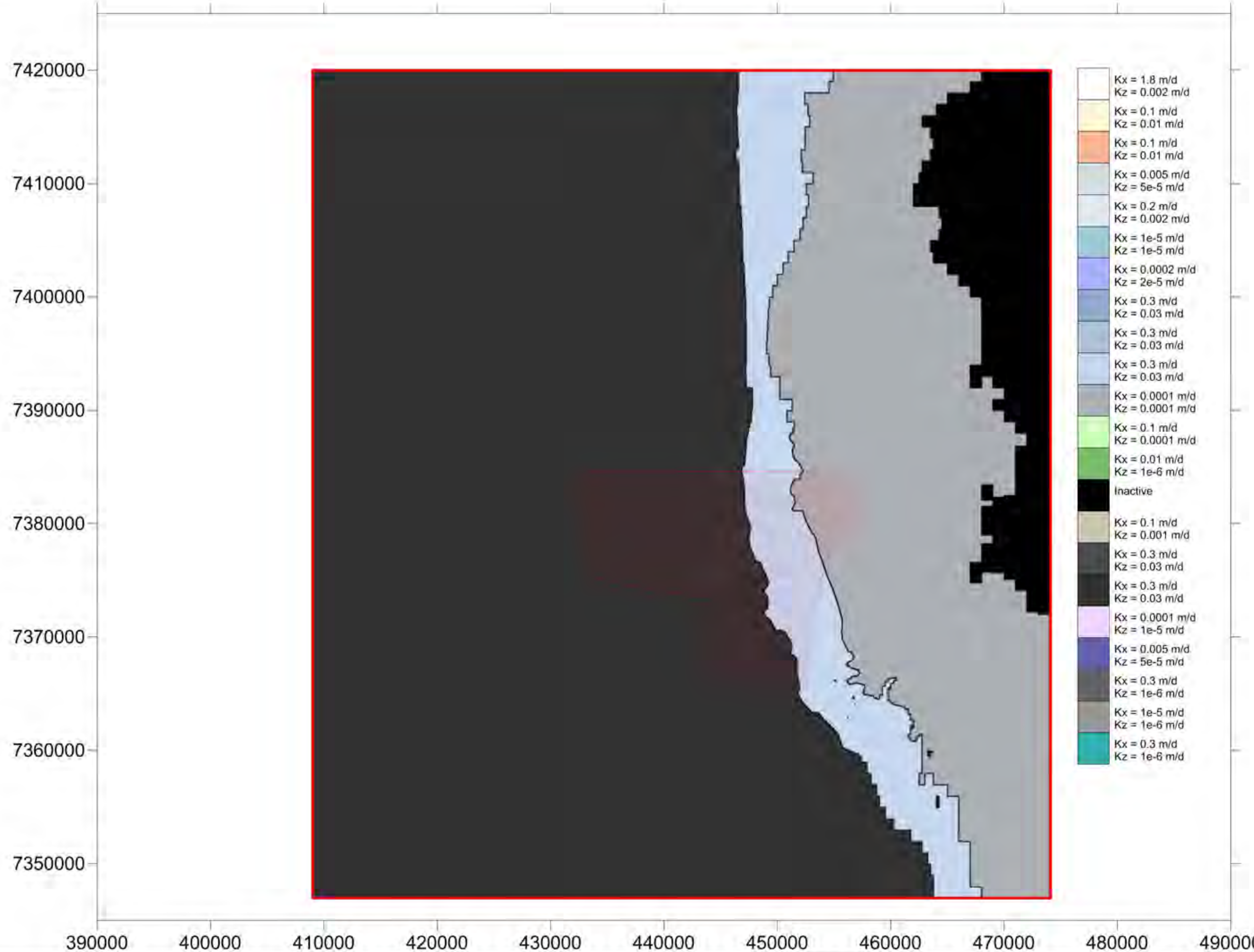
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 04 FIGURE F.19

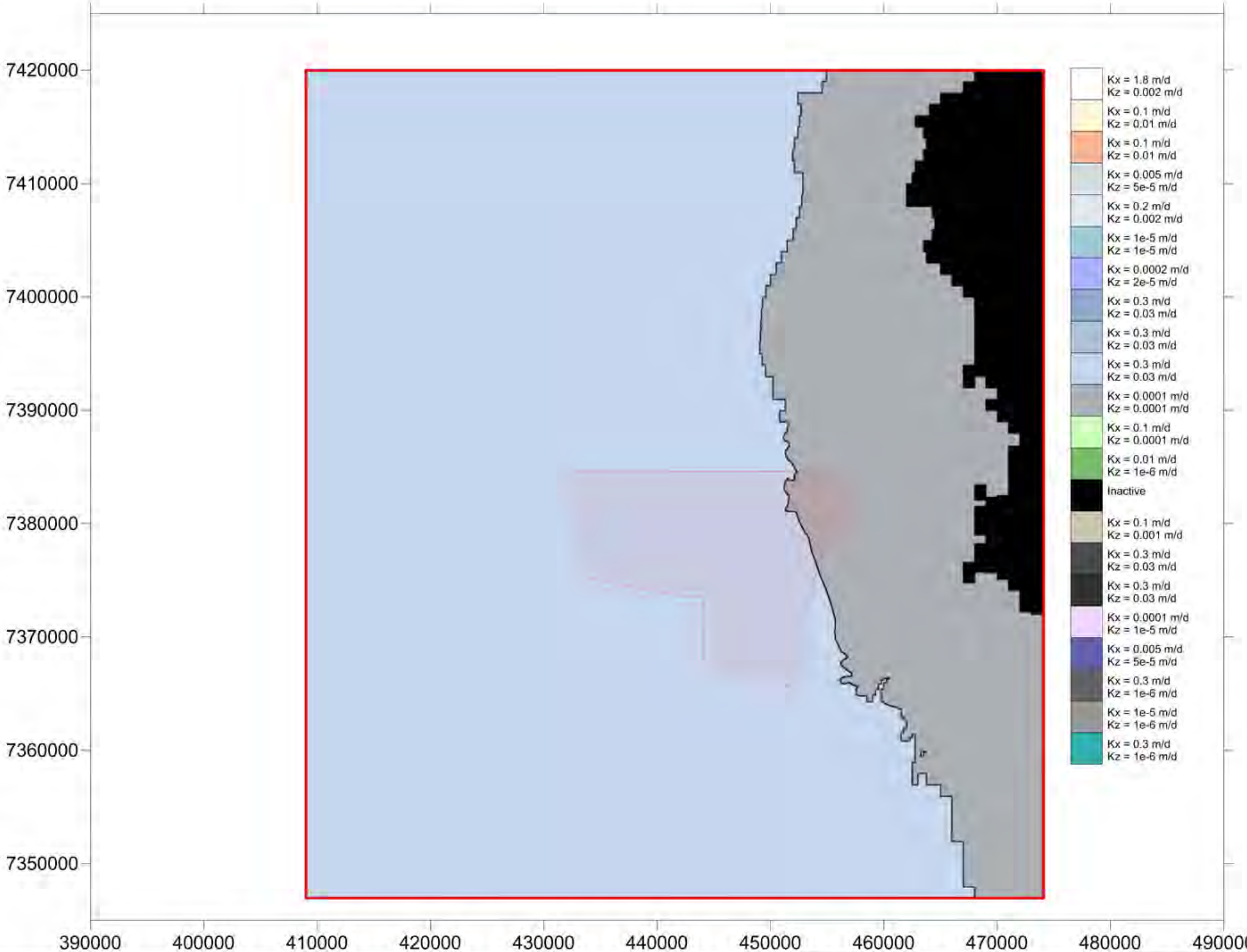
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 05 FIGURE F.20

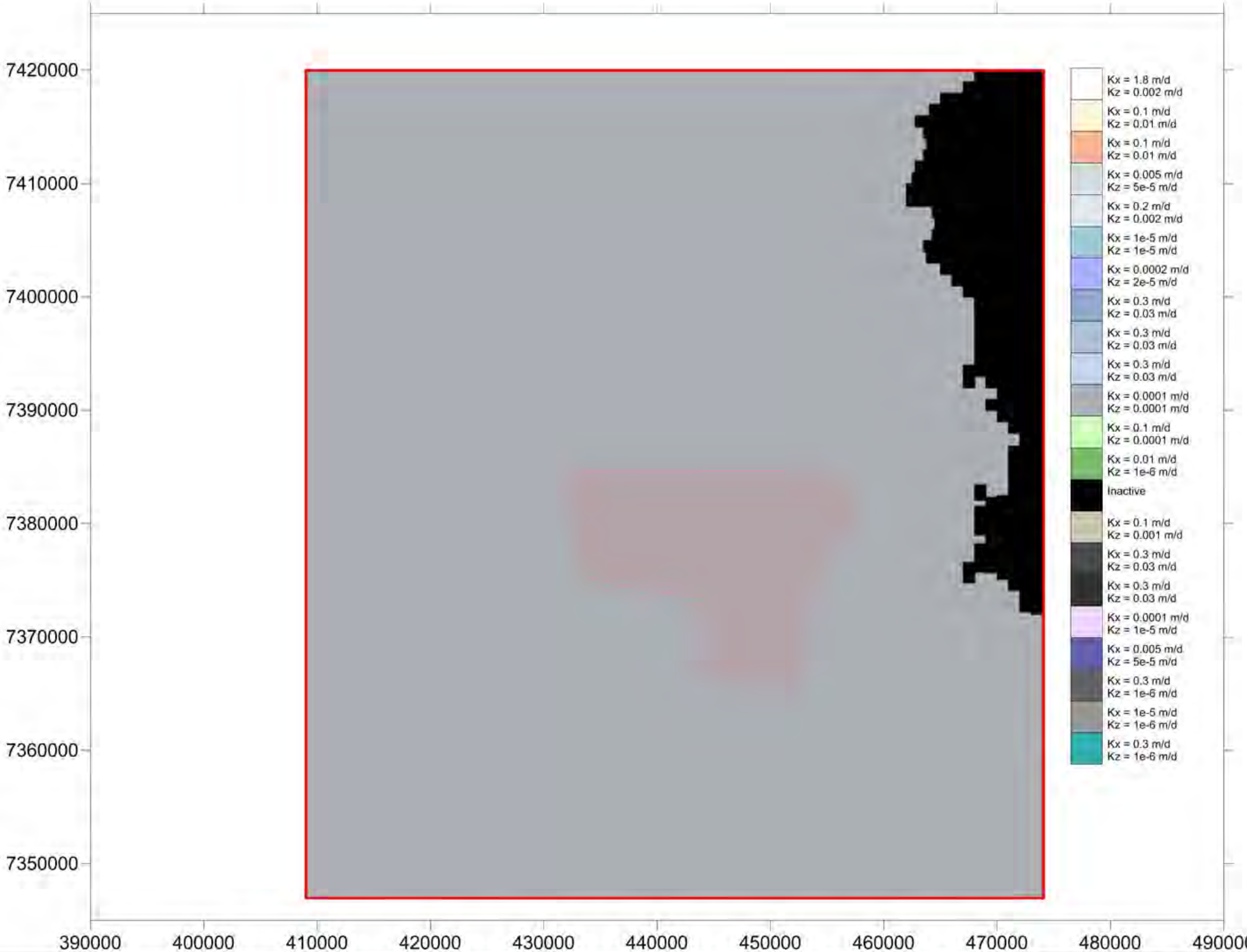
F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf



RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 06 FIGURE F.21

F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf

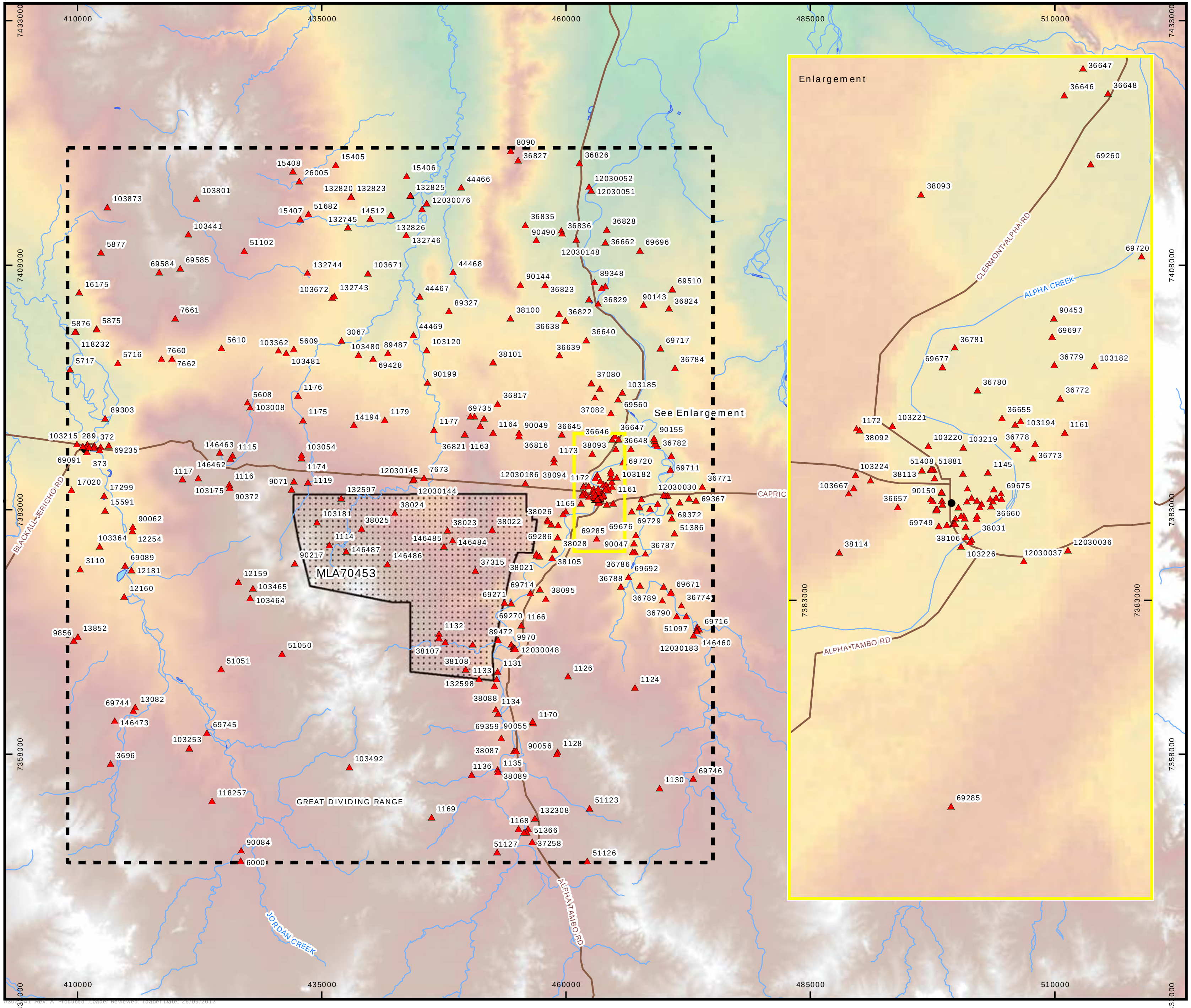


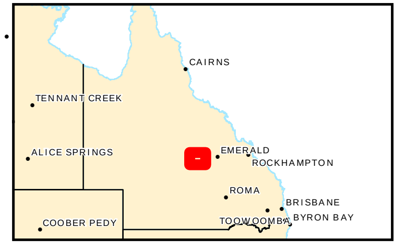
RPS Aquaterra

SOUTH GALILEE - HYDRAULIC CONDUCTIVITY - LAYER 07 FIGURE F.22

F:/Jobs/A302C/600/Model_Boundary_Conditions_and_properties.srf

APPENDIX G:
MODEL RESULTS





LEGEND

- Registered Bore (DNRM Data)
- Locality
- Highways
- Rivers
- Model Extent
- Waterbodies
- Mining Lease Application Boundary

Elevation (mAHD)
High : 914
Low : 224

5 0 5 10
Kilometres

APPROX SCALE 1:550,000 @ A4

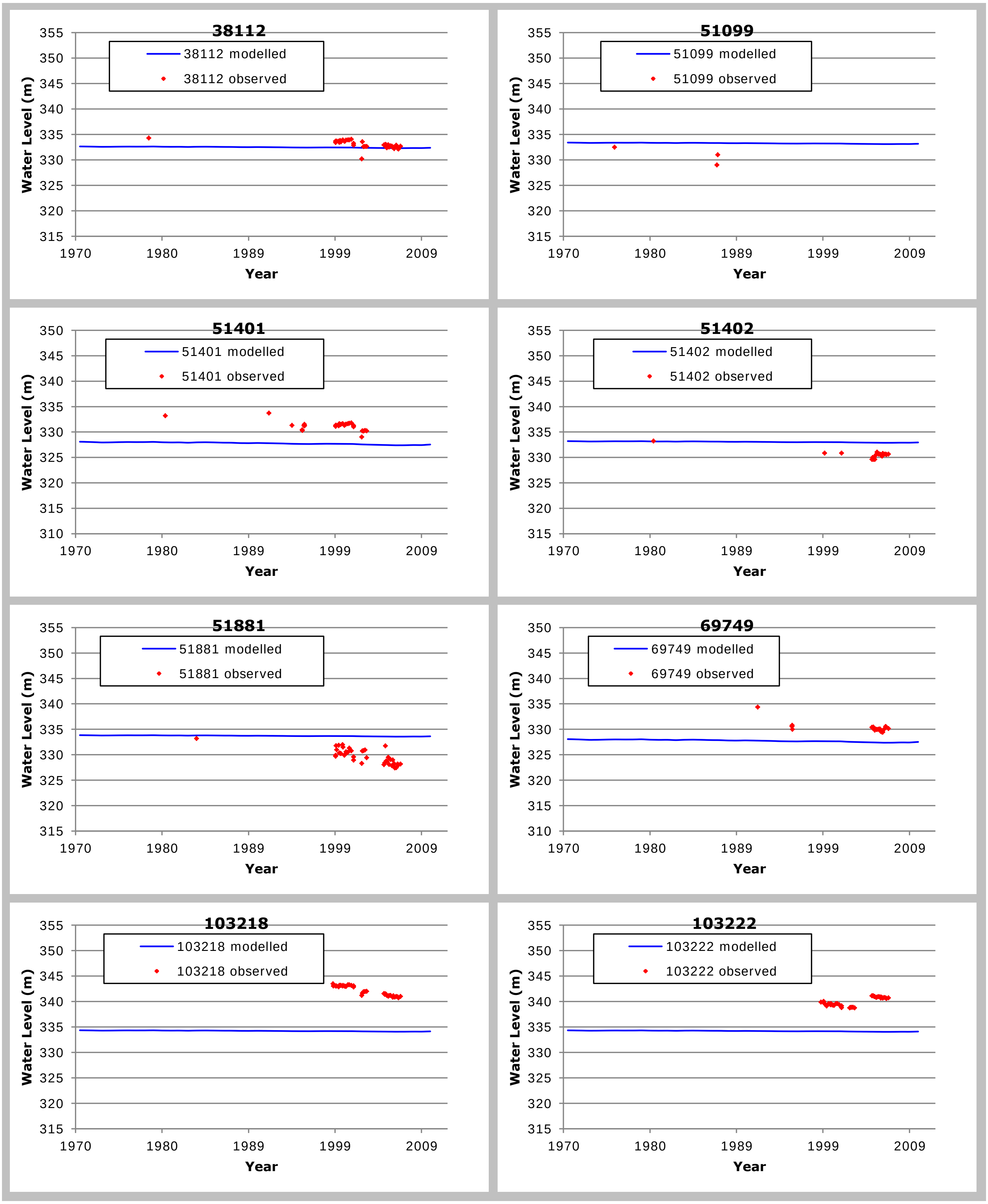
GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
DNRM

RPS Aquaterra

FIGURE G.1

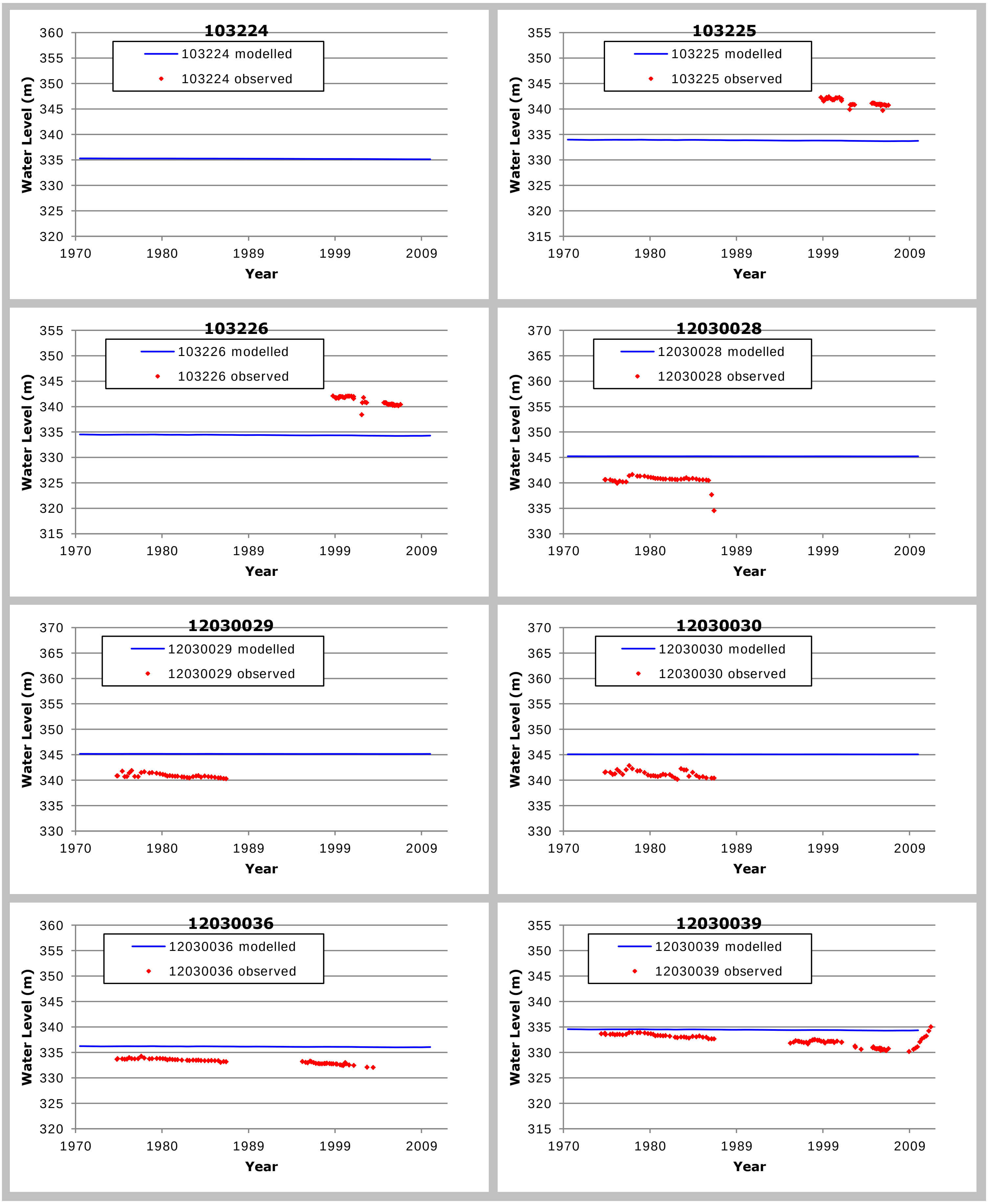
Location of Registered Bores (DNRM Data)



RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.02

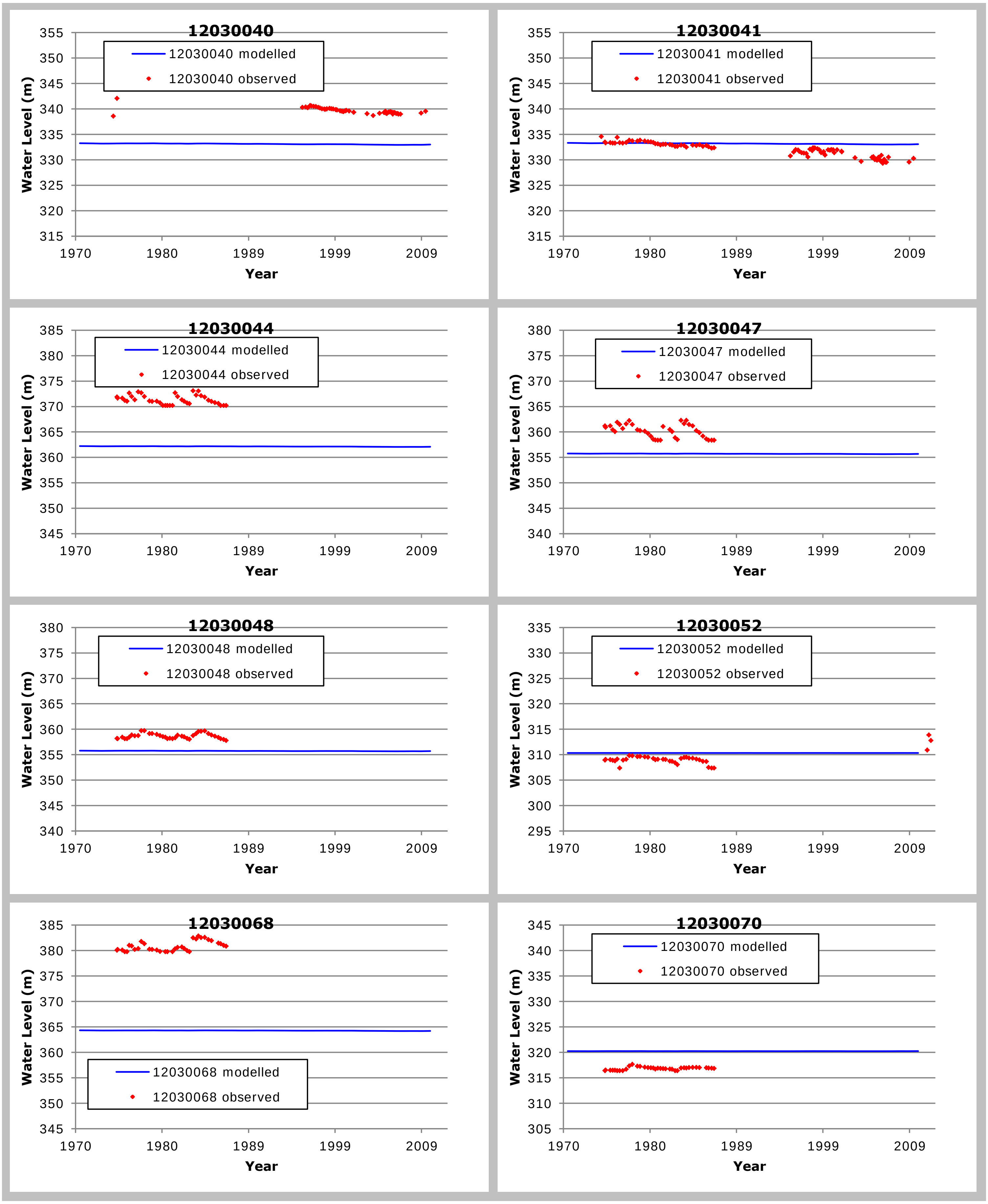
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_01



RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.03

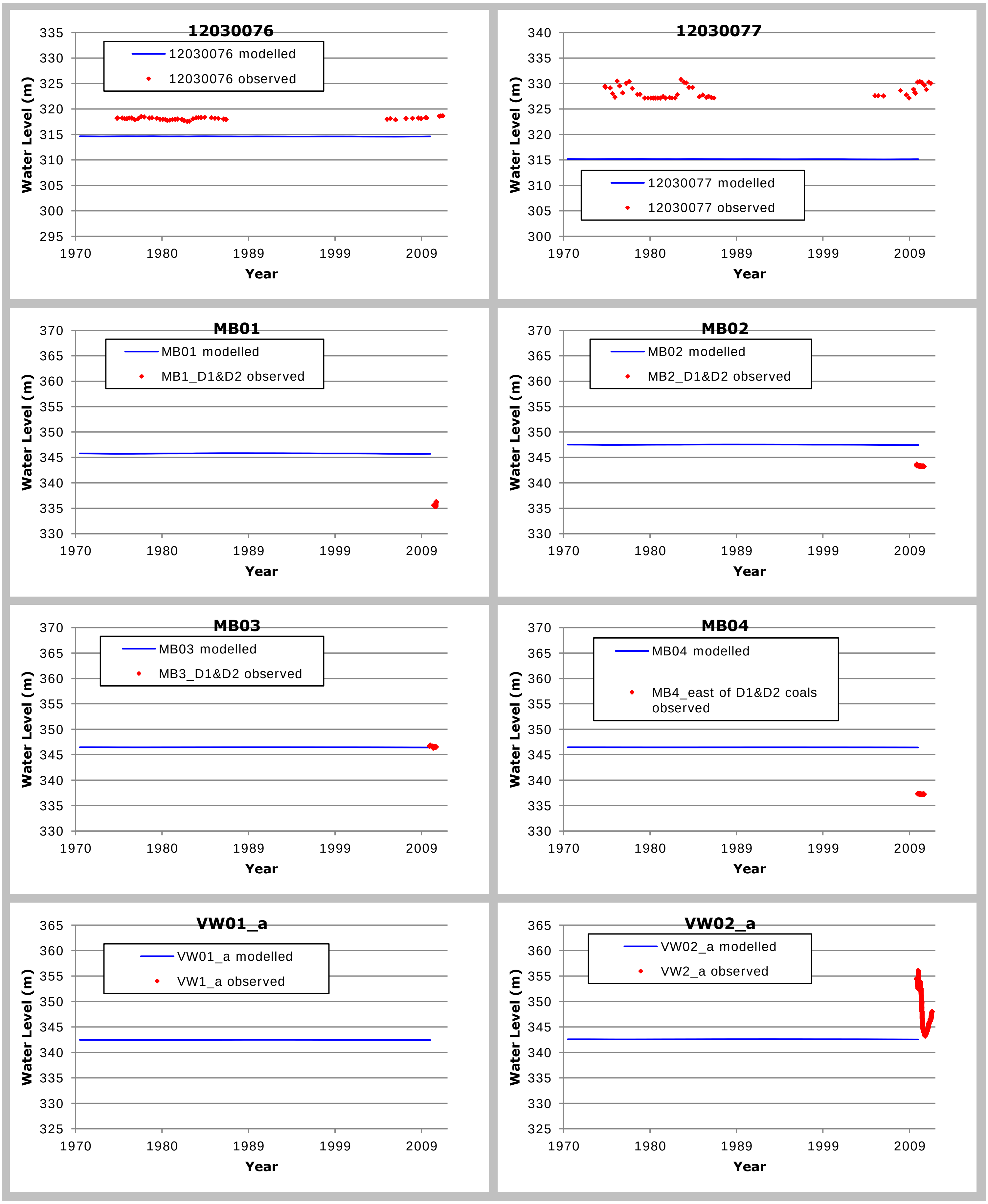
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_02



RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.04

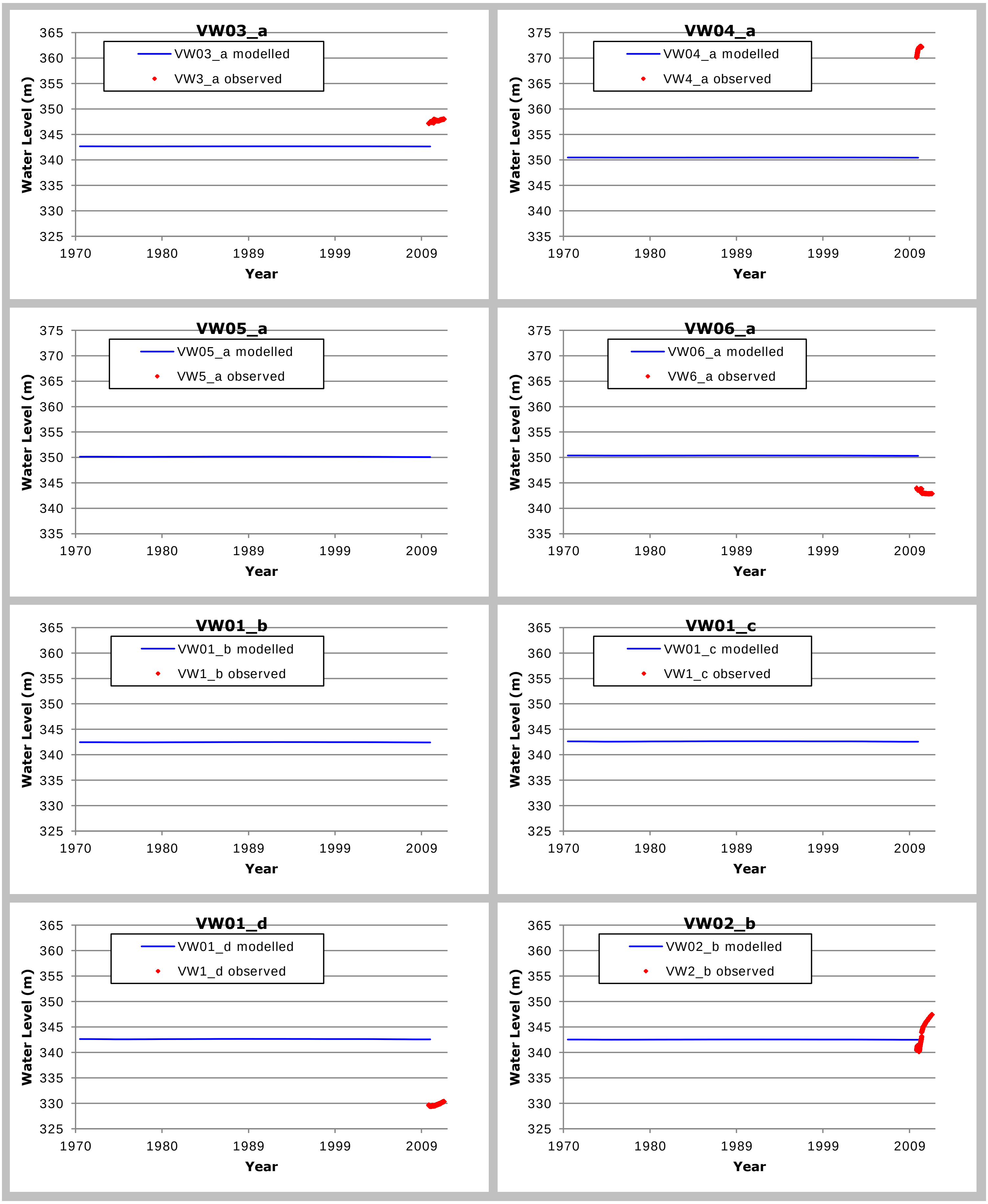
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_03



RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.05

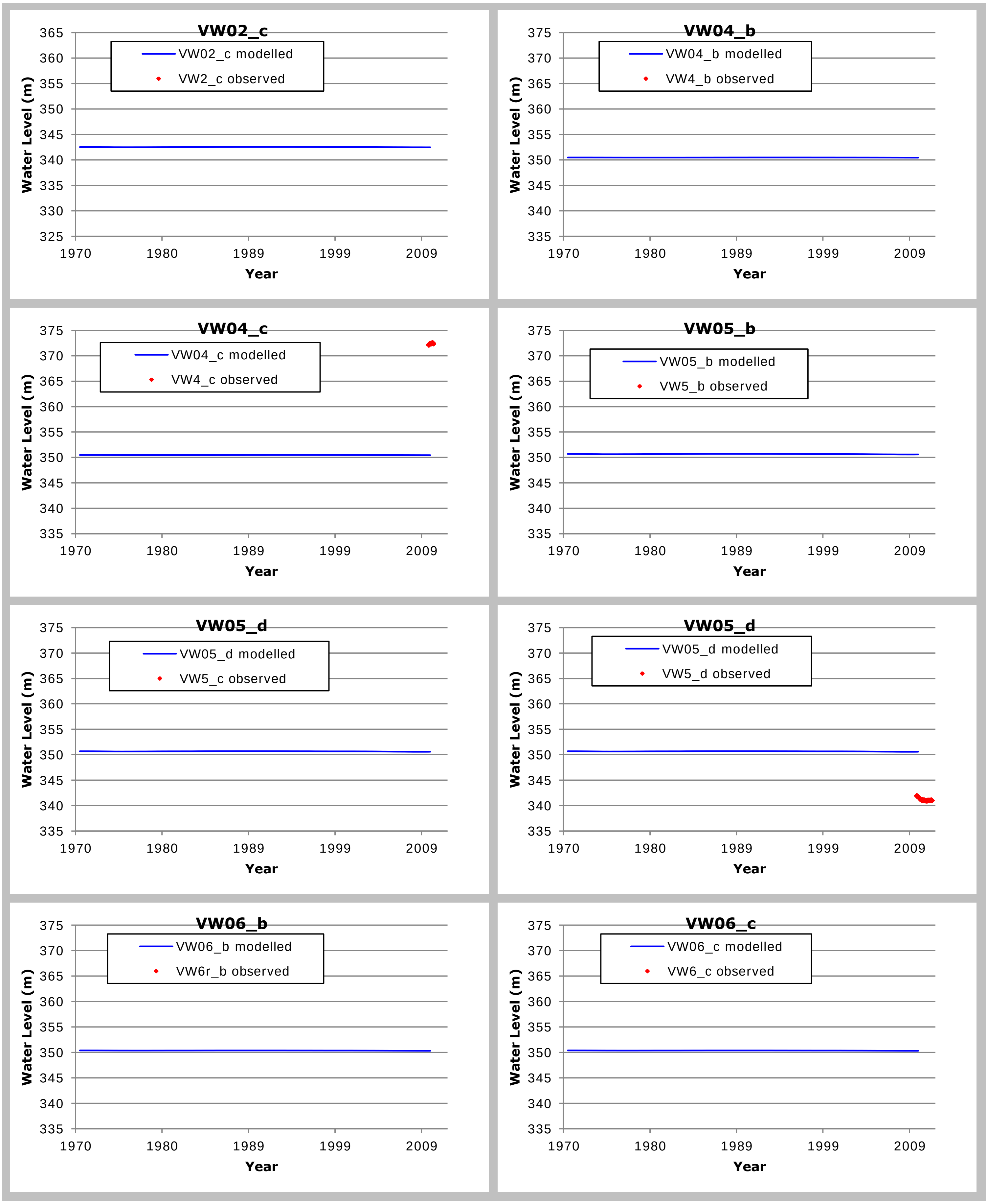
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_04



RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.06

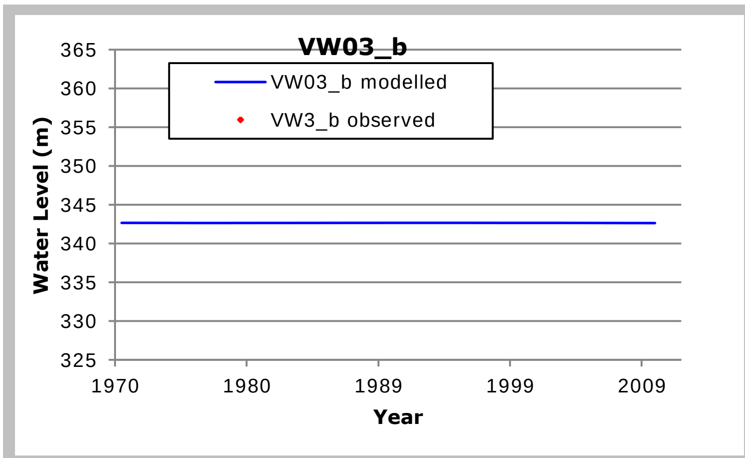
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_05

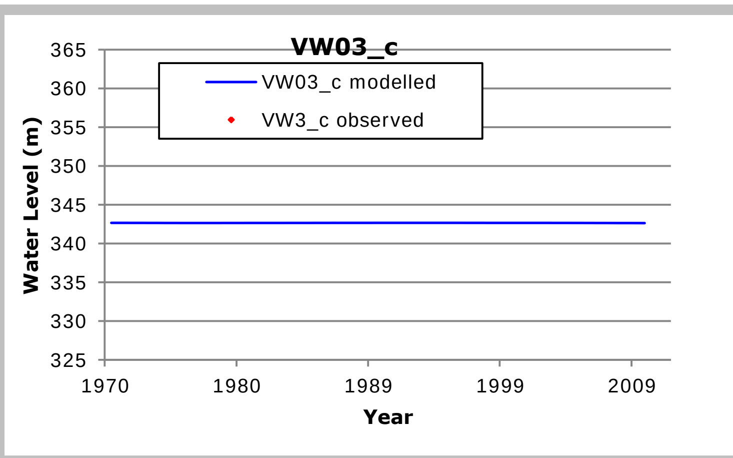


RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.07

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_06

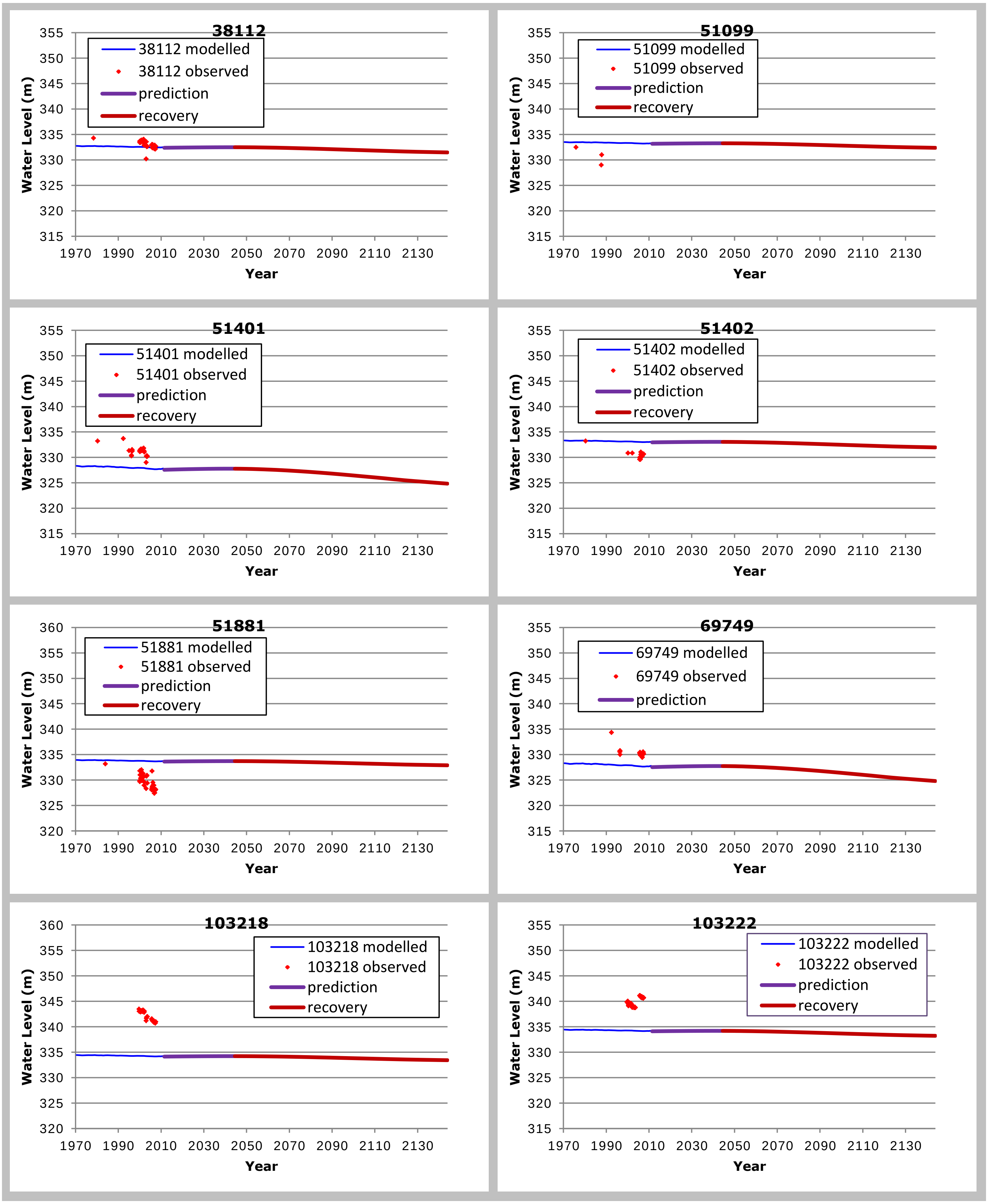




RPS Aquaterra

SOUTH GALILEE CALIBRATION- MODELLED VS MEASURED - FIGURE G.08

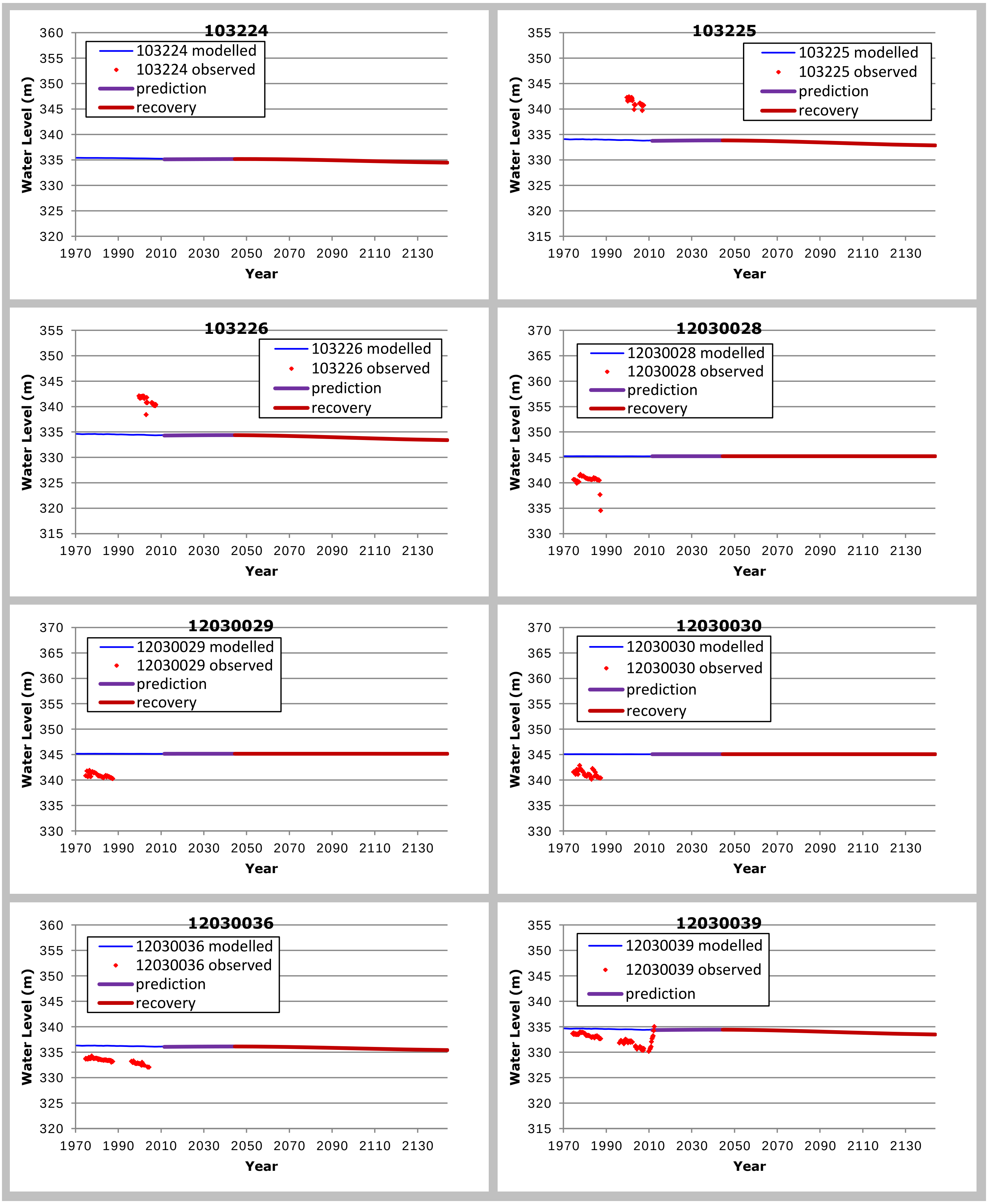
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calibration.xls]Figure_07



RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.10

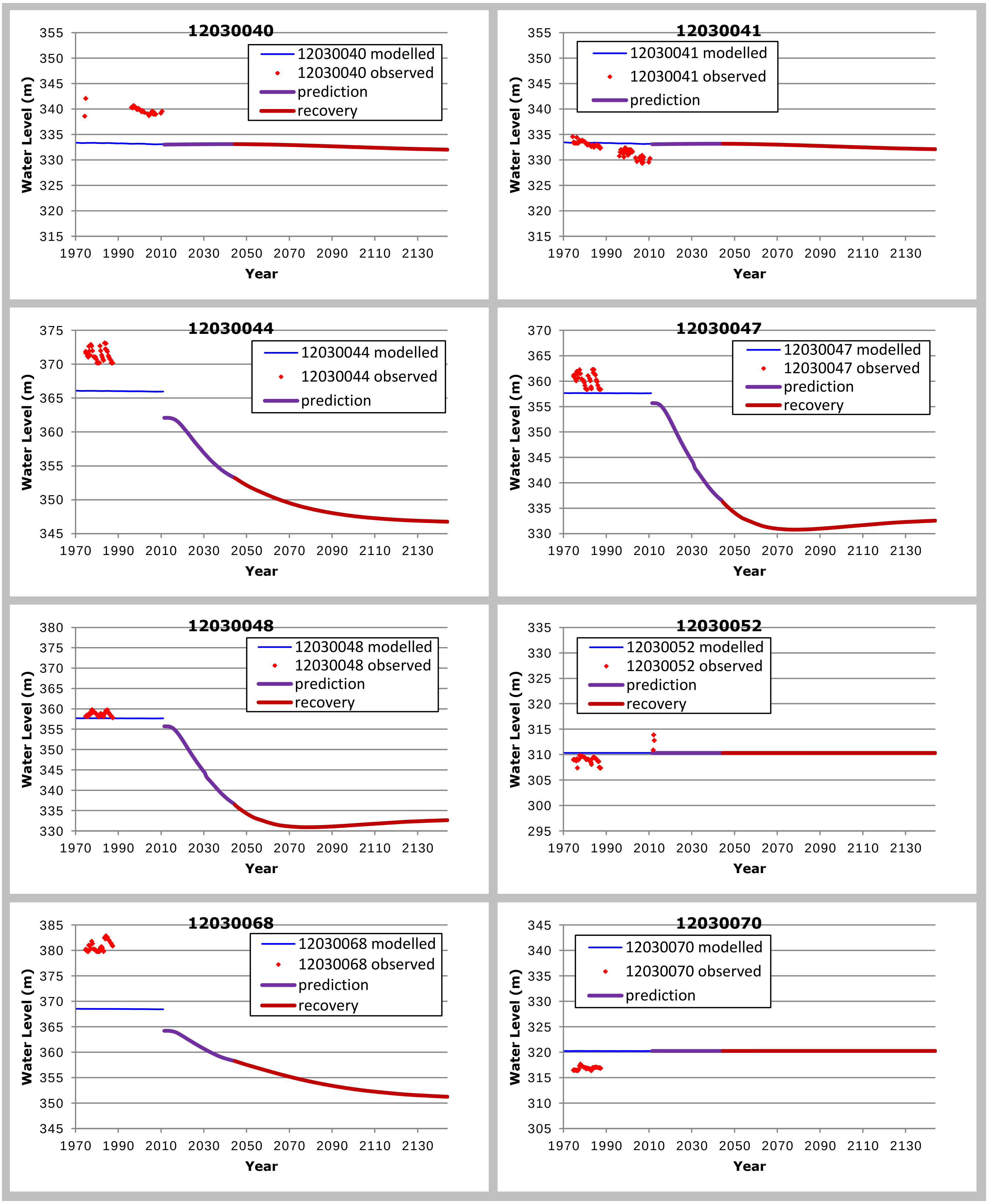
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_01



RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.11

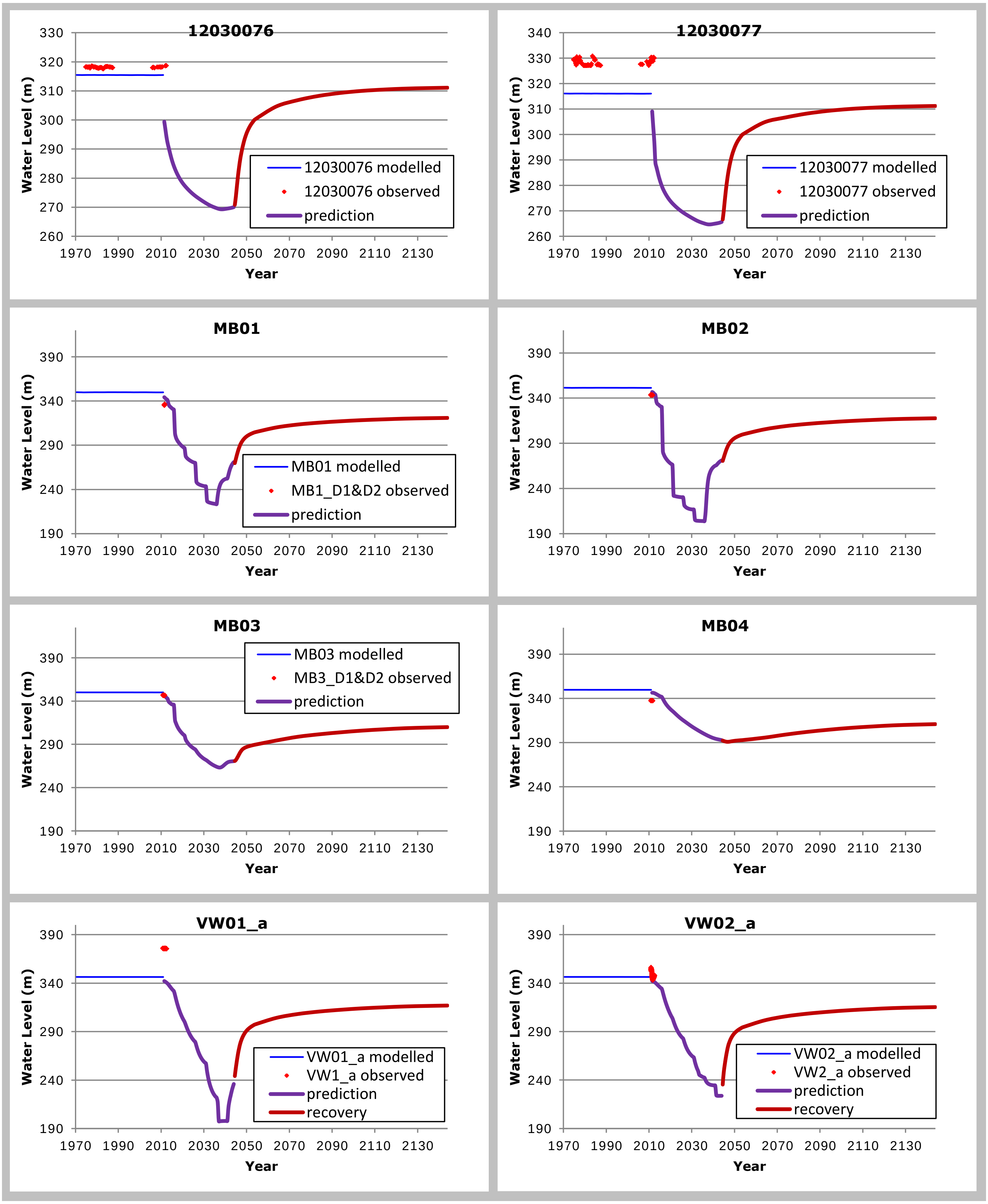
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_02



RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.12

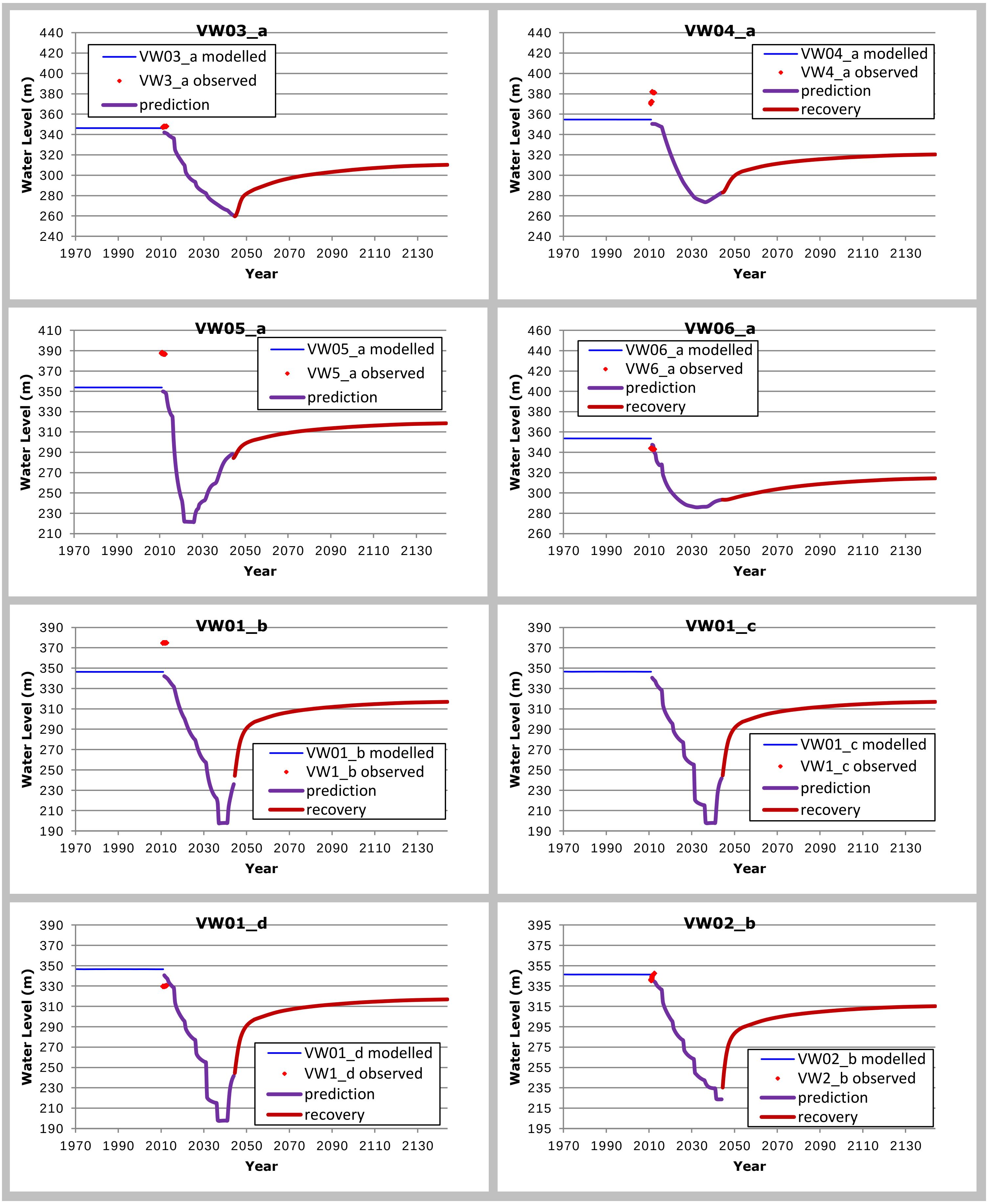
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_03



RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.13

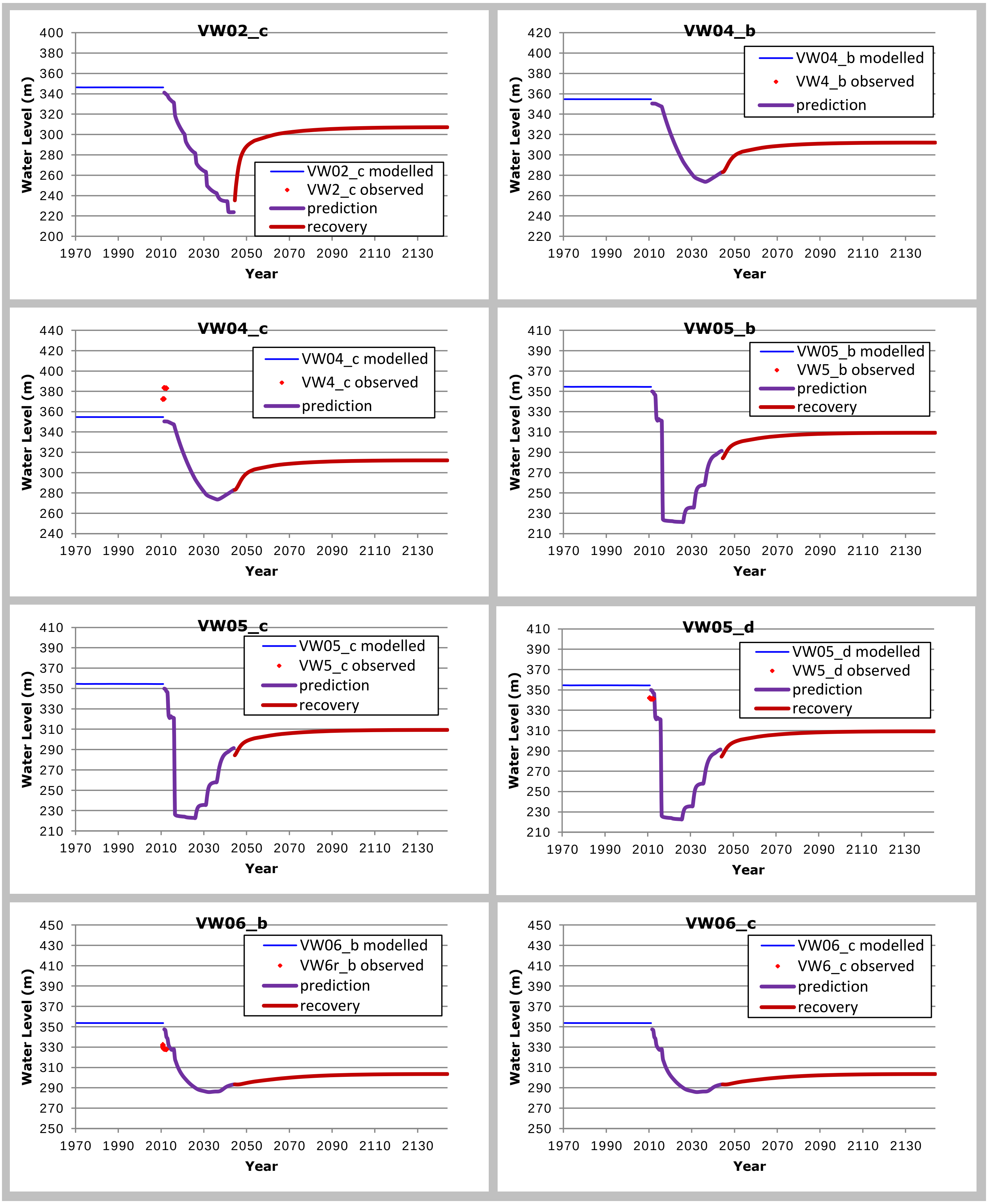
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_04



RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.14

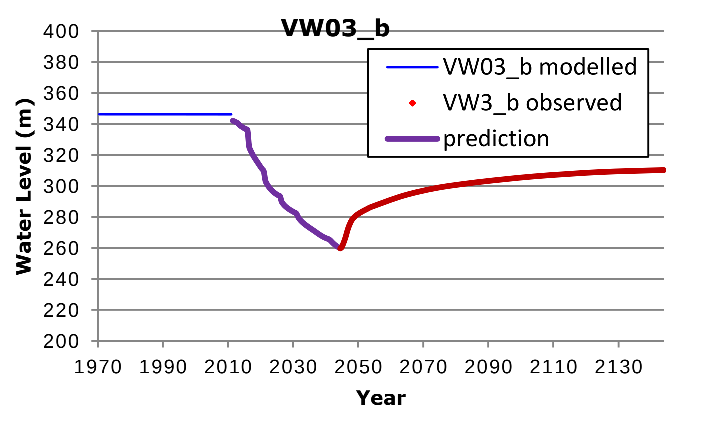
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_05

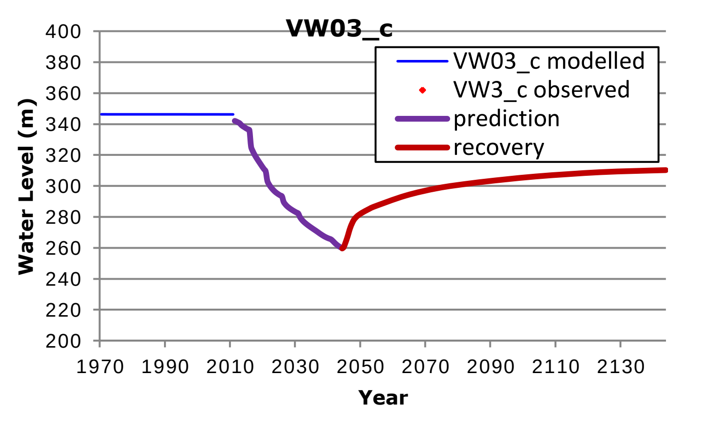


RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.15

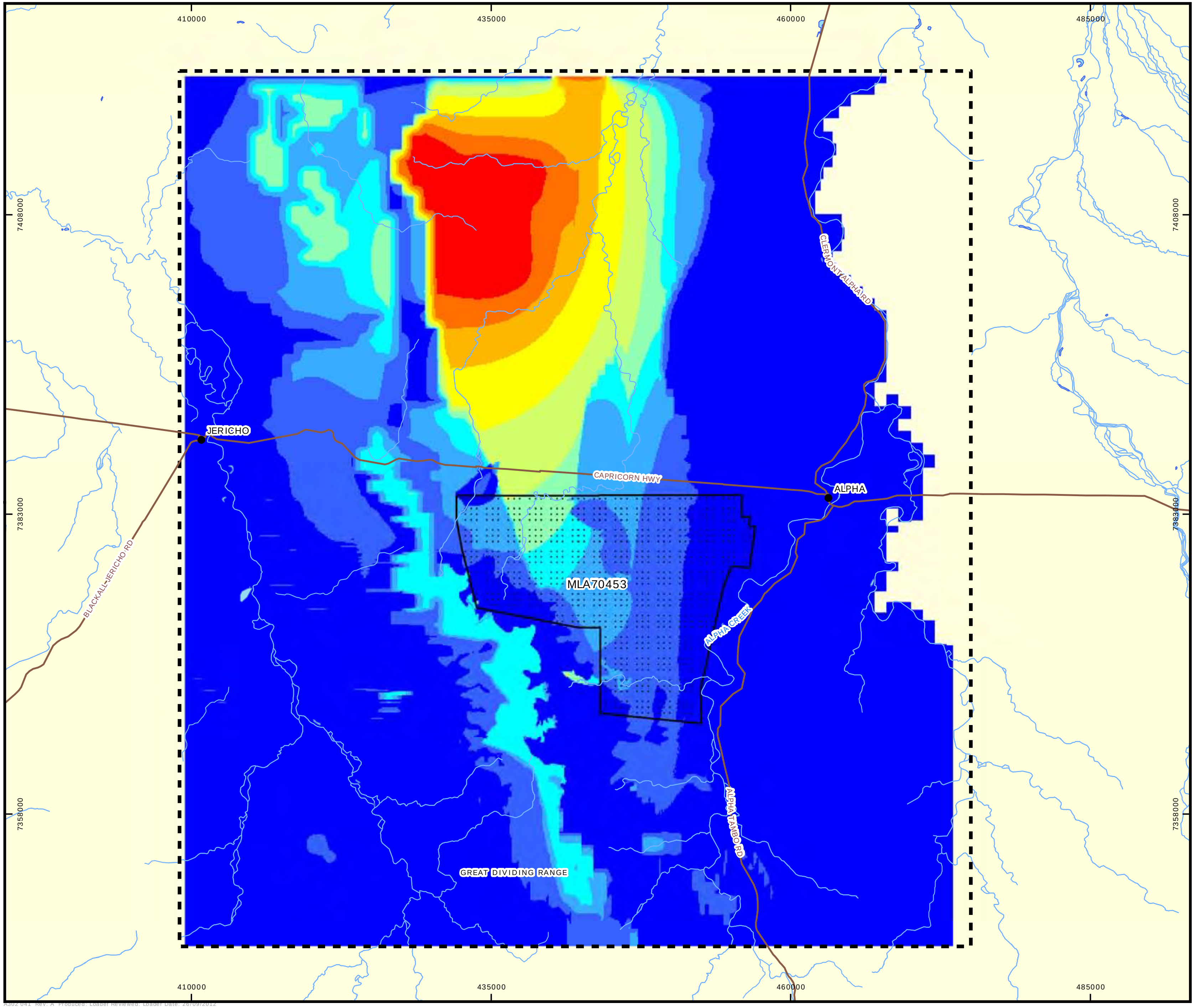
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_pred_rec.xls]Figure_06

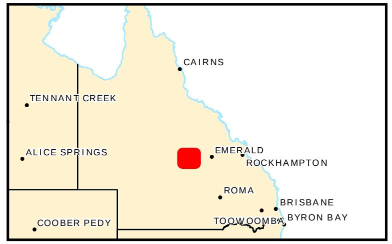


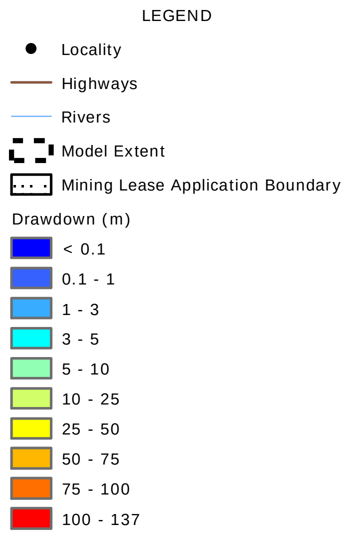


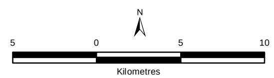
RPS Aquaterra

SOUTH GALILEE MODELLED PREDICTION AND RECOVERY - FIGURE G.16









APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

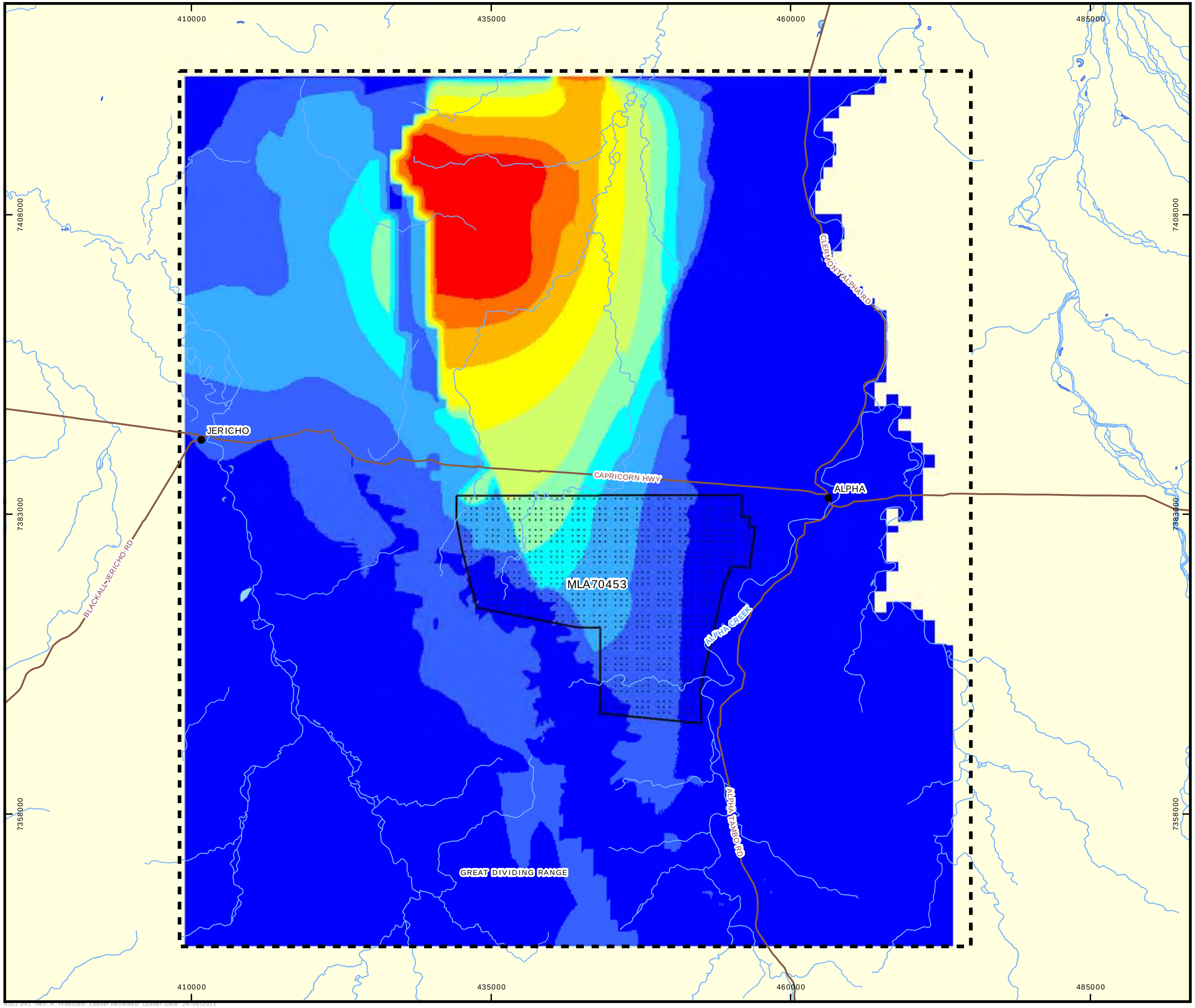
DATA SOURCES
SRTM
Geoscience
RPS

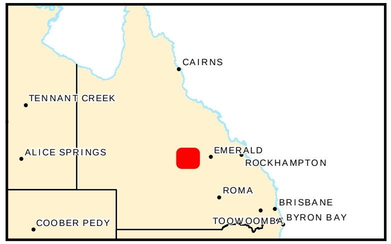
RPS Aquaterra

FIGURE G.17

Predicted drawdoen in Layer 1 after 5 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 137

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

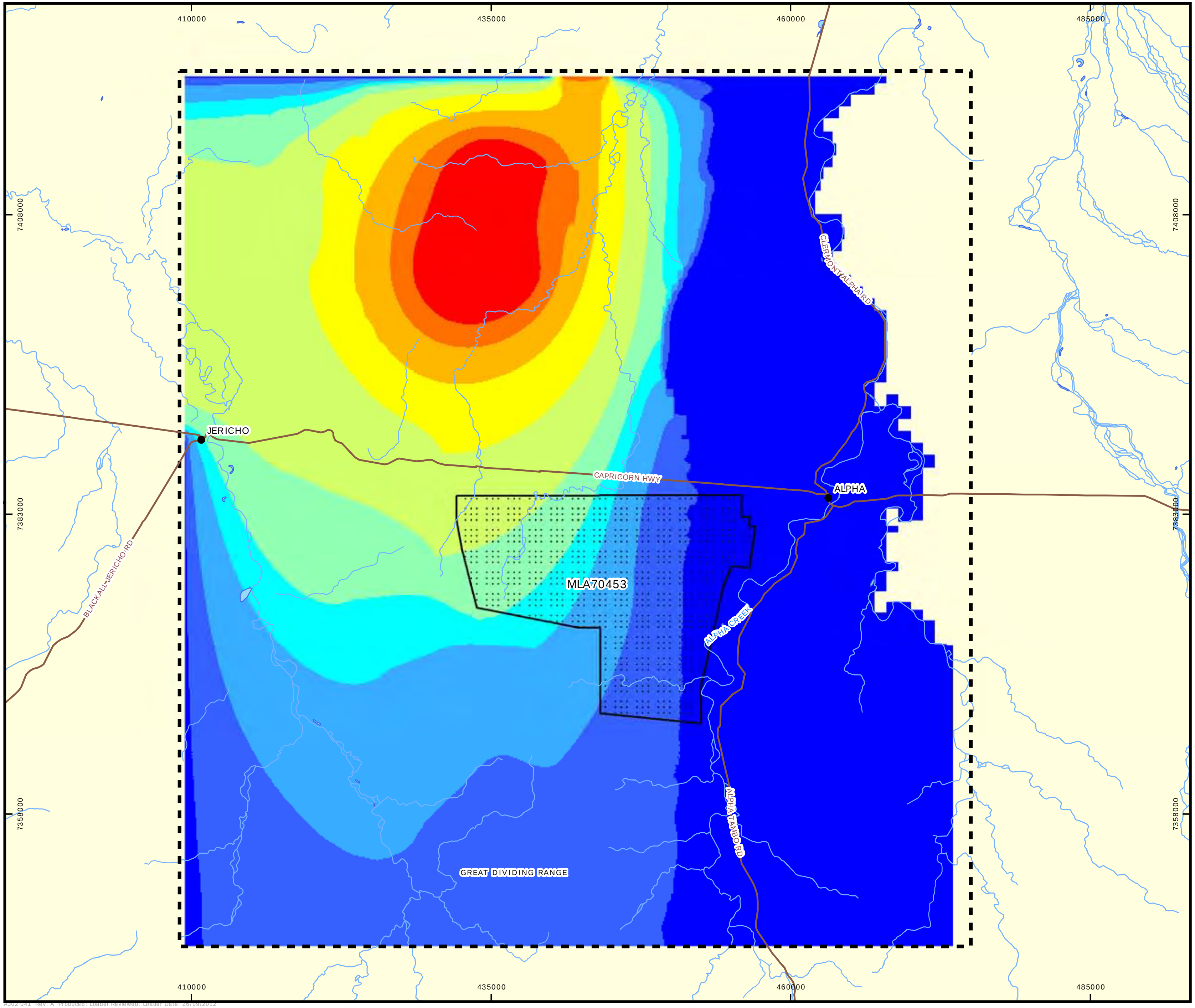
DATA SOURCES
SRTM
Geoscience
RPS

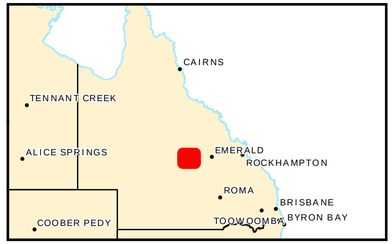
RPS Aquaterra

FIGURE G.18

Predicted drawdoen in Layer 2 after
5 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 209

Kilometres

APPROX SCALE 1:450,000 @ A4

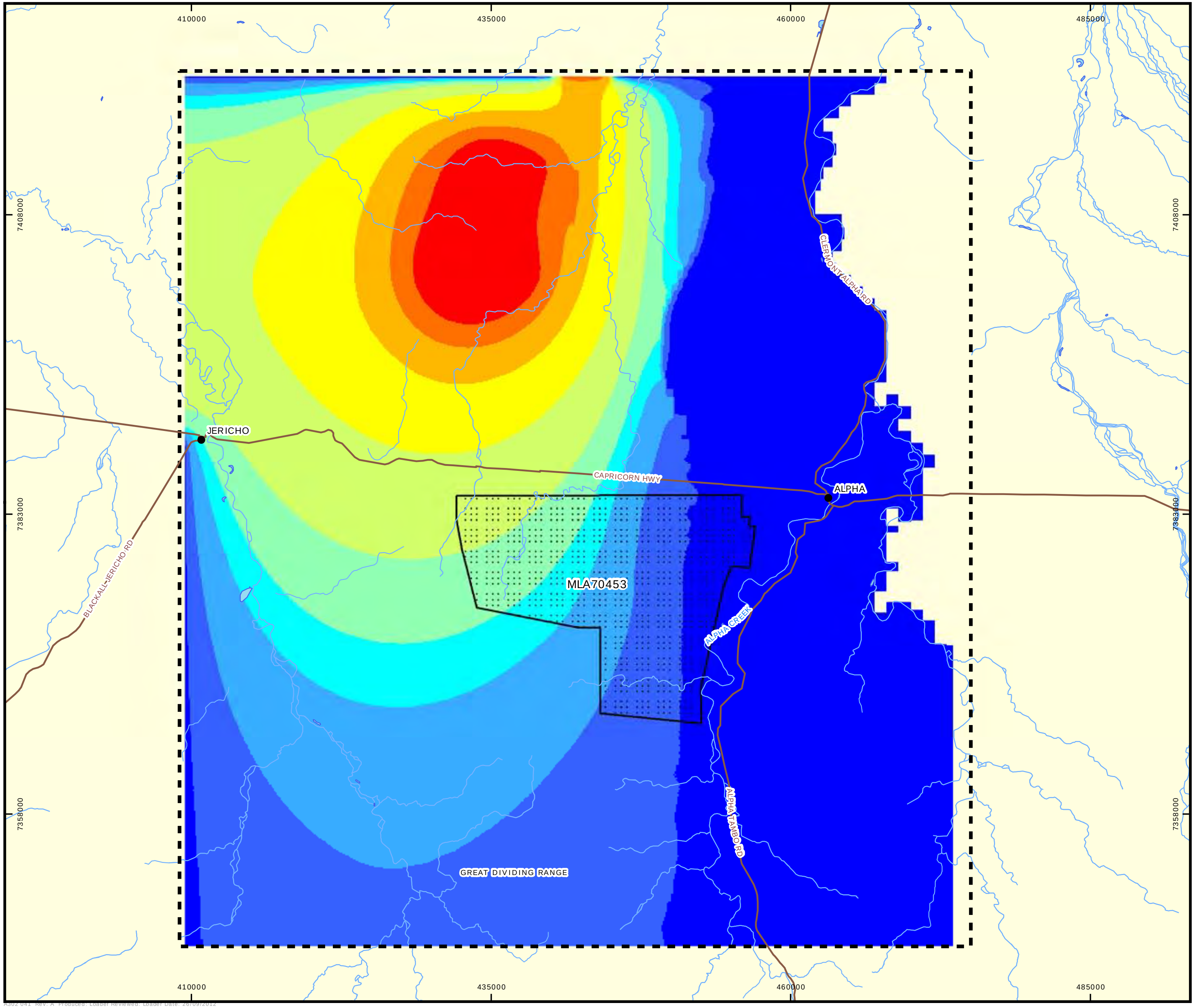
GDA 1994 MGA Zone 55

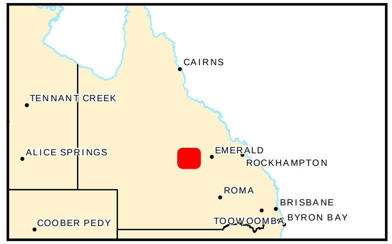
DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

FIGURE G.19

Predicted drawdoen in Layer 3 after 5 years of mining (in-situ parameters)





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 210

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

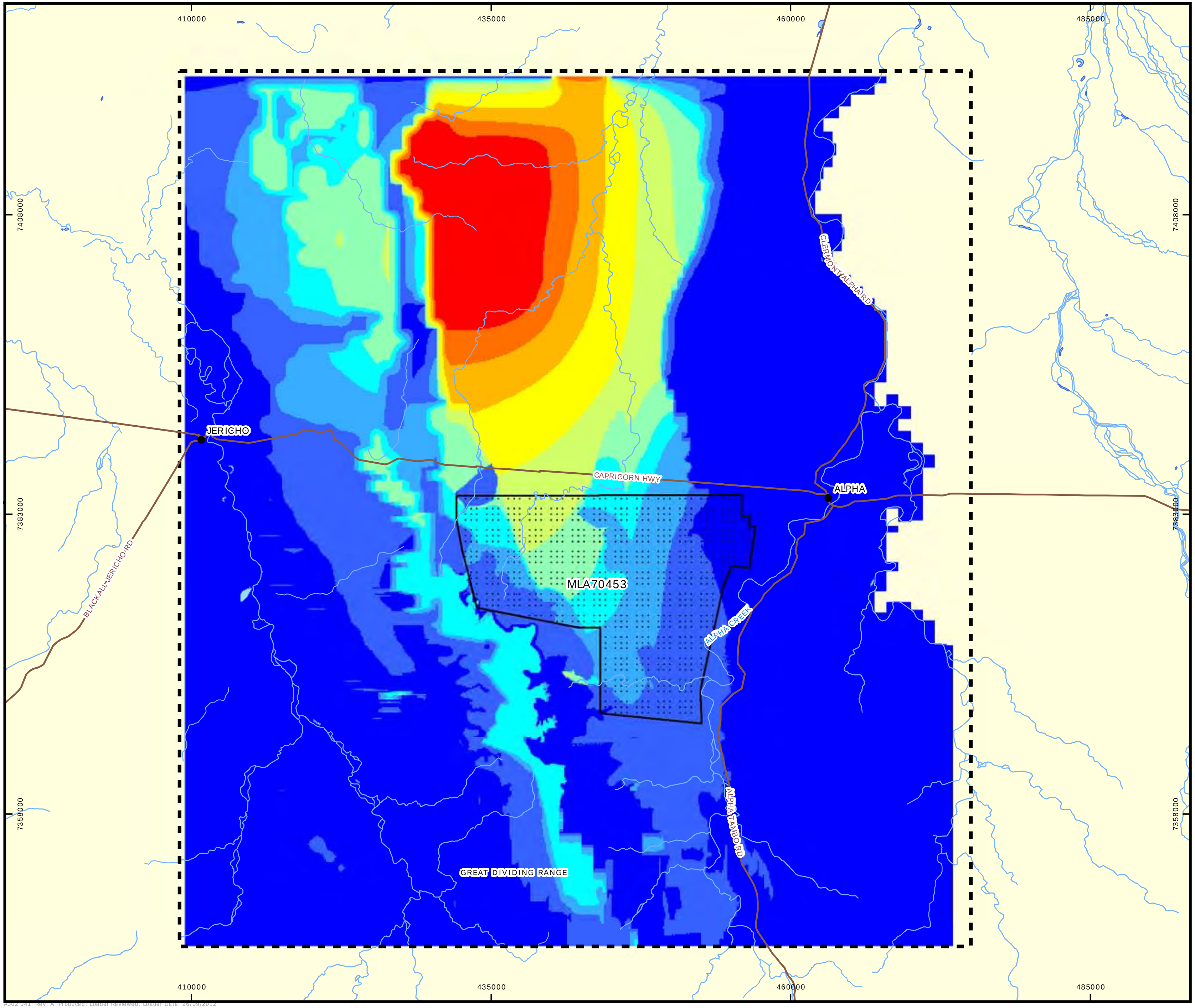
DATA SOURCES
SRTM
Geoscience
RPS

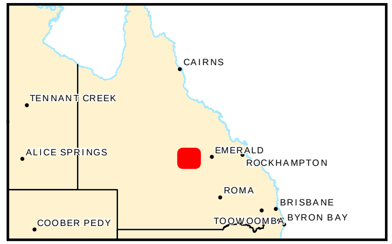
RPS Aquaterra

FIGURE G.20

Predicted drawdoen in Layer 5 after 5 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 158

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

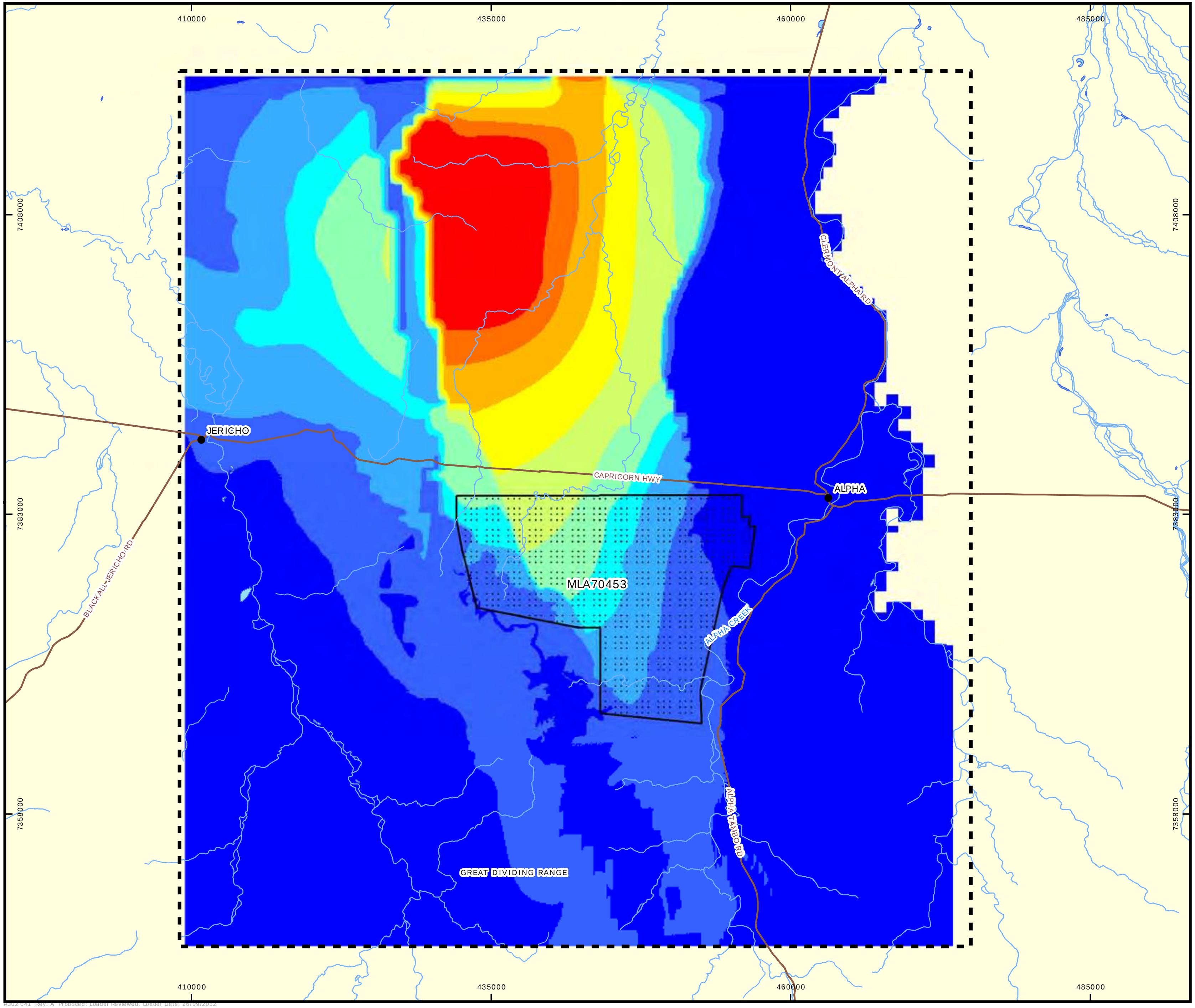
DATA SOURCES
SRTM
Geoscience
RPS

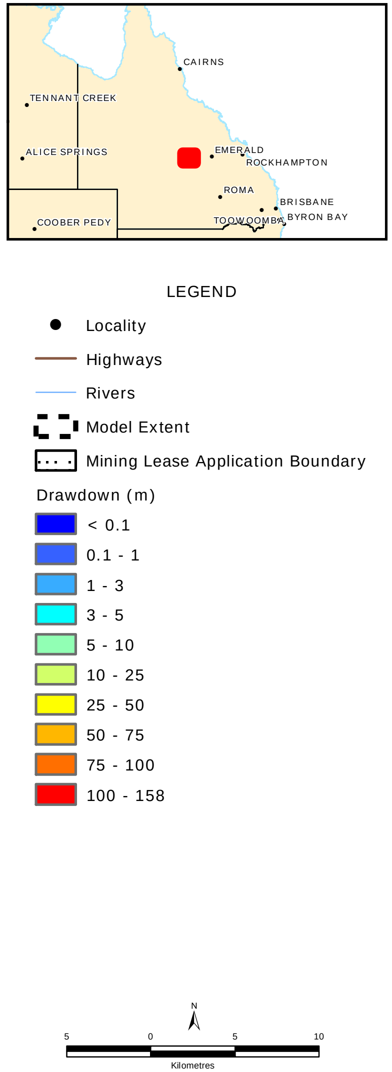
RPS Aquaterra

FIGURE G.21

Predicted drawdoen in Layer 1 after 10 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





APPROX SCALE 1:450,000 @ A4

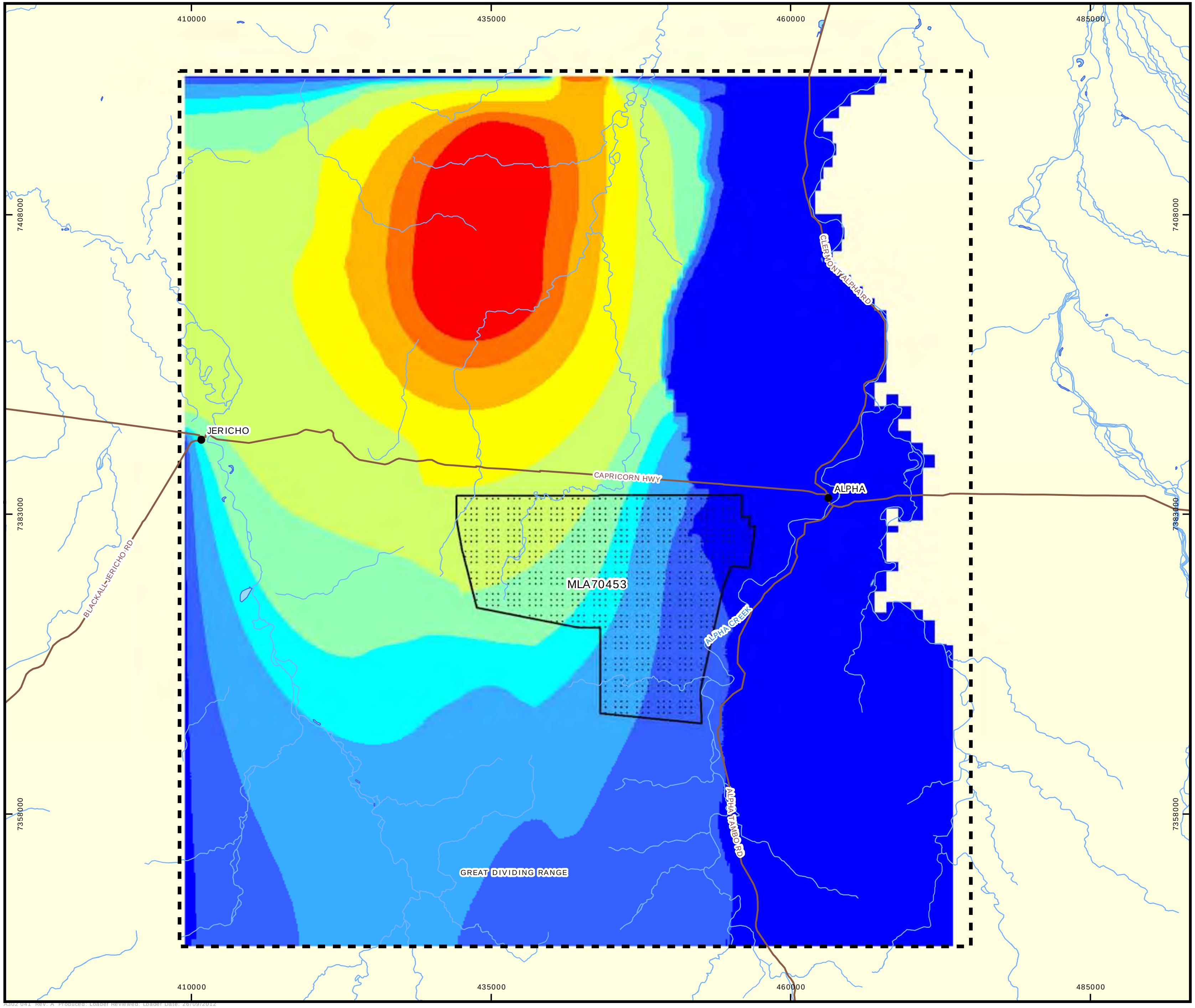
GDA 1994 MGA Zone 55

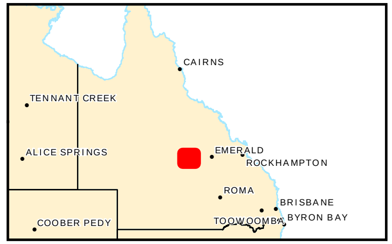
DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

FIGURE G.22

Predicted drawdoen in Layer 2 after 10 years of mining (in-situ parameters)





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 206

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

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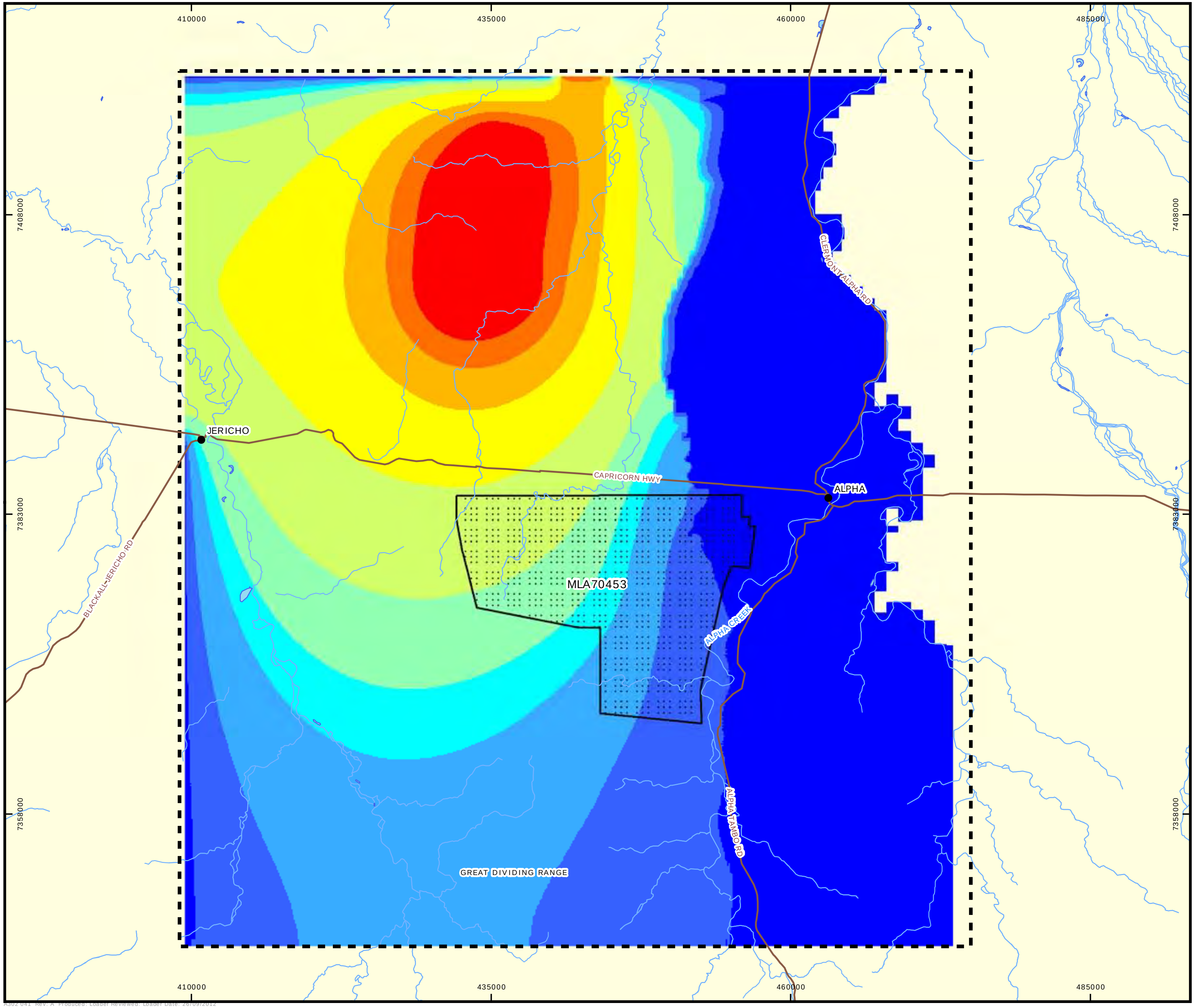
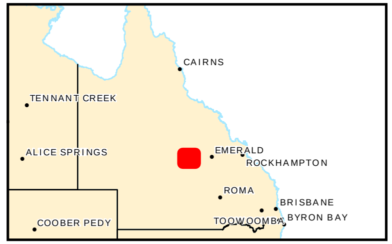
FIGURE G.23

Predicted drawdoen in Layer 3 after 10 years of mining (in-situ parameters)





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 206

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

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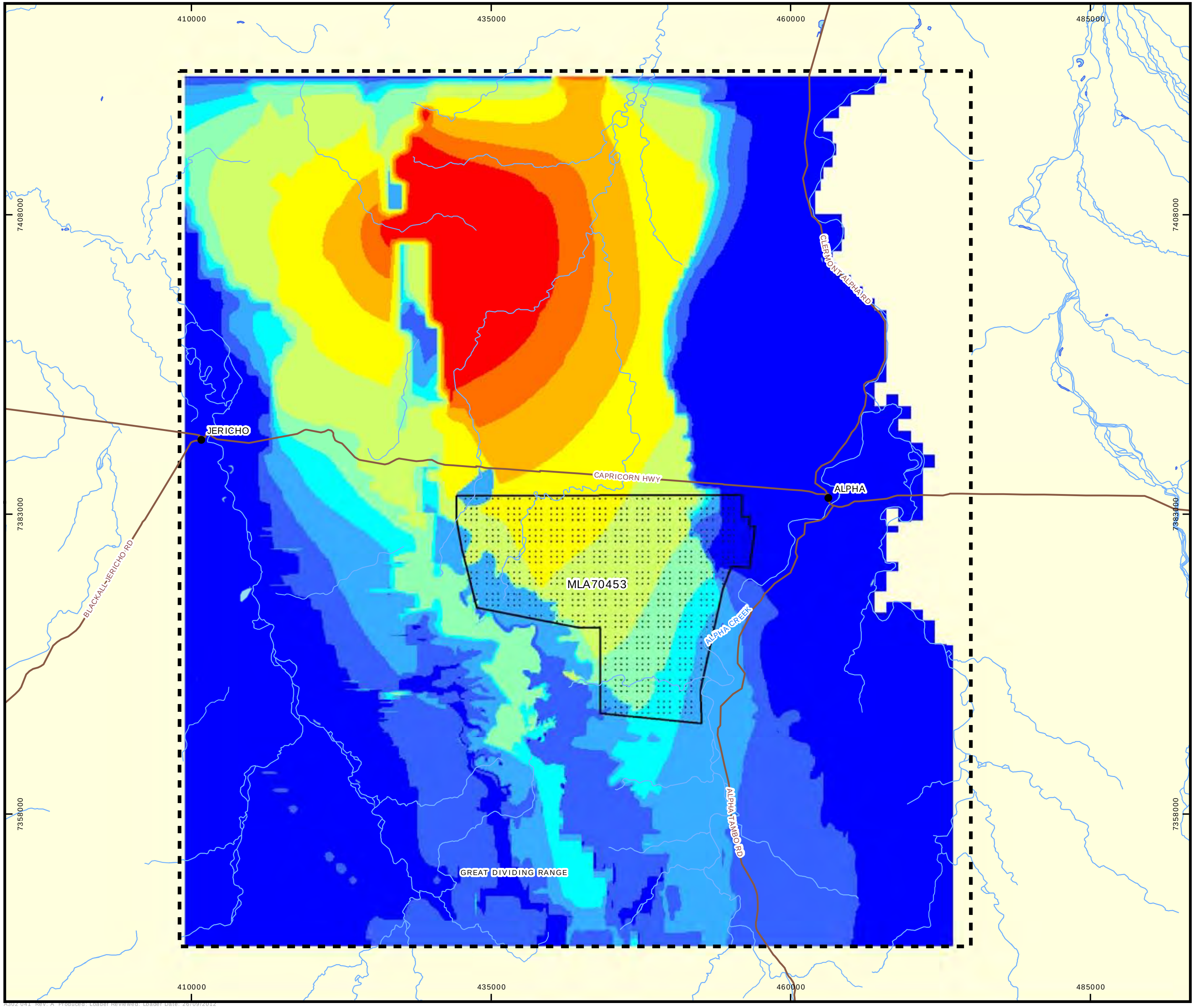
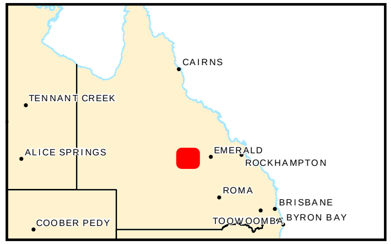
FIGURE G.24

Predicted drawdoen in Layer 5 after 10 years of mining (in-situ parameters)





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 184

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

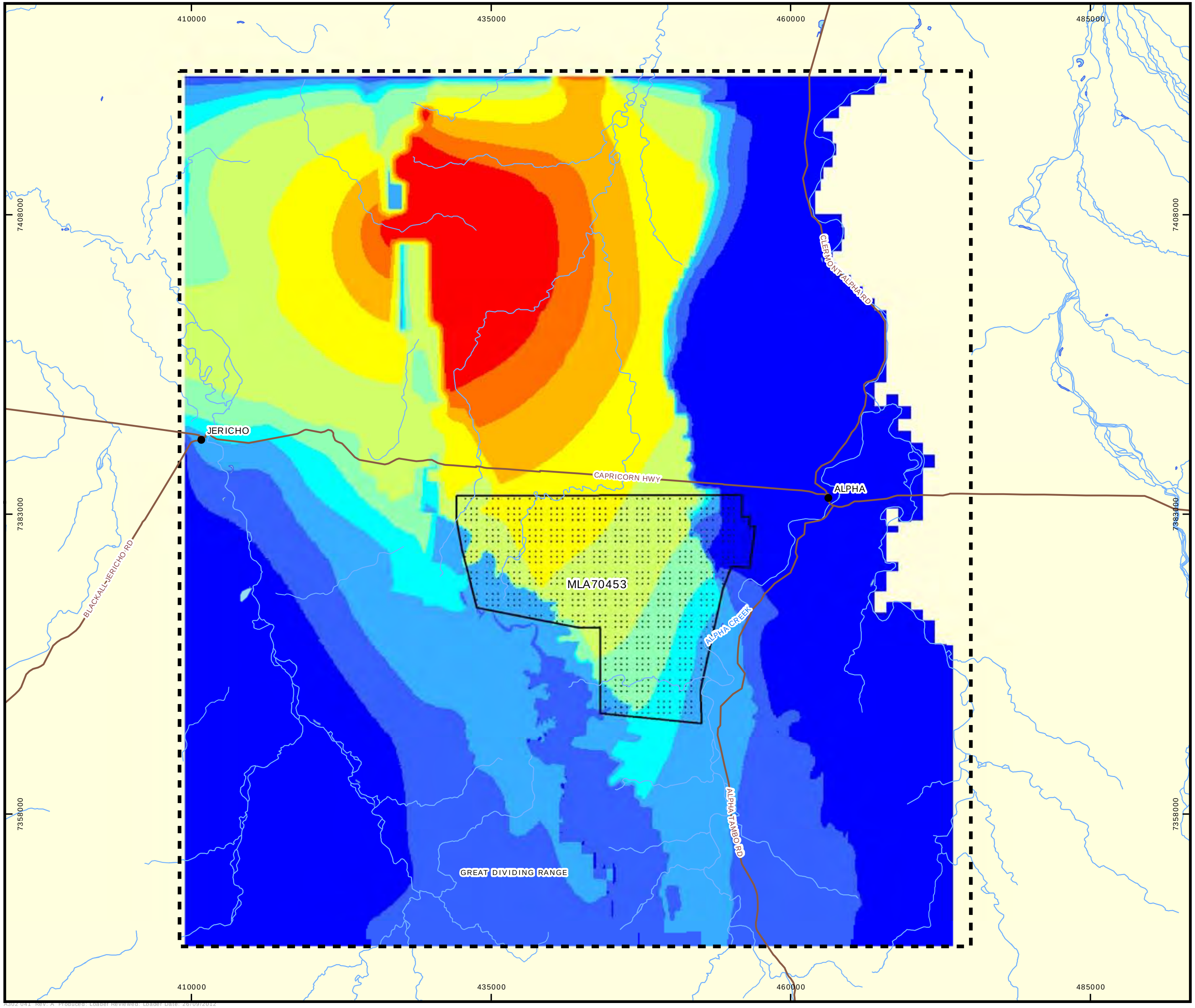
DATA SOURCES
SRTM
Geoscience
RPS

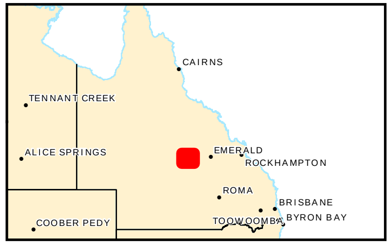
RPS Aquaterra

FIGURE G.25

Predicted drawdoen in Layer 1 after 33 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 184

5 0 5 10
Kilometres

APPROX SCALE 1:450,000 @ A4

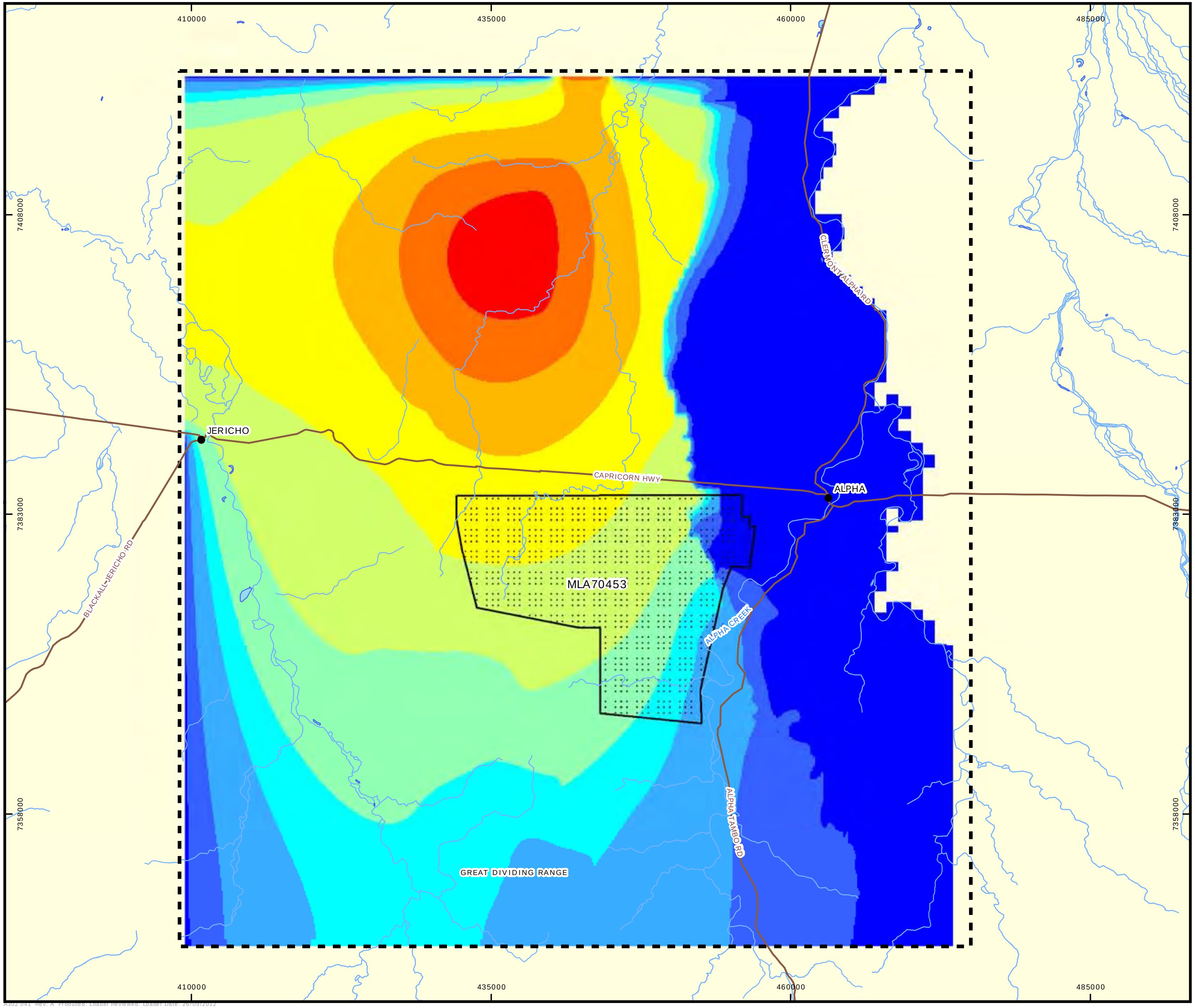
GDA 1994 MGA Zone 55

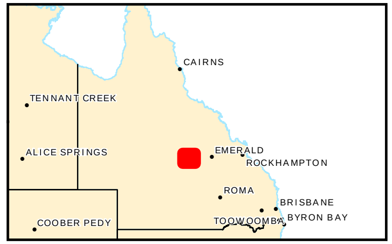
DATA SOURCES
SRTM
Geoscience
RPS

RPS Aquaterra

FIGURE G.26

Predicted drawdoen in Layer 2 after 33 years of mining (in-situ parameters)





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 127

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

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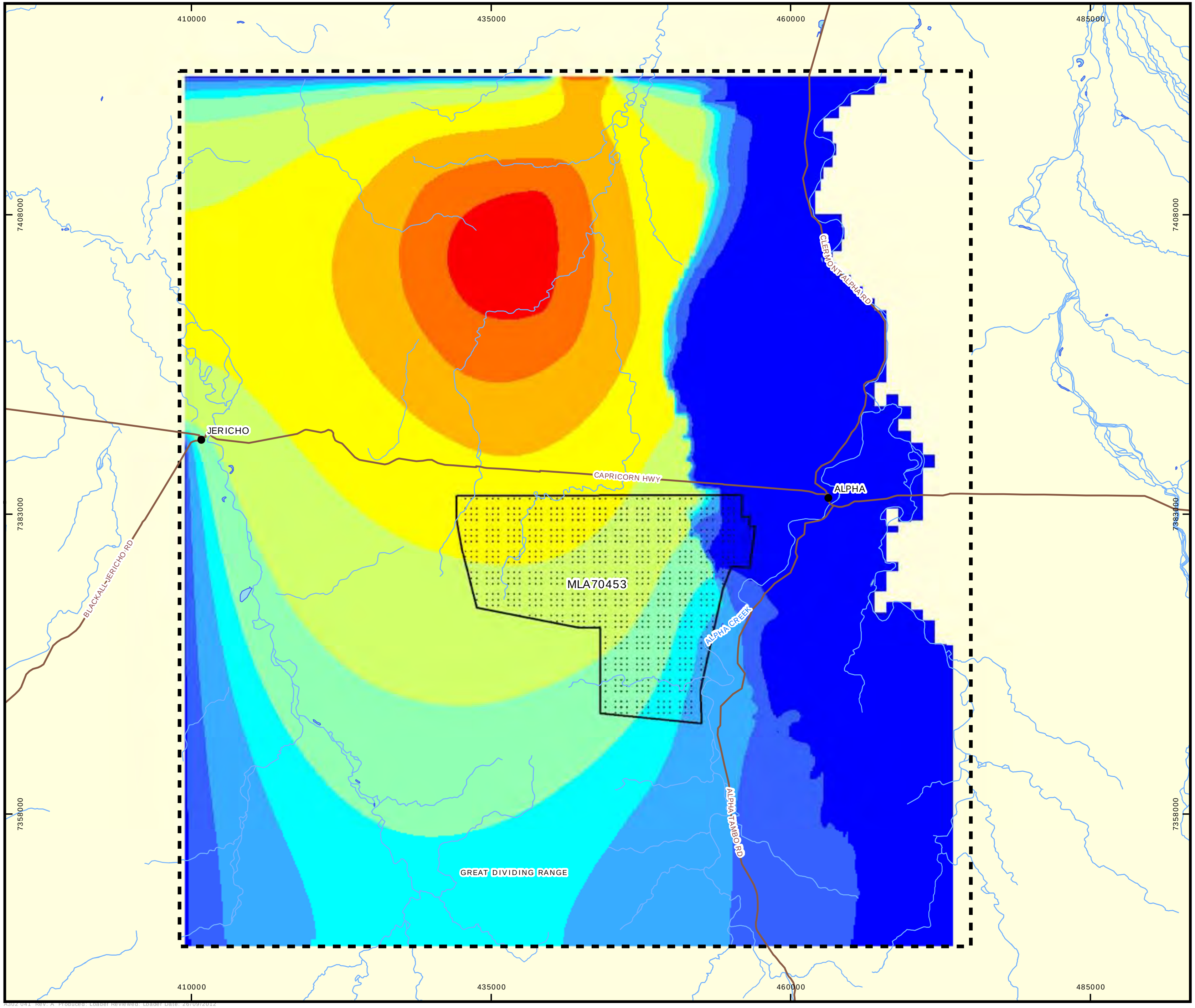
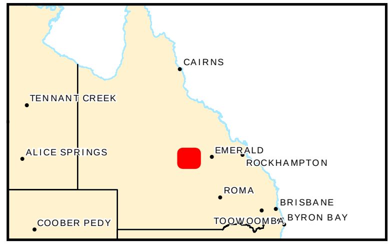
FIGURE G.27

Predicted drawdoen in Layer 3 after 33 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Drawdown (m)

- < 0.1
- 0.1 - 1
- 1 - 3
- 3 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 127

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

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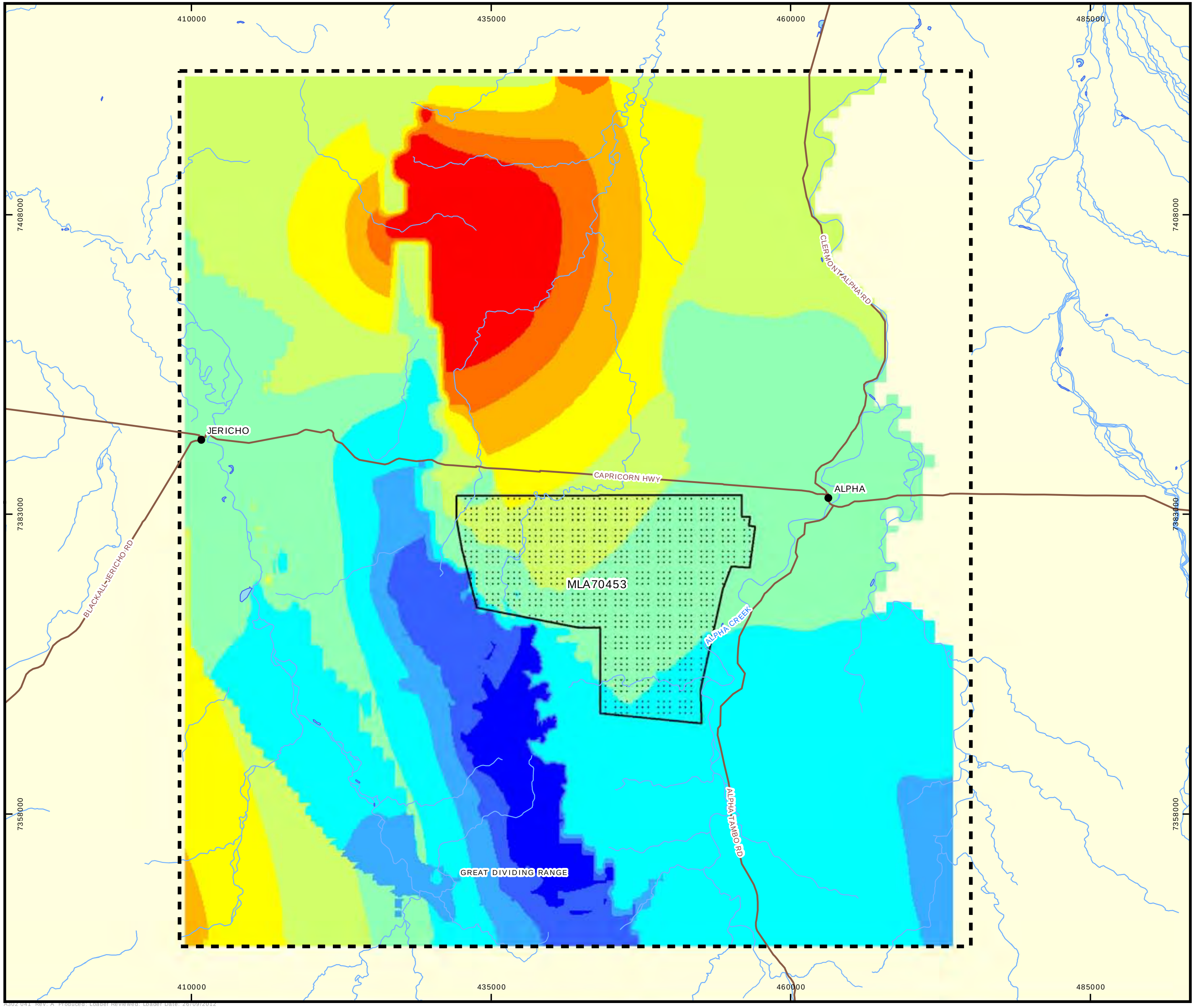
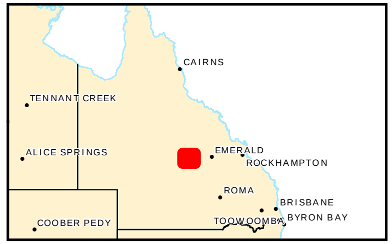
FIGURE G.28

Predicted drawdoen in Layer 5 after
33 years of mining (in-situ parameters)

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

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DATA SOURCES
SRTM
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RPS

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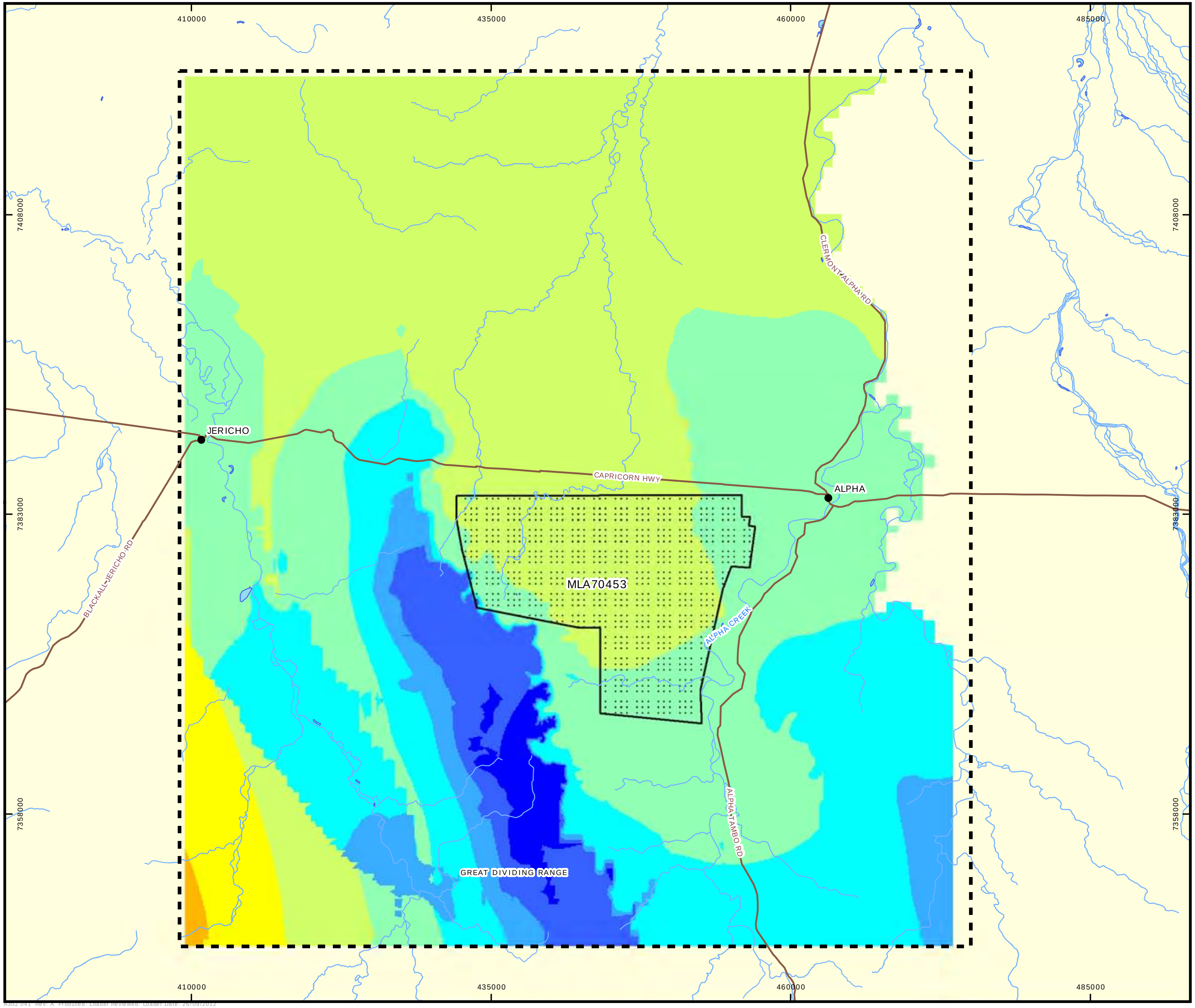
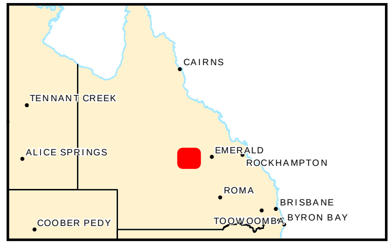
FIGURE G.29

Predicted Water Table
- End of Mining

A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012





LEGEND

- Locality
- Highways
- Rivers
- Model Extent
- Mining Lease Application Boundary

Watertable Elevation (mAHD)

- < 225
- 225 - 250
- 250 - 275
- 275 - 300
- 300 - 325
- 325 - 350
- 350 - 375
- 375 - 400
- 400 - 425
- > 425

N

5 0 5 10

Kilometres

APPROX SCALE 1:450,000 @ A4

GDA 1994 MGA Zone 55

DATA SOURCES
SRTM
Geoscience
RPS

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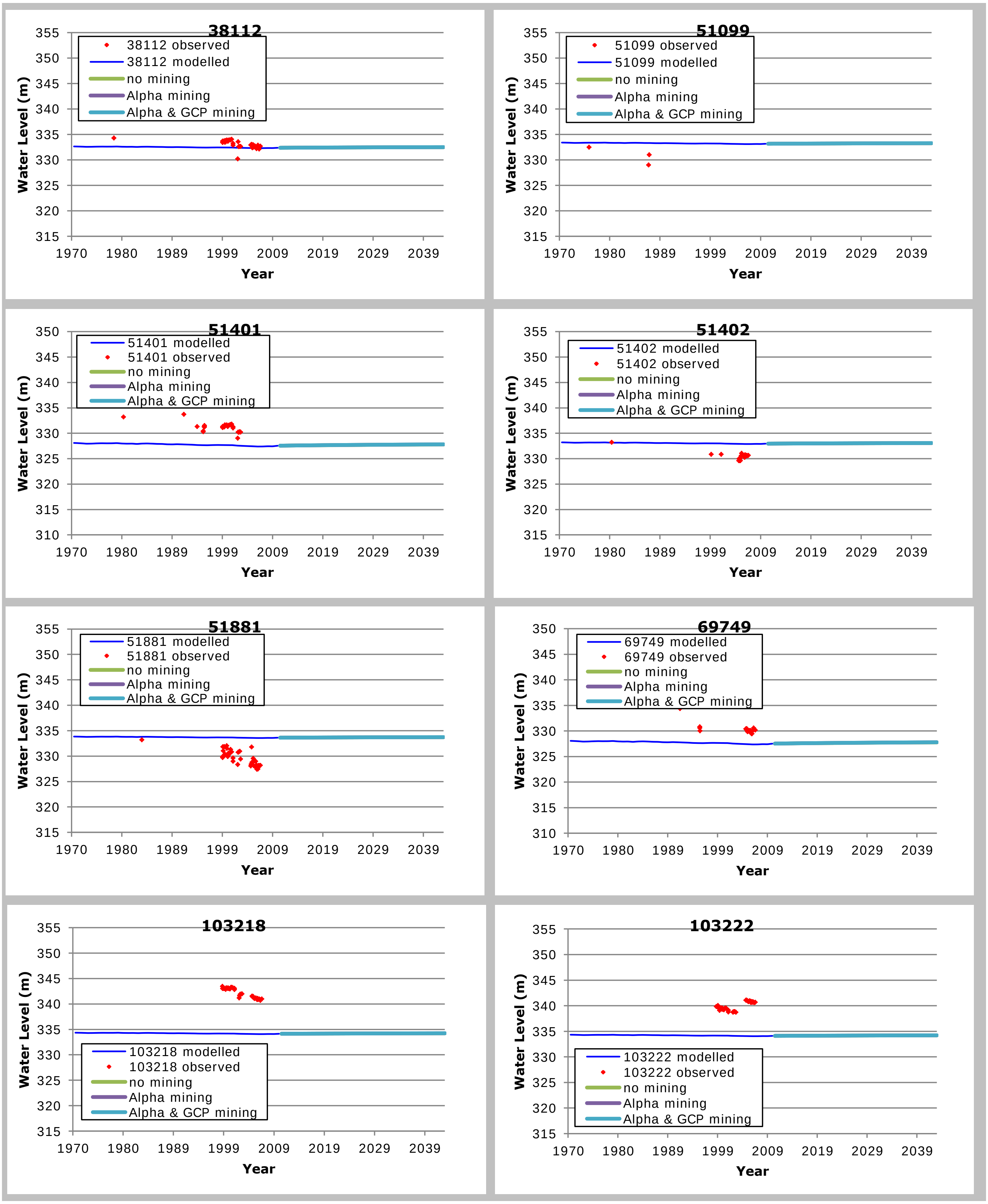
FIGURE G.30

Predicted Water table
- After 100 Years Recovery

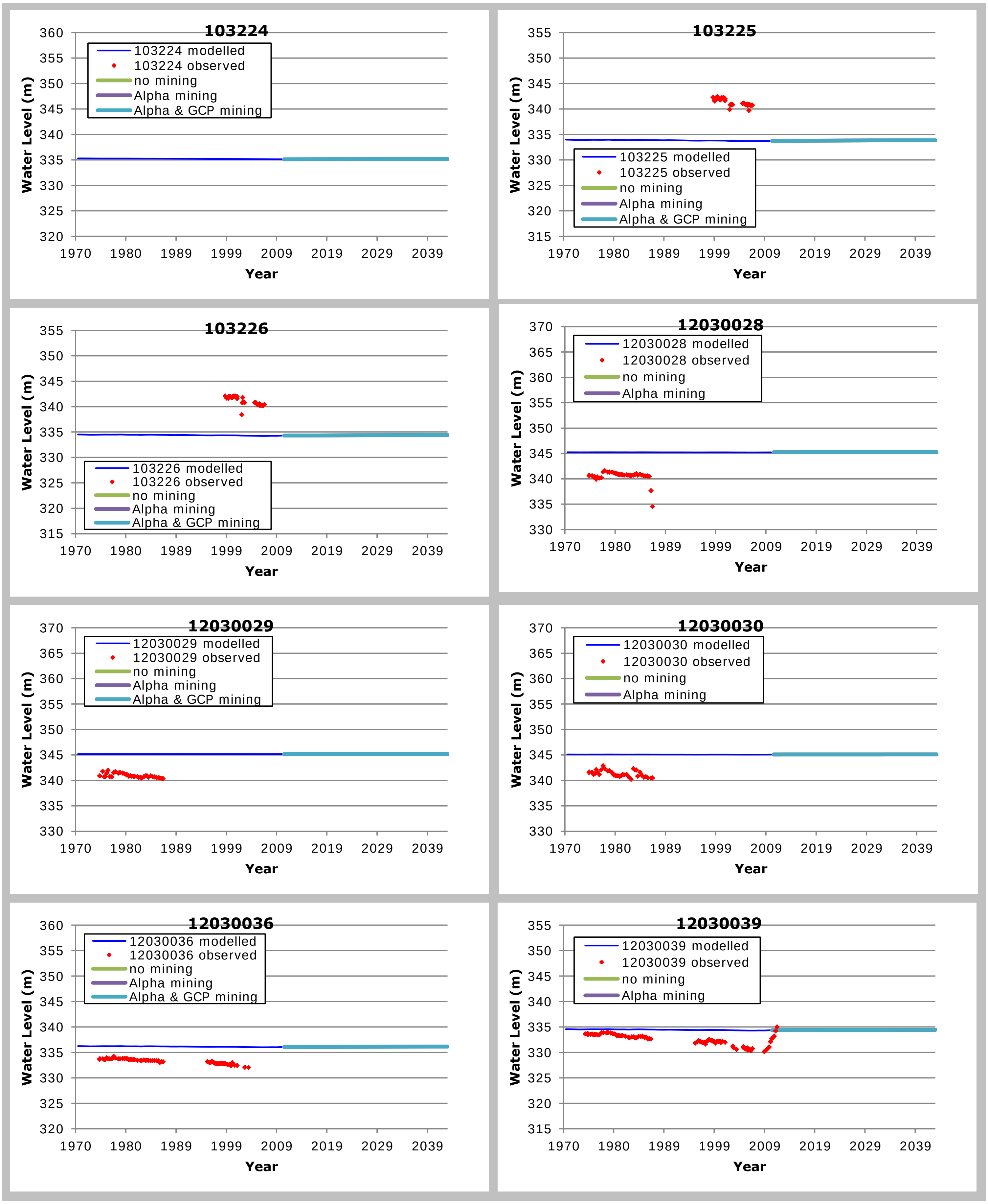
A302 041 Rev: A Produced: Loader Reviewed: Loader Date: 26/09/2012



RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.31

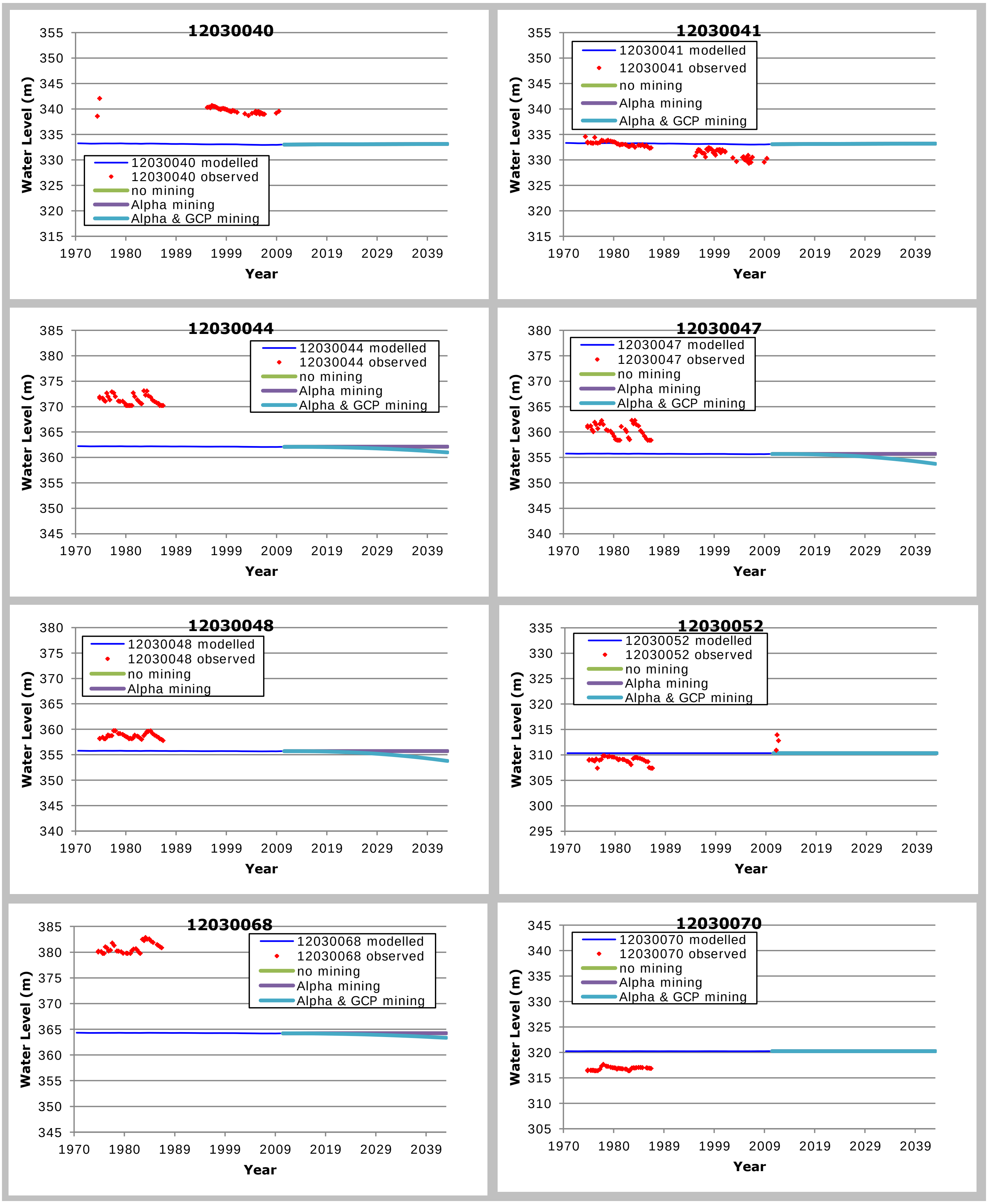
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_01



RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.32

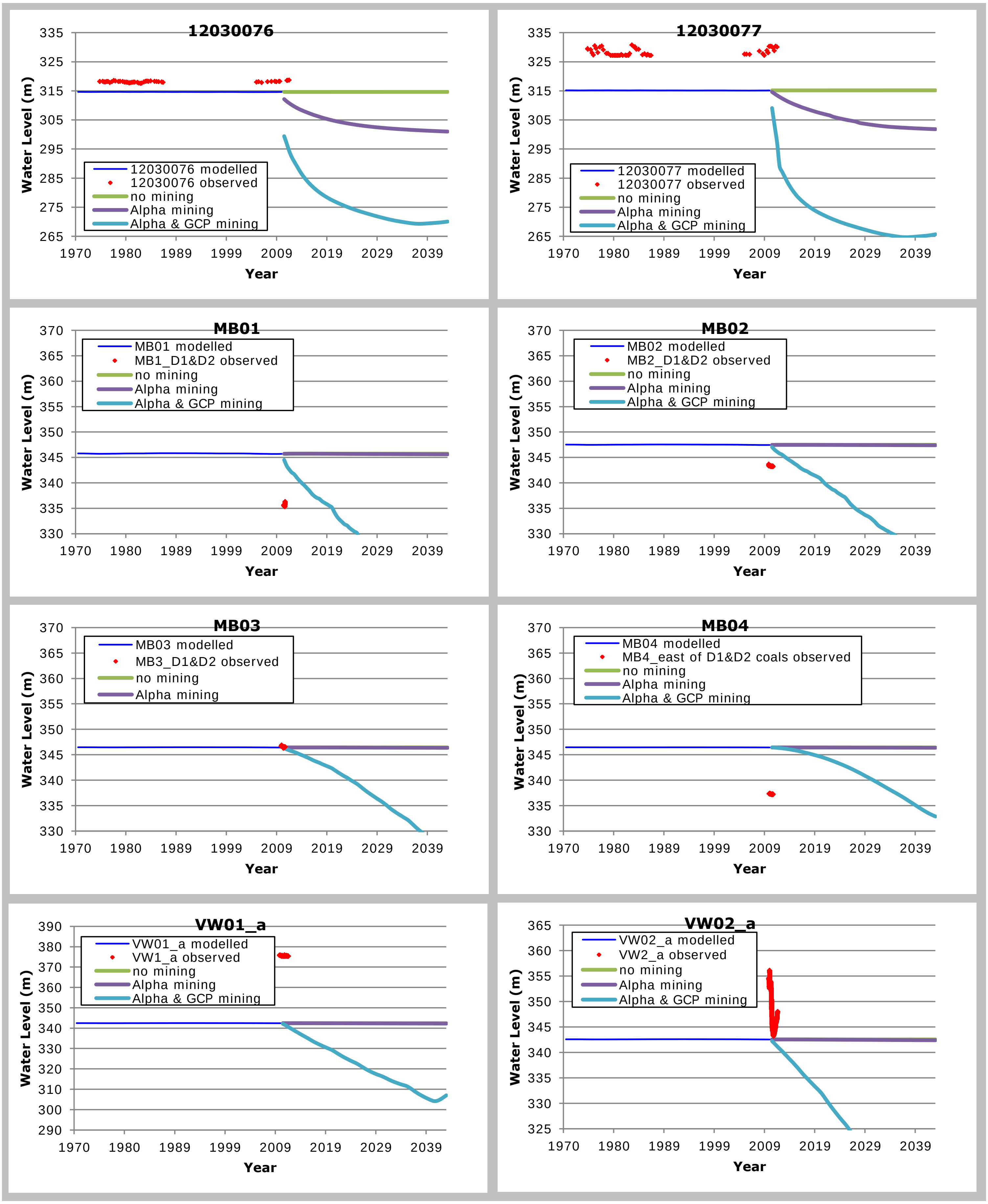
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_02



RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.33

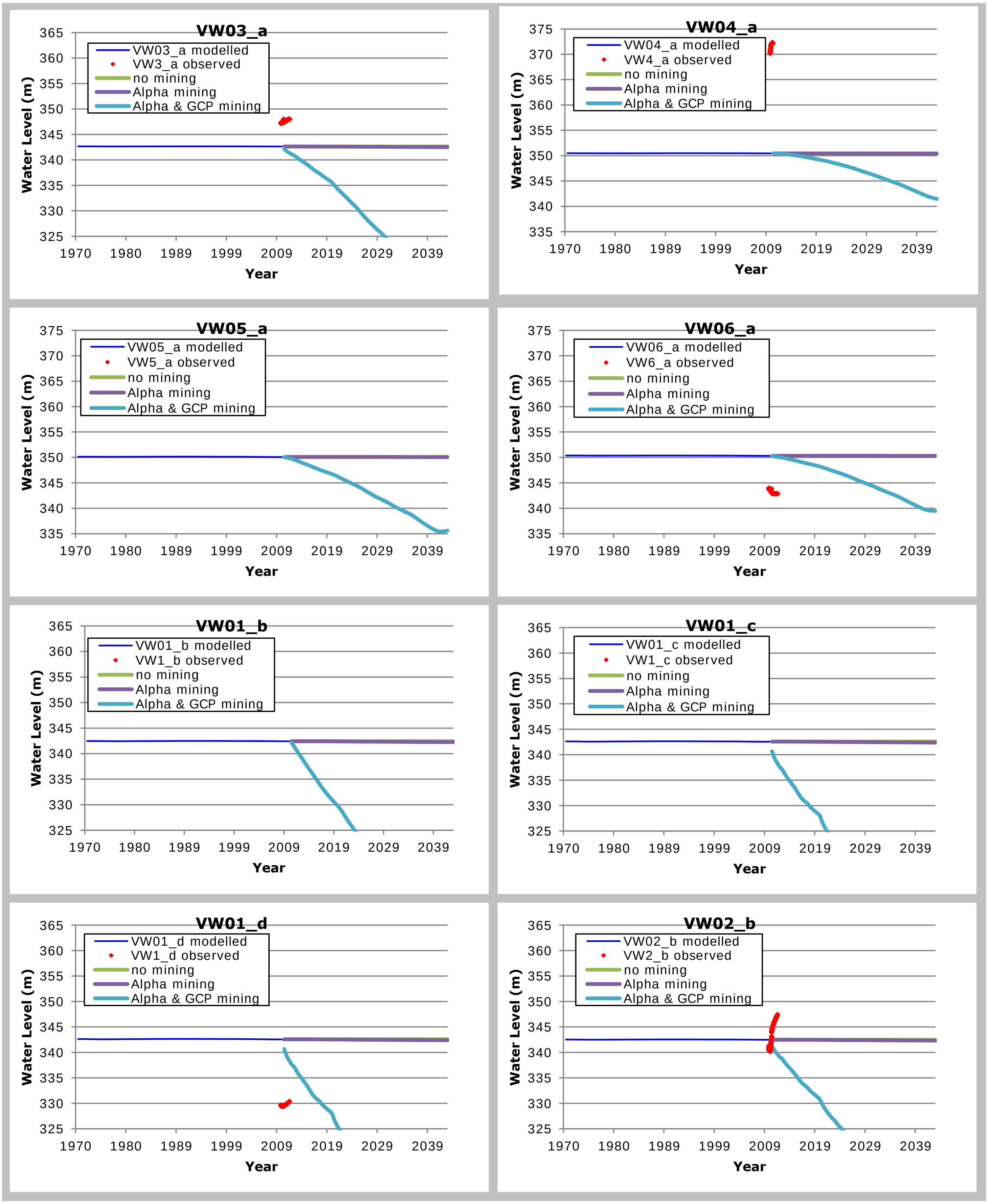
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_03



RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.34

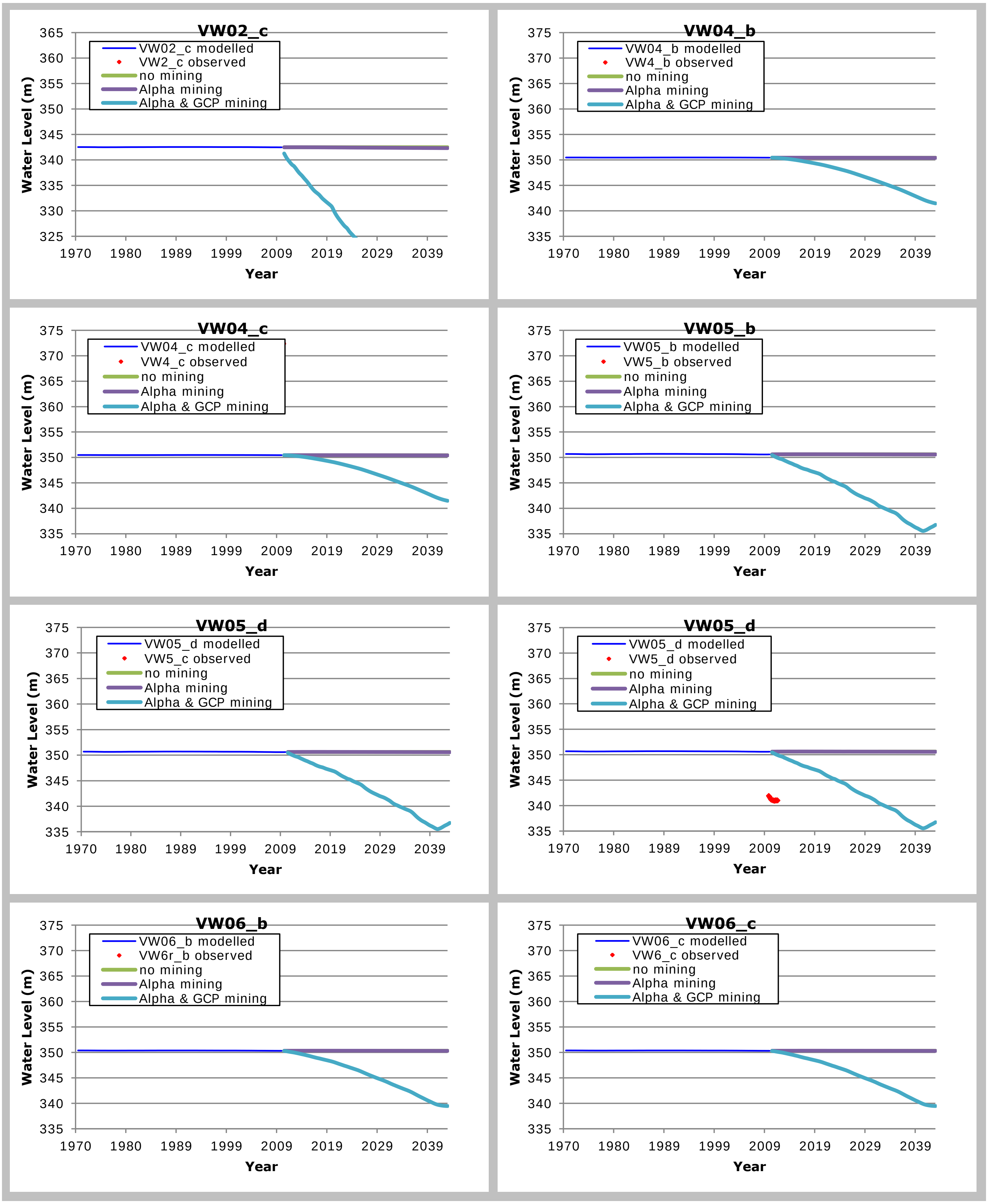
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_04



RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.35

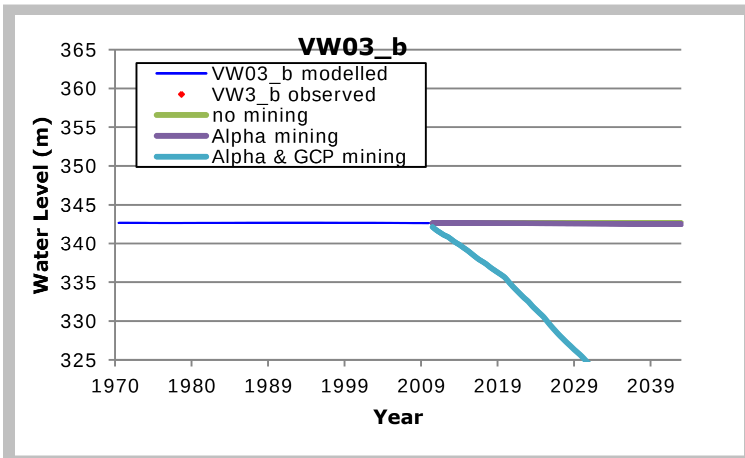
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_05

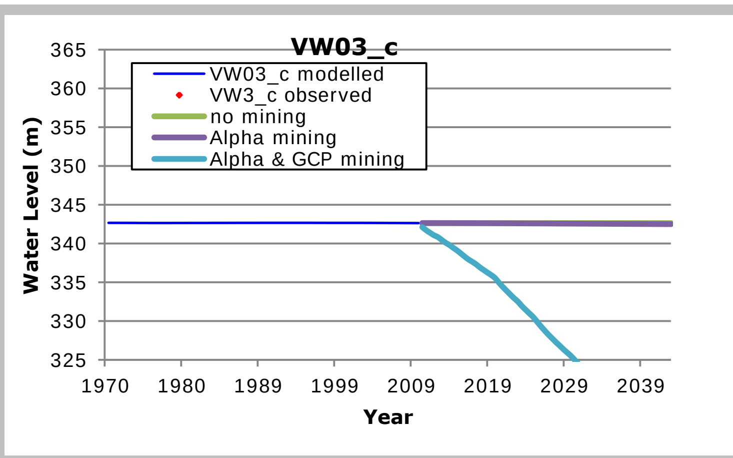


RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.36

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_06

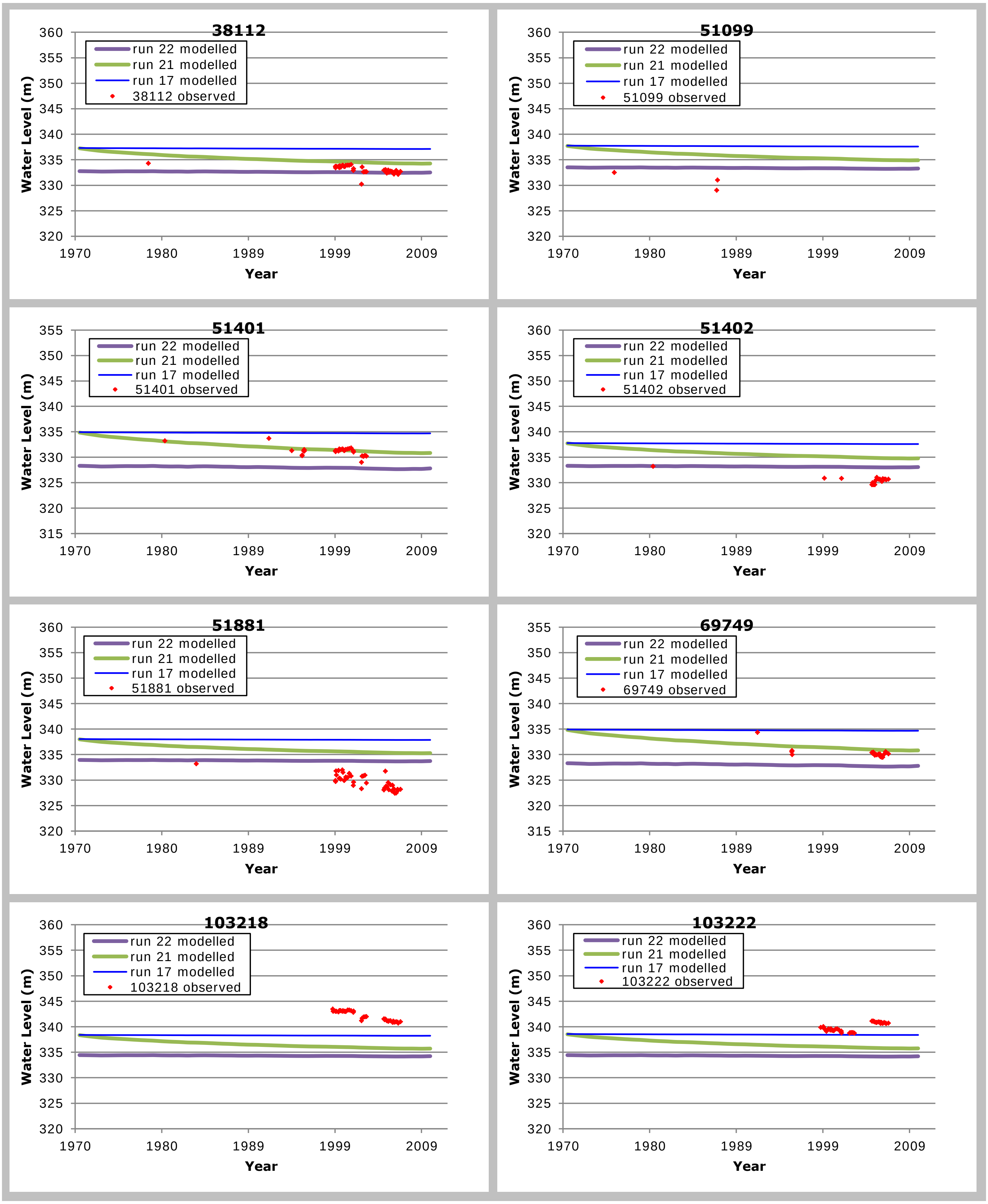




RPS Aquaterra

SOUTH GALILEE MINE IMPACT UNPACKING PREDICTIONS - FIGURE G.37

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_mine_impact_unpack_calib_pred.xls]Figure_07



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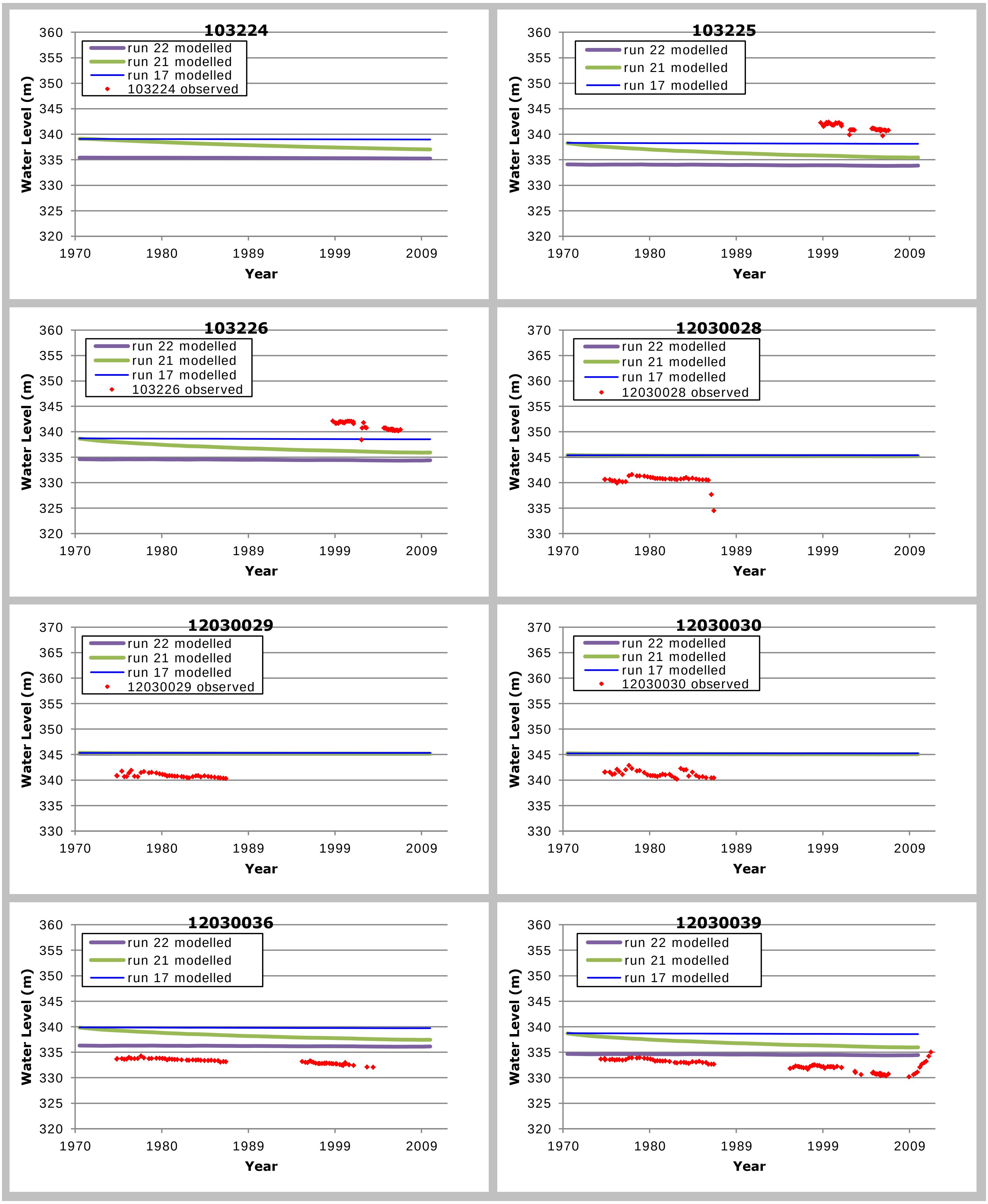
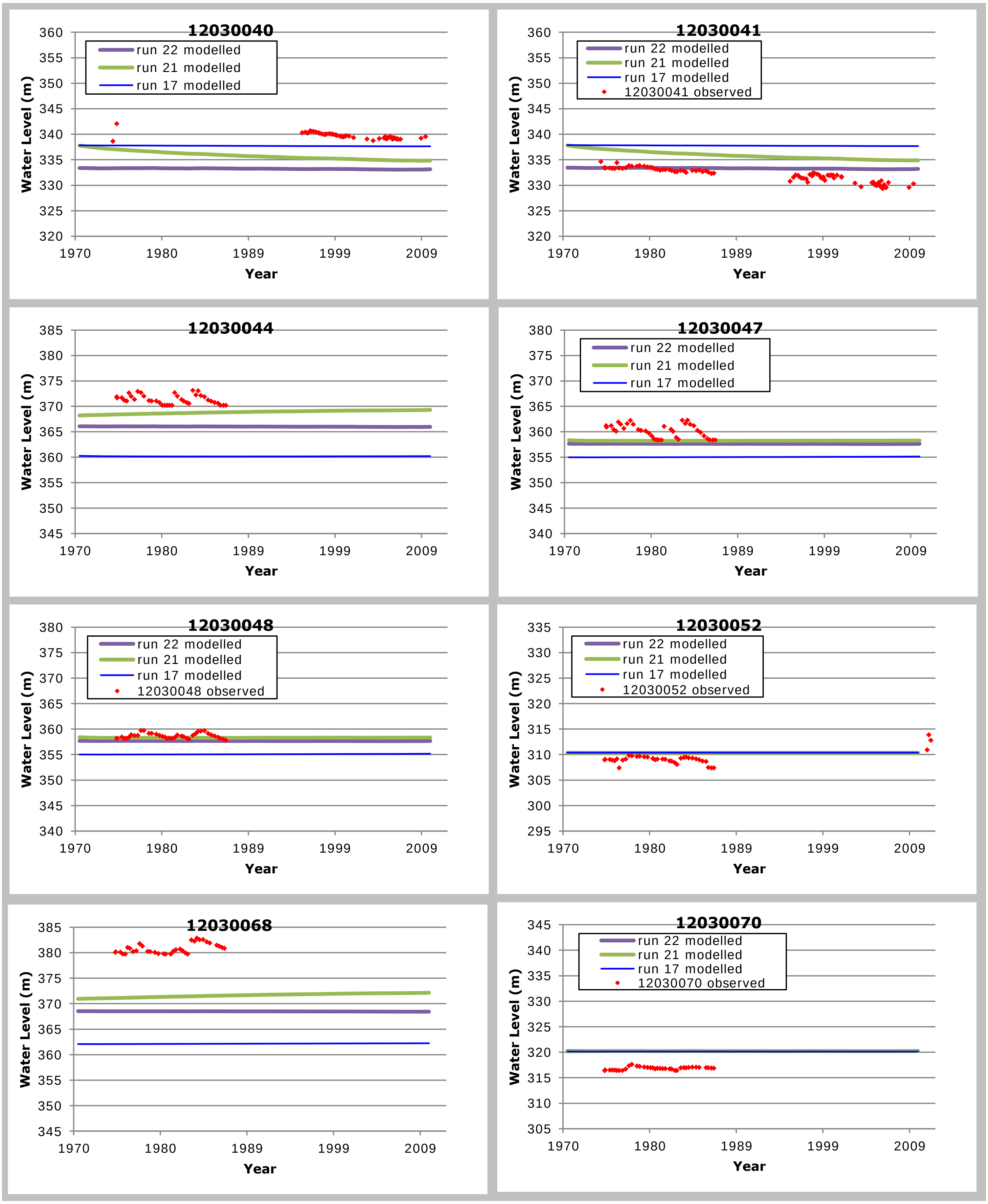
SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.38

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_01



SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.39

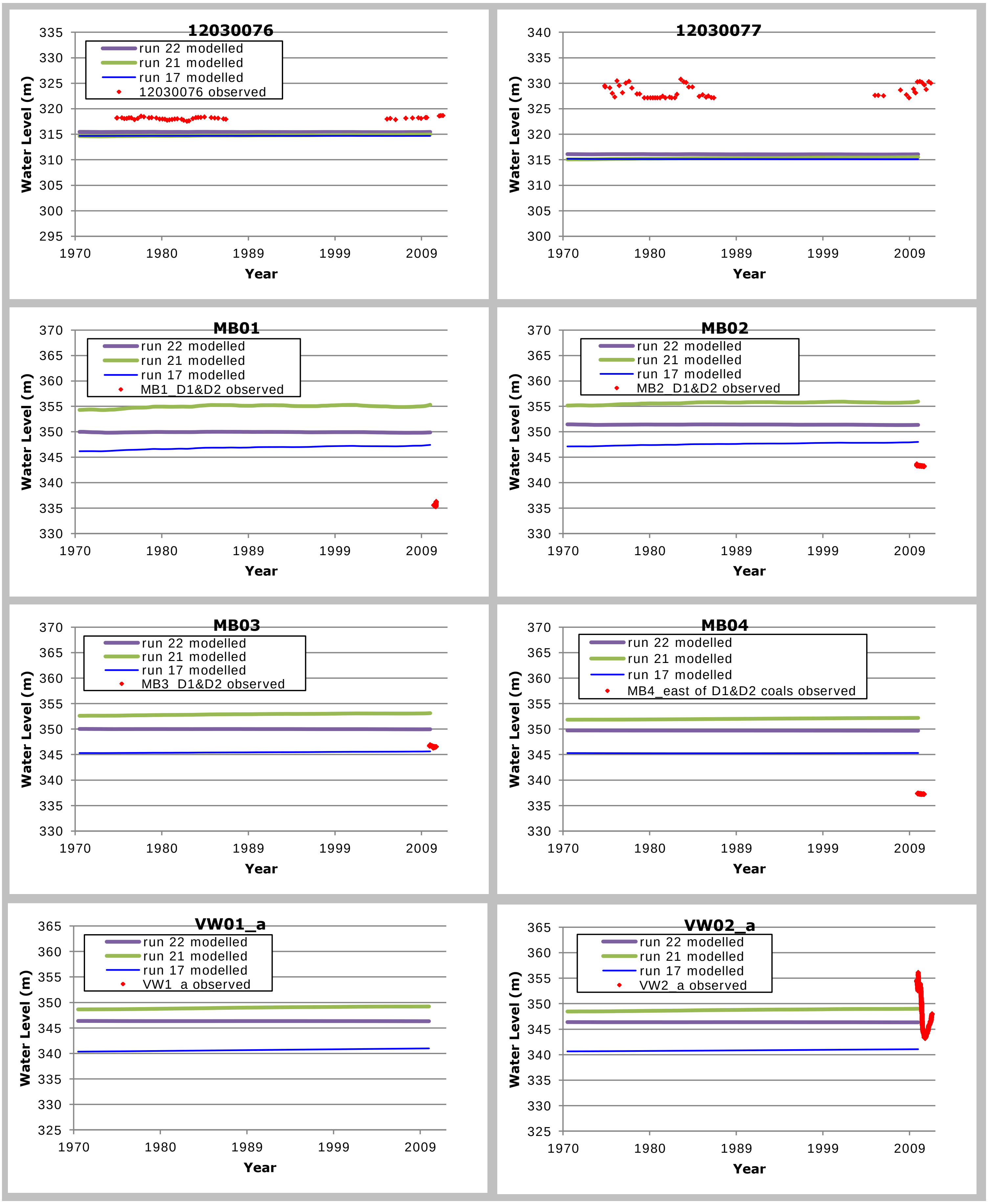
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_02



RPS Aquaterra

SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.40

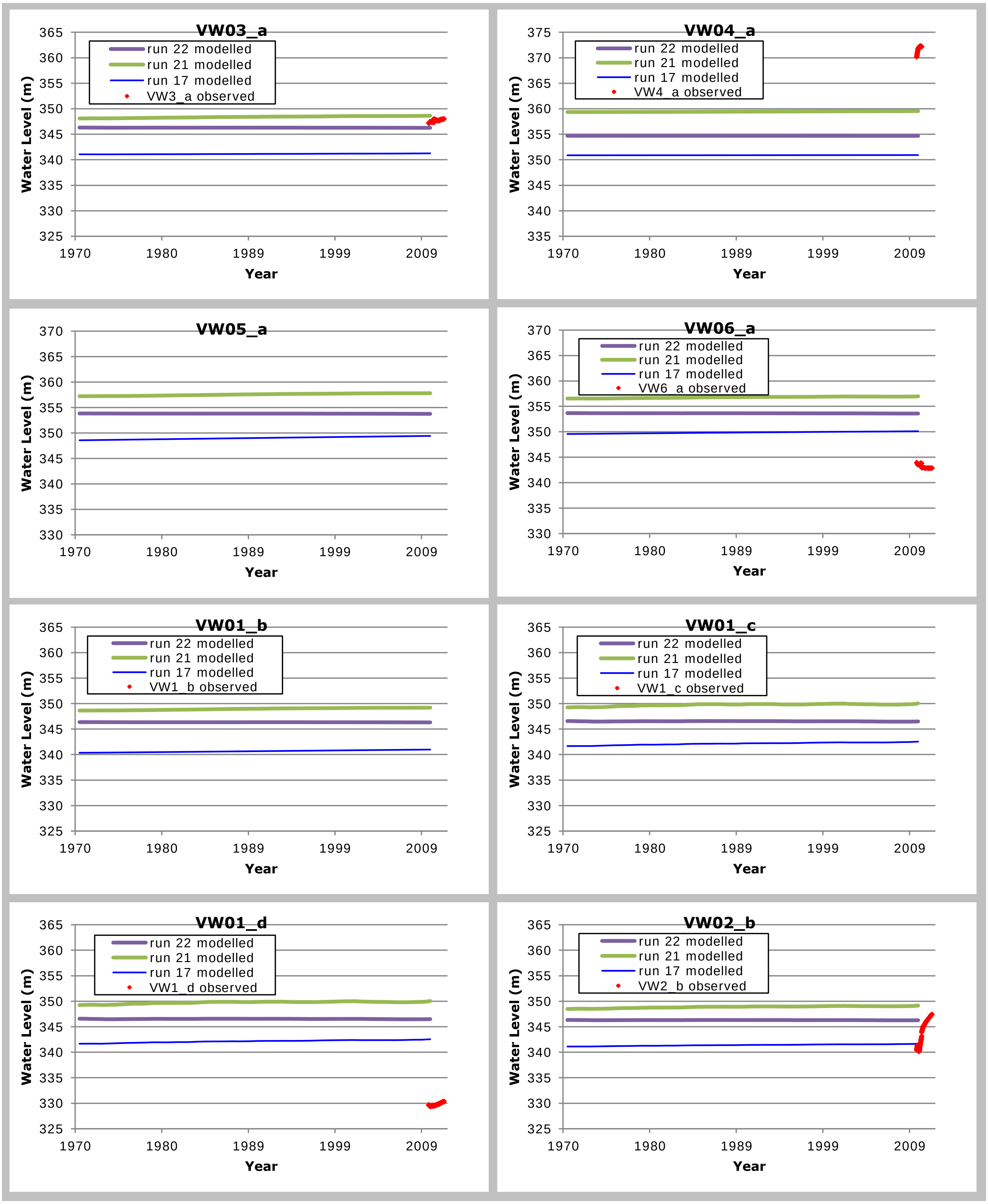
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_03



RPS Aquaterra

SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.41

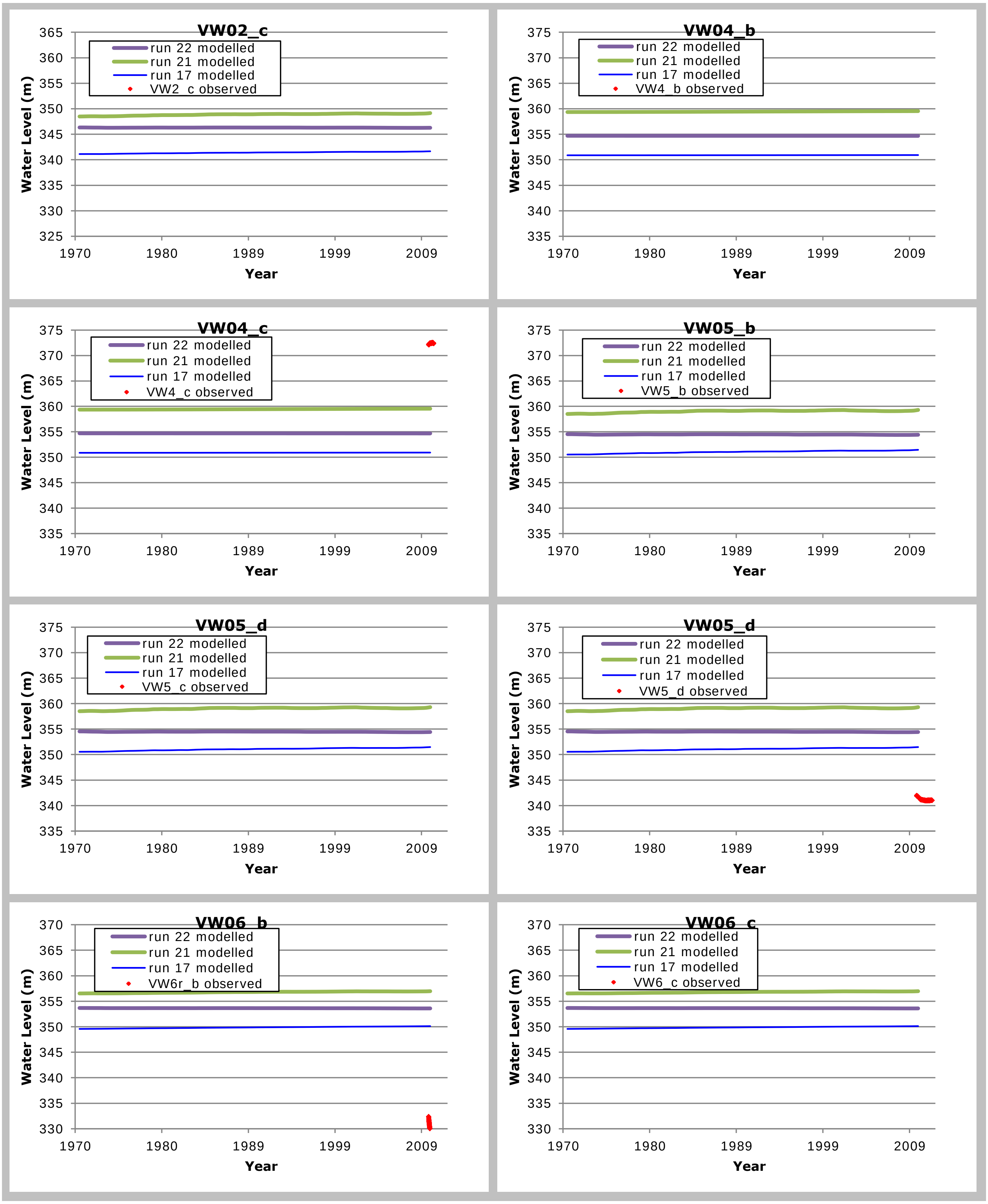
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_04



RPS Aquaterra

SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.42

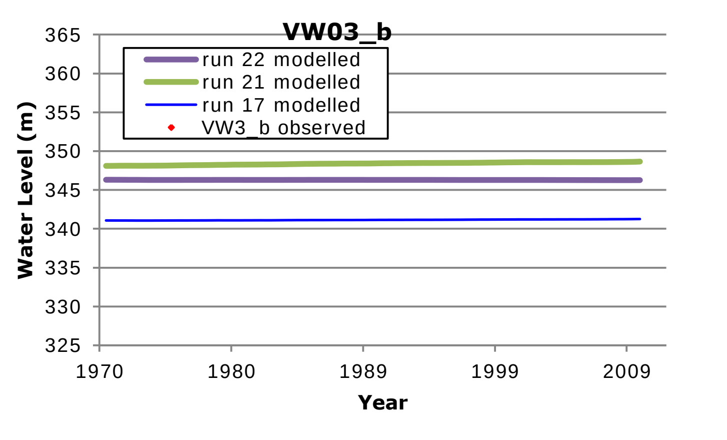
F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_05

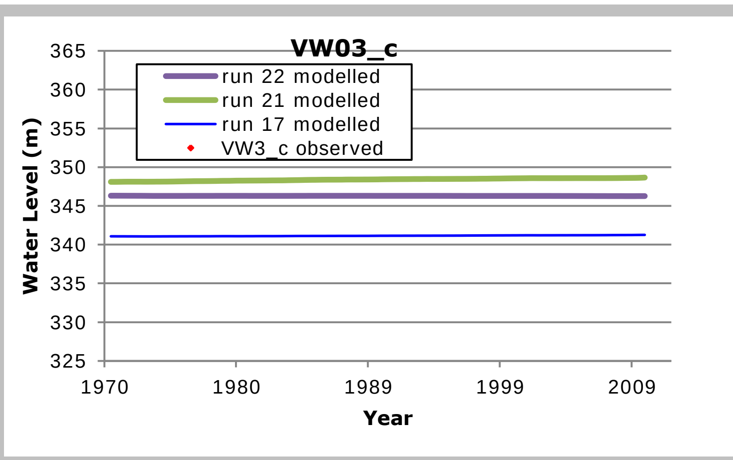


RPS Aquaterra

SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.43

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_06





RPS Aquaterra

SOUTH GALILEE SENSITIVITY ANALYSIS - FIGURE G.44

F:\Jobs\A302C\300\Model_Output\Run25\[auto_hydrographs_run25_calib_sensitivity.xls]Figure_07