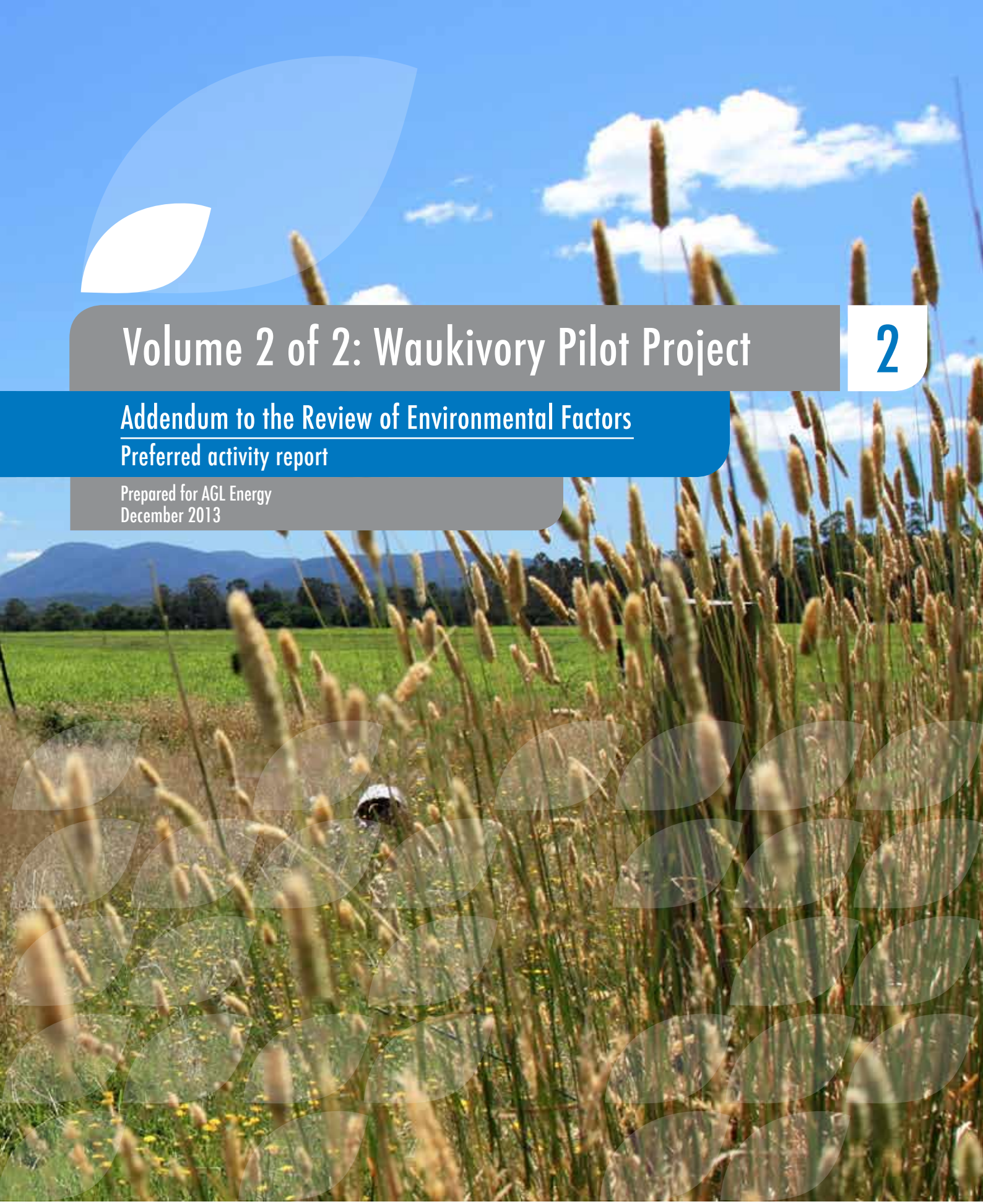

Volume 2 of 2: Waukivory Pilot Project

2

Addendum to the Review of Environmental Factors

Preferred activity report

Prepared for AGL Energy
December 2013

AGL Energy in action.

EMM
EMGA Mitchell McLennan

Volume 1 of 2:
Waukivory Pilot Project – Addendum to the Review of Environmental Factors
PAR Chapters 1 to 12

Volume 2 of 2:
Waukivory Pilot Project – Addendum to the Review of Environmental Factors
PAR Appendix A to E

Appendix A

HDD - Fluid Management Plan

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HDD – Fluid Management Plan

		Publish Date	30/08/2013
Division:	Drilling		
Approver:	KEIRAN FETTERPLACE		
Maintainer:	Site Supervisor/ Contractor		

00	30/08/13	Initial submission	**KF** QA Manager		**KF** Project Director
REV	**DATE**	**DESCRIPTION**	**PREPARED BY**	**CHECKED BY**	**APPROVED BY**

1 INTRODUCTION

It is recognised by Fetterplace Civil that the consequences of uncontrolled losses of drilling fluids could potentially have negative impacts on the surrounding environment.

This HDD-Fluid Management Plan (HDD-FMP) addresses the following issues:

- The Purpose and Properties of Drilling Fluid;
- The Use of Drilling Fluid during a Horizontal Directional Drilling (HDD) operation;
- The Possible Paths by which Drilling Fluid could be lost to the environment;
- Safeguards Fetterplace Civil will put in place to minimise the chance of Drilling Fluid being lost to the environment;
- Inspection Procedures Fetterplace Civil will implement to ensure the safeguards are adequately maintained;
- Drilling Fluid Volume Tracking Procedures to ensure that drilling fluid volumes are being checked;
- Drilling Fluid Loss Response Management Procedure that will be used if Drilling Fluid Loss has been detected;
- Management of ground water ingress.

The implementation of this Management Plan will:

- Ensure all practical safeguards are put in place to minimise the chance of Drilling Fluid being lost to the environment.
- Inspection Procedures will be in operation to maintain the integrity of the safeguards.
- Volumetric Drilling Fluid Tracking Procedures will be in operation to ensure that any Drilling Fluid lost or gained is detected and action is taken.

2 DRILLING FLUID

Drilling Fluid is a major factor in the success of any directional drilling program, and as such deserves careful consideration.
The principal functions of the drilling fluid during a successful HDD operation are:

- To drive down hole motors, drill bits and reamers.
- To remove the cuttings from the bottom of the hole and carry them to the entry point.
- To cool and lubricate the drill string and drill bit.
- To line, support and protect the walls of the hole.

For a HDD operation, the fluid demands are different from those required for drilling vertical wells. Hole cleaning ability or the ability of the drilling fluid to suspend cuttings is a much more critical factor for HDD. Gel strength is the measure of this property.

For HDD, low viscosity and high gel strength are required to ensure the cuttings are effectively suspended in the slurry and returned to the entry point. For this operation we will be using the following products to mix the Drilling Fluid and guarantee these properties are met:

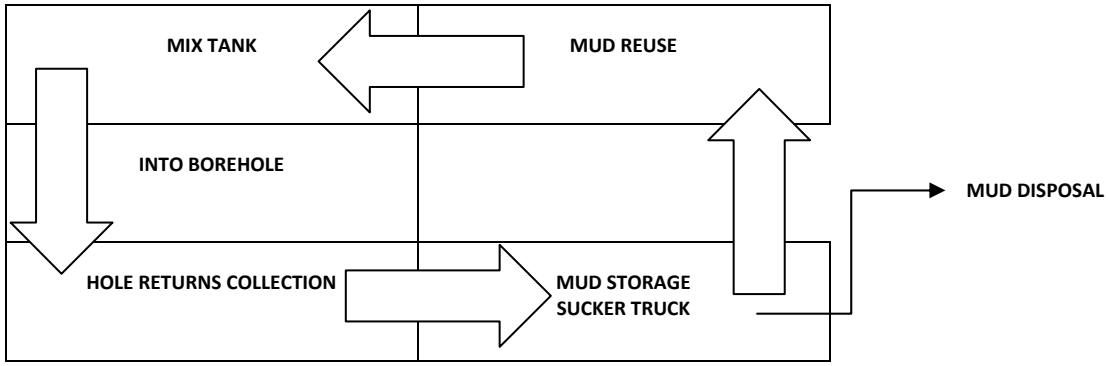
- BENTONITE
- EZ-MUD GOLD
- BORE-GEL

These products produce a drilling fluid with low viscosity, high gel strength and sufficient Bentonite content. The Bentonite content of the drilling fluid is critical for drilling boreholes through rock. The fine particles of Bentonite form a thin, low-permeability filter cake around the walls of the borehole. This filter cake seals the pores and other openings in rock preventing the escape of drilling fluid through the rock and the inflow of formation fluids. Soda ash is sometimes used in small quantities to treat out calcium hardness and/or raise PH, it reduces the amount of mud material required after water treatment.

The Material Safety Data Sheets (MSDS's) for these products will be kept on site. BENTONITE and EZ-MUD GOLD have been classified as not hazardous according to the criteria of Worksafe Australia. BORE-GEL Contains HAZARDOUS SUBSTANCES crystalline silica, tridymite 0 – 1%, crystalline silica, cristobalite 0 – 1% and crystalline silica, quartz 1 – 5%.

3 DRILLING FLUID CIRCULATION

It is important to gain an understanding of how drilling fluid is circulated during horizontal directional drilling; to better understand the safeguards and inspection procedures intends to implement to manage drilling fluid during the drilling operations.



For actual locations of the mud circulation equipment refer to the site layout drawings. (Provided separately)The drilling fluid circulation diagram shows the mud getting mixed in the mixing tank, once the mud has been mixed adequately it is transferred to the active tank, from the active tank the drilling fluid is pumped to the drilling rig, through the drill pipe, into the borehole and onto the cutting face, the drilling fluid then suspends the cuttings and travels out of the borehole and into the borehole returns collection. The

borehole returns is positioned directly behind the hole entry point. From returns collection the mud shall be pumped to the sucker truck tank or recirculated.

This drilling fluid recirculation system produces a great assurance against mud overflow to the environment because of the closed circuit drilling fluid recirculation system. The site set up plans should be referred to for containment facilities such as the site sedimentation fencing, sumps & bunds as this plan only refers to directional drilling related controls.

Management of excess drilling mud will either be on site through beneficial reuse in accordance with the EPA general exemption for treated drilling mud or disposed at an appropriately licenced facility.

4 HAZARD PATH IDENTIFICATION

To assist in reducing the risk of drilling fluid escaping to the environment Fetterplace Civil has identified the following paths by which it is possible that drilling fluid could enter these sensitive areas.

- Runoff or surface water could escape the drilling compound during periods of rainfall.
- Drilling Fluid could escape the drilling compound and potentially find its way into the environment.

  Drilling Fluid could potentially escape the borehole during drilling through unconsolidated formation and/or discontinuities (cracks & fissures) in the rock. This could result in drilling fluid being deposited into underground aquifers or breaking out to the surface or surfaces waters.
- Groundwater or surface water could seep into the borehole during the drilling operation. This ingress will result in increased drilling fluid volume and could cause drilling fluid containment facilities to become filled to capacity and possibly overloaded.
- Loss of fluid from mobile tanks during removal from site to waste disposal centre

These are the only paths by which drilling fluid could be potentially lost to the environment. Therefore it is the goal of this Management Plan to minimise the chance of drilling fluid escaping via these paths through the use of safeguards and the implementation of inspection procedures.

5 SAFEGUARDS

This section deals with the safeguards that Fetterplace Civil intends to use during the execution of this project, to control the previously identified potential drilling fluid escape paths.

REFERENCE	HDD-FMP Safeguard	Responsibility

Drilling Compound Runoff Groundwater Mixing With Drilling Fluid **Surface and groundwater Mixing With Fuel/Oil/Grease**	Where required diversion earth bunds and drainage channels will be placed around the upper edges (upslope) of the drill sites and work areas, to divert natural runoff around and away from the sites so that it doesn't mix with drilling compound runoff. This concentration of the flow will require erosion and sedimentation control measures to be in place. All facilities utilised in the surface mud handling (mixing, cleaning & pumping) shall be bunded. This shall ensure natural / clean runoff contained within the compound is not mixed with drilling fluid or contaminated by oil/fuel/grease. Safety fencing, Sediment fencing and earth bund and/or sand bag base will be placed around all open sump pits to contain any spillage. Any pits will be pumped out into the mud system at the end of drilling each day. This will ensure that given a rain event, there will be sufficient freeboard to accommodate rainfall, thereby preventing mud overflow. All products used to mix the drilling fluid will be covered before they are used to mix the drilling fluid. The unmixed drilling mud shall be stored dry on pallets keeping them off the ground and not stored within drainage lines. This will prevent the chance of any drilling fluid components escaping the drilling compound and becoming contaminants to the environment. All stationery plant & equipment on site is inspected on a daily basis to ensure it is in good working order to minimise the chance of fuel/oil/grease leakage. Spill control kits containing absorbent materials, to cleanup spills from mobile equipment shall be on site at all times. All excess oils and greases shall be contained within a purpose built Oil storage container in order to prevent any chance of leakage.	F/C F/C F/C F/C F/C F/C F/C F/C

	All used oil or grease taken from machinery during services is stored within a controlled bund or taken off site. The mud return lines are to be tested before use to ensure the integrity is ok. The pipe will be regularly inspected to ensure no leaks of mud. Mud return lines shall have flanges removed before being pulled from vegetation / crossing site	
Ingress of Groundwater or Surface Water	Borehole annulus may be grouted post pipe installation if groundwater inflow is observed or determined to be a problem. The geotechnical investigation report shall be referred to during design to confirm standing water levels prior to drilling commencing. Drilling fluid "make" (ie ingress of ground water or surface water) onsite shall be monitored (in accordance with the Drilling Fluid Volume Tracking Procedure as detailed in Section 7) to ensure early intervention using weighting material agent and or grouting.	F/C
Downhole Fluid Loss To Formation Or Surface (including to Surface Waters)	By designing the drill profile using the necessary information Fetterplace Civil can be confident that an adequate amount of cover can be provided beneath the surface. The careful selection of the cover minimises the chance of encountering any inconsistencies (cracks and fissures) in the underlying formation through which drilling fluid could escape. There will be a minimum of 2m cover below water courses. Watercourses will be monitored by an observer for visual triggers such as changes to turbidity or other visible disturbance to in the unlikely event that a breakthrough occurs. The products selected to mix the drilling fluid have been carefully selected to provide the drilling fluid with sufficient Bentonite content. The Bentonite content of the drilling fluid will ensure a thin, low-permeability filter cake forms on the walls of the boreholes. This will mitigate drilling fluid losses through the walls of the boreholes.	F/C F/C

Seepage Into Ground	Chances of drilling fluid seeping in the ground through storage pits (returns pits & sump pit) is extremely unlikely. The drilling fluid provides a filter cake within the boreholes and this process will also provide an impermeable barrier within the pits hence stopping fluid from seeping into ground.	F/C

Any spills must be contained, reported and cleaned up under the guidance of the Fetterplace Civil site manager.

6 INSPECTION PLAN

This section deals with the inspection procedures by which Fetterplace Civil intends to implement

REFERENCE	HDD-FMP Inspection Procedure	Responsibility
Drilling Compound Runoff	Where required diversion earth bunds and drainage channels placed around the edges of the drilling compounds will be inspected on a daily basis and/or during & after any significant rain event to ensure their adequacy and integrity. Before the commencement of drilling and at the close down each day, all components of the mud circulation system will be visually inspected to check for signs of drilling fluid loss and to ensure its adequacy for the containment of drilling fluid. All valves shall be closed.	F/C F/C F/C
Ingress of Groundwater or Surface Water	The Drilling Fluid Volumetric Tracking procedure) shall be utilised. This tracking procedure will be regularly updated to ensure that any ingress of groundwater into the borehole is quickly detected.	F/C
Down hole Fluid Loss To Formation Or Surface (including Surface Waters)	The Drilling Fluid Volumetric Tracking procedure shall be utilised. This drilling fluid tracking procedure will be regularly monitored and recorded to ensure any down hole fluid loss to the ground is quickly detected.	F/C
Mud Return lines	The mud return lines are to be visually inspected for leaks during operation.	F/C

7 DRILLING FLUID VOLUME TRACKING PROCEDURE

The drilling fluid volume tracking procedure for the drilling operations is quick and easy. It has been designed this way so that regular and accurate checks can be made throughout each day to ensure that any water (ground or surface) ingress or down hole drilling fluid loss is detected quickly. This will minimise the volume of any drilling fluid loss from the compounds due to overload of containment facilities (i.e. groundwater ingress) or drilling fluid loss to the ground through the borehole (i.e. down hole drilling fluid loss) and allow remediation activities to start promptly.

The drilling fluid tracking procedure involves a simple volumetric balance. That is, measuring the volume of drilling fluid mixed and comparing it to the volume that the drilling fluid is occupying (this is dependent of the length of hole drilled and the volume in surface containment facilities). These two values can readily be measured onsite and comparison of the values will quickly determine the volume of drilling fluid gained due to groundwater ingress or lost due to down hole fluid loss.

It is true that if groundwater ingress were to equal the down hole drilling fluid loss then the drilling fluid volume tracking procedure would not detect any loss. However this situation is extremely unlikely, during normal drilling operations we expect to be pumping between 6L/s to 30L/s of drilling fluid up the borehole whilst groundwater water ingress would be expected to be less than 1L/s.

The measurement of the drilling fluid volume mixed can easily be measured by making the assumption that the volume of drilling fluid produced is equal to the amount of water added to the drilling fluid tank. Taking into account a negligible difference between these two values due to the solid bulk of the Bentonite.

The theoretical volume that the drilling fluid is occupying is also a value that can be easily calculated. Two components contribute to this value. The first is the volume of drilling fluid occupying the drilled hole and the second is the volume of drilling fluid contained within the drilling fluid recycling system.

The volume of drilling fluid down hole is a simple calculation knowing the diameter and the length of hole drilled. The volume of drilling fluid contained within the drilling fluid recycling system can also be measured onsite easily. A measurement needs to be taken of the level of drilling fluid within both the drilling fluid tank and the drilling fluid return sump. Knowing these two values and knowing the dimensions of these containment vessels the volume can again be calculated easily.

Fetterplace Civil proposes to make this volumetric comparison regularly each day. A minimum of three checks shall be made each shift for the duration of drilling the pilot hole.
Should inconsistent ground material be found during drilling operations (this is possible due to the depth of profile beneath the ground and the geotechnical information supplied) the monitoring frequency will be increased to one reading for every 10m drilled.
The Drilling Fluid Tracking procedure checks shall form part of the Inspection and Test Plan.

8 DRILLING FLUID LOSS REPORTING SYSTEM

Note: it is important to understand that it is normal to expect some drilling fluid loss, during a horizontal directional drilling operation. Some losses are expected because the fluid is filling the borehole annulus (between the pipe and the bore walls), the fluid is lining the edges of the borehole and while recycling of fluids takes place, some losses are expected during the screening of cuttings.

Therefore it is important that normal drilling fluid losses are taken into account in the reporting system. The reporting system proposed for this project is summarised in the following table:

Drilling Fluid Loss	Situation	Action
0-15%	Normal	Continue Drilling One Reading in 30m drilled
15-25%	Alarm	Continue Drilling Increase Monitoring Frequency One Reading in 10m drilled
> 25 %	Abnormal	Cease Drilling Follow Drilling Fluid Response Plan

Drilling Fluid Loss 0-15%

The volumetric drilling fluid balance has shown 0-15% drilling fluid loss. It is normal to expect some drilling fluid loss during a HDD operation. The situation within this zone is quite acceptable and work should continue on as normal.

Drilling Fluid Loss 15-25%

The volumetric drilling fluid balance has shown 15-25% drilling fluid loss. The loss of drilling fluid has now become a concern. The volumetric balance is immediately re-calculated and the drilling compound is checked to ensure there is no other reason for drilling fluid loss besides down hole loss. The drilling fluid volume tracking procedure is increased from normal (three times a day) to hourly checks until the level of drilling fluid loss exceeds 25% or decreases below 10%. Surface inspections shall be made along the crossing alignment to check for surface frac outs.

Drilling Fluid Loss > 25%

The drilling fluid tracking procedure has shown that drilling fluid loss has exceeded 25%. It has been checked that the only reason for this drilling fluid loss is down hole drilling fluid losses. The drilling of the borehole is immediately ceased, surface inspections shall be made on the site compound and along the alignment.

Section 10 of this report should be followed. This response plan is shown in this document and displays a flow chart of the procedure to be used when Loss of Drilling Fluid to the ground water is experienced.

9 RESPONSIBILITIES

The nominated personnel for Fetterplace Civil implementation of this HDD-FMP:

Project Director:
Project Manager:
Drilling Supervisor:

10 DRILLING FLUID LOSS RESPONSE PLAN

The response to loss down hole drilling fluid loss in general terms will be:

1: Cease Drilling: When down hole loss exceeds 25%

2: Notify Project Supervisor

3: Notify AGL Operations Manager and Environmental Advisor

4: Response Coordinators to co-ordinate sealing of the borehole. It is impossible to supply an answer to exactly what is done until the exact situation is known however possible solutions are as follows:

- Pump Extremely High Viscosity Drilling Fluid in to borehole in order to attempt to gel up the leakage;
- Utilise leak sealing mud or lost circulation material additives into the drilling fluid in order to attempt to seal the leakage (Baraswell, PAC/R);
- Addition of products such as rice husks, cotton or shredded paper into the drilling fluid in order to attempt to seal the leakage;
- Grouting the borehole at the leakage location and drilling through the grout and continue the hole.
- The response to containment facilities failure in general terms will be:
- 1: Cease Drilling: When containment failure is detected
- 2: Notify Project Coordinators:

5: Response Coordinators to co-ordinate containment and cleanup of the drilling fluid leakage. It is impossible to supply an answer to exactly what is done until the exact situation is known however possible solutions are as follows:

- Mobilise transportable pumps on the worksite to the location of the spill and transfer the mud to a contained area;
- Utilise the excavator on site to form windrows in order to divert the flow back into contained areas;

- Utilise the excavator on site to dig a temporary hole in order for escaping drilling fluid to gather in and mobilise transportable pumps to transfer mud to a contained area;
- Mobilise Suck Trucks to the worksite in case there are no more effective contained areas on the site for the mud to be stored within i.e. cannot utilise transportable pumps to transfer the mud

Appendix B

Flowback Water Transport Management Plan

Waukivory Pilot Project

TRAFFIC MANAGEMENT PLAN FOR THE TRANSPORTATION OF FLOWBACK WATER

AGL Upstream Gas Investments Pty Ltd

December 2013

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1. Introduction

This traffic management plan for the transportation of flowback water (TMP) has been prepared in accordance with the traffic access management sub-plan (TASMP) in the environmental management plan (EMP) for exploration activities within petroleum exploration lease 285 (PEL 285).

This TMP has been developed to specifically address and manage traffic matters on Fairbairns Road, between the property access on Fairbairns Road (for the water staging point at Waukivory 13 pilot well – WK13) and its intersection with The Buckets Way It is envisaged that flowback water will be transported over a 16 week period from the water staging point to an appropriate off-site facility for lawful disposal.

Traffic impacts on The Bucketts Way, a State road, are not part of this TMP. A previous assessment (EMM 2011) considered traffic volumes within the local road network and concluded there is sufficient capacity to accommodate these additional traffic movements with minimal effects.

This TMP is based on the current AGL Energy Life Guard System and more information is available in the EMP, which is available on AGL's website.

1.1. Objective

The objective of this TMP is to outline protocols, procedures and management measures to mitigate and minimise potential traffic impacts on the local community from the transportation of flowback water from the site along Fairbairns Road.

1.2. Target

Zero incidents or complaints received regarding traffic disruption.

1.3. Responsibilities

Personnel responsible for implementing this TMP include the following:

- Should unexpected impacts to traffic flows on public roads occur, the Land and Approvals Manager and Project Coordinator (or delegate) are responsible for liaising with Roads and Maritime Services (RMS) and/ or Gloucester Shire Council.
- The AGL Environment Advisor or Health and Safety Business Partner is responsible for informing site personnel of the required procedures and protocols for traffic and access management via an induction program.
- The Project Coordinator is responsible for ensuring compliance with this TMP and site-specific requirements.
- The Community Relations Manager is responsible for addressing and managing public enquiries in relation to traffic movements and access arrangements related to flowback water.

- All employees and contractors are responsible for working in a manner which minimises potential traffic impacts on community safety and the environment.

1.4. Abbreviations

Table 1-1: Table of Abbreviations

Acronym	Definition
AGL	AGL Upstream Investments Pty Limited
DPI	NSW Department of Primary Industries
EMP	Environmental Management Plan
EP&A Act	Environmental Planning and Assessment Act 1979
HSE	Health Safety and Environment System
PEL	Petroleum Exploration Lease
REF	Review of Environmental Factors
RMS	NSW Roads and Maritime Services
Roads Act	Roads Act 1993
TASMP	Traffic and Access Management Sub Plan
TMP	Traffic Management Plan for the transportation of flowback water
WK13	Waukivory 13 pilot well

2. Requirements

Table 2-1 lists the key licences and approvals for exploration activities in relation to traffic of flowback water.

2.1. Key licence / approvals

Table 2-1: Summary of key licence / approvals

Reference	Requirement
Petroleum Exploration Lease 285 (PEL 285)	» Operations must not affect any road or track unless with the prior written approval of the Director-General and subject to any conditions stipulated. » The licence holder must pay the local council, the Crown Land Division of the Department of Primary Industries (DPI) (formerly part of the Department of Lands) or RMS the costs incurred in fixing any damage to roads caused by the operations carried out under the licence. » The use of any road or track must be restricted during wet weather to prevent damage to such road or track.
PEL 285 Waukivory Pilot Approval	» The works must be carried out at the location(s) and in accordance with the methods contained in: ▪ Review of environmental factors (REF): Waukivory Pilot project, dated September 2013 by AGL Upstream Investments. ▪ Preferred activity report (PAR), dated December 2013 by AGL Upstream Investments.

2.2. Key legislative and regulatory requirements

The transportation of flowback water will comply with all relevant legislation, regulations and guidelines. These include but are not limited to the legislation described in Table 2-2.

Table 2-2: Key statutory requirements for the Waukivory Pilot Project

Act	Statutory requirements	Notes
Environmental Planning and Assessment Act 1979 (EP&A Act)	» Requires consideration of the environmental impacts of a proposed activity, including those related to traffic and access.	Flowback water has been assessed in the REF and PAR.
Work, Health and Safety Act 2011	» Other requirements include Australian Standard AS 1742.3 and the RMS' "Traffic Control at Work Sites" manual.	The on-site contractor will ensure compliance with the relevant aspects of AS 1742.3 and the RMS manual.
Road Transport (Vehicle Registration) Regulation 2007	» Limits the overall size (width, height and length) and some internal dimensions of vehicles to ensure that they have adequate manoeuvrability and that they are compatible with road systems and other traffic. A permit is required from the RMS to exceed dimensions if the length, rear overhang, forward projection, width or height of a vehicle exceeds the limits allowed by the Regulation.	Anticipated vehicle type to be used for transportation of flowback water will not exceed the dimensions stated in the Roads Transport (Vehicle Registration) Regulation 2007. No permit will be required.
Road Transport Act 2013	» RTA Vehicle Standards Information Sheet No. 5 – Vehicle Dimension Limits sets out the limits for vehicle length, height and width, ground clearance, projecting loads and equipment, loading space, rear overhang, turning circle and axle groups and suspension systems.	The vehicles to be used for transportation of flowback water will comply with the relevant RTA (now RMS) standards.

3. Management measures

3.1. Overview

The disposal of flowback water will require transport of flowback water by truck from the turkeys nest dam at WK13 to an appropriate off-site facility for lawful disposal. Trucks will access the turkeys nest dam at WK13 from an existing property access on Fairbairns Road and the existing internal access track to WK13.

Transportation of flowback water will involve up to 240 truck movements over a period of up to 16 weeks, being an average of three water trucks per day departing from WK13. These flowback water trucks will operate Monday to Friday, 7.00 am to 6.00 pm, and Saturday, 8.00 am to 1.00 pm. Transportation along Fairbairns Road during school times, 8.00 am to 8.30 am and 3.30 pm to 4.00 pm, on school days will be avoided.

3.2. Potential traffic impacts

3.2.1. Transport of flowback water along Fairbairns Road

Traffic resulting from the transport of flowback water from WK13 may cause some minor interruptions to traffic flow on Fairbairns Road.

3.3. Control measures – traffic and access management

The following control measures are outlined in the overarching TAMSP for exploration activities within PEL 285. The TAMSP requires the TMP (this plan) to outline routes, number of vehicles, management of vehicles for an activity with potential for generating significant traffic movements over a period of time.

The identified measures in Table 3-3 will be implemented for the transportation of flowback water from WK13.

Table 3-1: Traffic control measures for flowback water transportation

Activity	Action	Responsibility
Prior to transport of flowback water	Undertake a road dilapidation report in order to satisfy PEL 285 requirements	Project Coordinator
Wet weather transportation	The use of Fairbairns Road and local access tracks will be monitored during wet weather and if required, restrictions put in place to ensure the prevention of damage.	Project Coordinator
Speed limits	All personnel shall adhere to site vehicle speed limits and take extra precaution when driving near stock.	All
Vehicle maintenance	All vehicles should be maintained according to manufacturer's specifications.	All

Activity	Action	Responsibility
Access	Site access will only be from the property access for the water staging point at WK13.	Project Coordinator
Vehicle size	Suitable size trucks for use on Fairbairns Road will be used (ie maximum size of 25,000 litres and either a single semi trailer or truck and dog scenario).	Project Coordinator
Travel times and restrictions	Trucks will operate Monday to Friday, 7.00 am to 6.00 pm, and Saturday, 8.00 am to 1.00 pm. The contractor will ensure transportation during school bus times, 8.00 am to 8.30 am and 3.30 pm to 4.00 pm, during school days will be avoided. The contractor will ensure transportation during periods when tourist groups are visiting the local herb farm on Fairbairn's Road are avoided, to minimise disturbance of this local business	Project Coordinator
Transport route (Fairbairns Road)	Vehicles transporting flowback water will only travel on the section of Fairbairns Road between the property access for WK13 and the intersection with The Bucketts Way.	Project Coordinator
Local community notification	AGL will notify residents along Fairbairns Road of the intended dates of commencement and completion of the trucking operation by an appropriate means prior to the commencement of trucking. Residents will also be provided with AGL's project telephone number, website and email address to enable members of the community to comment on and identify any specific concerns relating to the haulage operation	Project Coordinator to inform community relations manager
Monitoring	All measures and procedures outlined in this TMP will be implemented and monitored through AGL's 'daily environment checklist' procedure to ensure compliance of the haulage operation with this TMP.	Company man

4. Monitoring and reporting

Monitoring to ensure works are being carried out in compliance with this TMP will be done by:

- site-specific inductions;
- spot checks;
- site inspections; and
- review of records including minutes of site-specific inductions and toolbox meetings, the complaints register and incident reports.

Complaints and incidents related to traffic and access management will be recorded, addressed and reported in accordance with sections 5.3.4 and 6.4 of the EMP and with this TMP.

5. Administrative

5.1. Site-specific plans

Site specific plans will be prepared as required. It is not anticipated given the number of vehicle movements required for the transportation of flowback water that these plans will require consultation with RMS and/ or Council.

Copies of these plans will be kept on file at site and will be available upon request.

5.2. Definitions

Currently not applicable.

5.3. Life Guard references

HSE Corporate Policy.

AGL Energy Safe Driving Policy.

LG-HSE-CG-049 Road-Vehicles Safety.

6. References

- Australian Standard AS 1742.3.
- RMS “Traffic Control at Work Sites” manual.

Appendix C

Groundwater modelling

Parsons Brinckerhoff Australia Pty Limited

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Certified to ISO 9001, ISO 14001, AS/NZS 4801
A GRI Rating: Sustainability Report 2011

Memo

Date 14 November 2013

To John Ross

From Becky Rollins

Ref 2193335A-DMS-MEM-001 RevA

Subject Waukivory Pilot REF

Introduction

The Office of Coal Seam Gas (OCSG) review of Waukivory Pilot Testing REF as part of AGL's Gloucester Gas Project has identified the need to assess depressurisation of the alluvium, shallow rock and upper coal measures and also the potential for impacts on groundwater levels at the outcrop areas. In response to this, a numerical cross-sectional model through the Waukivory pilot area in the Stage 1 GFDA was developed using FEFLOW (Figure 1). The model was constructed and parameterised using data from recent groundwater investigations (Parsons Brinckerhoff, 2012a) and in accordance with the hydrogeological conceptual model (Parsons Brinckerhoff, 2013a) and water balance (Parsons Brinckerhoff, 2013b) developed for the Gloucester Basin.

Model set-up

The Waukivory cross-sectional model is a 5km, roughly east-west section that passes through (or close to) the locations of the Waukivory 11 and 14 gas exploration wells, and the site of the Waukivory groundwater monitoring bores WKMB01, WKMB02, WKMB03 and WKMB04 (Figure 2). The model extends well outside the Stage 1 GFDA to the east and west so that the model boundaries have negligible influence on model predictions, and to a depth of 2000m, below the base of the Permian Coal Measures. The interpreted seismic cross section that forms the basis for the Waukivory model structure is shown in Figure 2.

The cross-sectional model was constructed as a vertical 3D block with a nominal width of 250 m, consisting of six model layers (seven slices). The cross section width allows radial flow to each gas well. Waukivory 11 and 14 gas exploration wells are within 250m of the cross-sectional line, and are therefore included in the model. Waukivory 12 and 13 gas exploration wells are greater than 250m from the cross-sectional line and therefore cannot be accurately represented in the model. However, additional cross-sectional models intersecting Waukivory 12 and 13 would be expected to provide similar results to those presented below.

The eastern and western boundaries were assigned as specified head boundary conditions consistent with observed or interpolated groundwater levels at those locations. Recharge was applied to the model top surface at 1% of rainfall, consistent with estimates of recharge across the shallow fractured rock domains. A specified head boundary condition was assigned to the top most nodes in the location of the Avon River.

Waukivory 11 and 14 gas exploration wells were assumed to be perforated against all major coal seams below 250 m depth, but fully grouted against the interburden units. The Waukivory pilot testing was simulated by applying a specified pressure boundary at nodes where the well intersects relevant coal seams. The pressures at the coal seams were assigned according to the expected down-hole pressures for the duration of the pilot testing (nominally 45 psi or 310 kPa).

Hydraulic conductivity in the shallow rock and deeper coal measures decreases with depth as fractures and pore space (including cleats in coal) close with increasing lithostatic pressure (Parsons Brinckerhoff, 2013a). Hydraulic conductivity was therefore applied to all lithologies and structures with depth functions as follows:

For Interburden: $K\ (m/d) = 0.03\ e^{-0.013*depth}$ (to 1000 m), constant $K\ (m/d) = 10^{-7}$ (below 1000 m)

For Coal seams: $K\ (m/d) = 0.3\ e^{-0.013*depth}$ (to 1000 m), constant $K\ (m/d) = 10^{-6}$ (below 1000 m)

The current conceptual hydrogeological model and a hydrogeological investigation of a strike-slip fault in the northern Gloucester Basin (Parsons Brinckerhoff, 2013c) indicate that faults are weak conduits near the surface and most likely weak barriers at depth. Faults were therefore represented in the model as weak conduits in the top 150m of shallow rock, and as weak barriers with associated depth function in the deeper coal measures. Weak conduit and barrier structures are represented in the model by having a hydraulic conductivity that is one order of magnitude (x10) higher or lower, respectively, than the adjacent interburden. The exact nature of the thrust fault in the area of the Waukivory Pilot is not known and is one of the main reasons for conducting the pilot.

Model results

The Waukivory pilot testing was simulated over 24 months. The simulated drawdown due to pilot testing is best illustrated in plots showing pressure drawdown (pressure change from steady state pre-development pressure distribution). The results are presented in the following figures:

- Contours of pressure drawdown at 6, 12 and 24 months (focussed on Waukivory 11 and 14) – Figure 3
- Contours of pressure drawdown at 6, 12 and 24 months (full Waukivory model) – Figure 4
- Modelled drawdown hydrographs at the WKMB monitoring bores – Figure 5

The results are presented in relation to groundwater pore pressure in kilopascals (kPa). For reference, one metre of hydrostatic head is equal to ~9.8 kPa; therefore any results expressed as kPa can be converted approximately to metres of head by dividing by 10.

The following conclusions are drawn from the Waukivory pilot testing simulation:

- Pressure drawdown due to gas flow testing forms a steep cone of depression around the perforated zones of the Waukivory gas wells. Hydrostatic pressure increases rapidly with distance away from the wells due to the low permeability of the rock mass (Figures 3 and 4).
- After 24 months of pilot testing, it is predicted that pressure drawdown is unlikely to extend to depths shallower than 70 mbgl (Figure 3). There is no predicted water table drawdown after 24 months of pilot testing (Figure 3).
- Groundwater level drawdown associated with the Waukivory pilot testing is predicted to be ~0.4 m at WKMB03 (screened at 200 to 208 mbgl), and ~0.02 m at WKMB04 (screened at 335 to 347 mbgl) after 24 months of flow testing (Figure 5).

- It is predicted that there will be no measurable groundwater level drawdown associated with the Waukivory pilot testing after 24 months at the WKMB01 (screened at 47 to 53 mbgl) and WKMB02 (screened at 51 to 60 mbgl) monitoring bores (Figure 5).
- The water balance for the Waukivory model implies that each well extracts ~0.75 l/s (0.065 Ml/d) on average over 24 months. It should be noted that this extraction rate is likely to be an over-estimation (and thus prediction of impacts may also be overestimated) because FEFLOW is a single-phase porous groundwater flow model and does not take into account the reduced permeability to water associated with dual phase flow near the gas well.

Yours sincerely

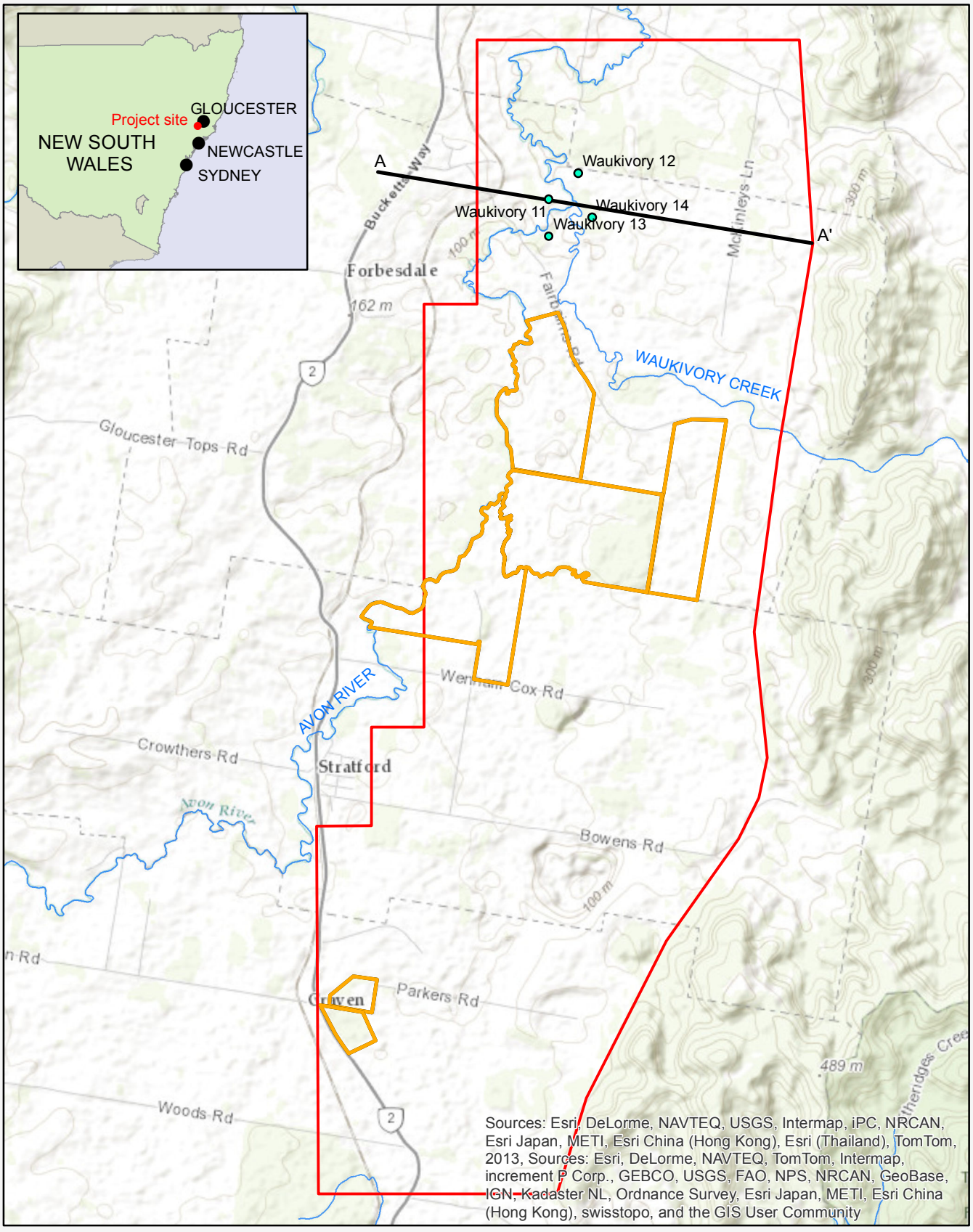
Becky Rollins
Hydrogeologist
Parsons Brinckerhoff

References

- Parsons Brinckerhoff (2012a) *Phase 2 Groundwater Investigations – Stage 1 Gas Field Development Area, Gloucester Gas Project*, Report PR_5630, dated January 2012
- Parsons Brinckerhoff (2013a) *Hydrogeological Conceptual Model of the Gloucester Basin*, Report PR_7266, dated June 2013
- Parsons Brinckerhoff (2013b) *Water Balance for the Gloucester Basin*, Report PR_7296, dated July 2013
- Parsons Brinckerhoff (2013c) *Hydrogeological Investigation of a Strike-slip Fault in the Northern Gloucester Basin*, Report PR_5741, dated August 2013

PARSONS BRINCKERHOFF

WAUKIVORY PILOT REF
AGL UPSTREAM INVESTMENTS PTY LTD



C:\AGL\GIS\02 Projects\2193335A_GLOUCESTER_REGIONAL_NUMERICAL\Figure 1 Location of Waukivory cross-sectional model.mxd Author: rollinsr 15/11/2013

- Rivers and streams
- Waukivory cross-sectional model
- Property Boundaries
- Stage 1 GFDA boundary
- Waukivory gas wells

Figure 1
Location of Waukivory cross-sectional model

N

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Kilometres

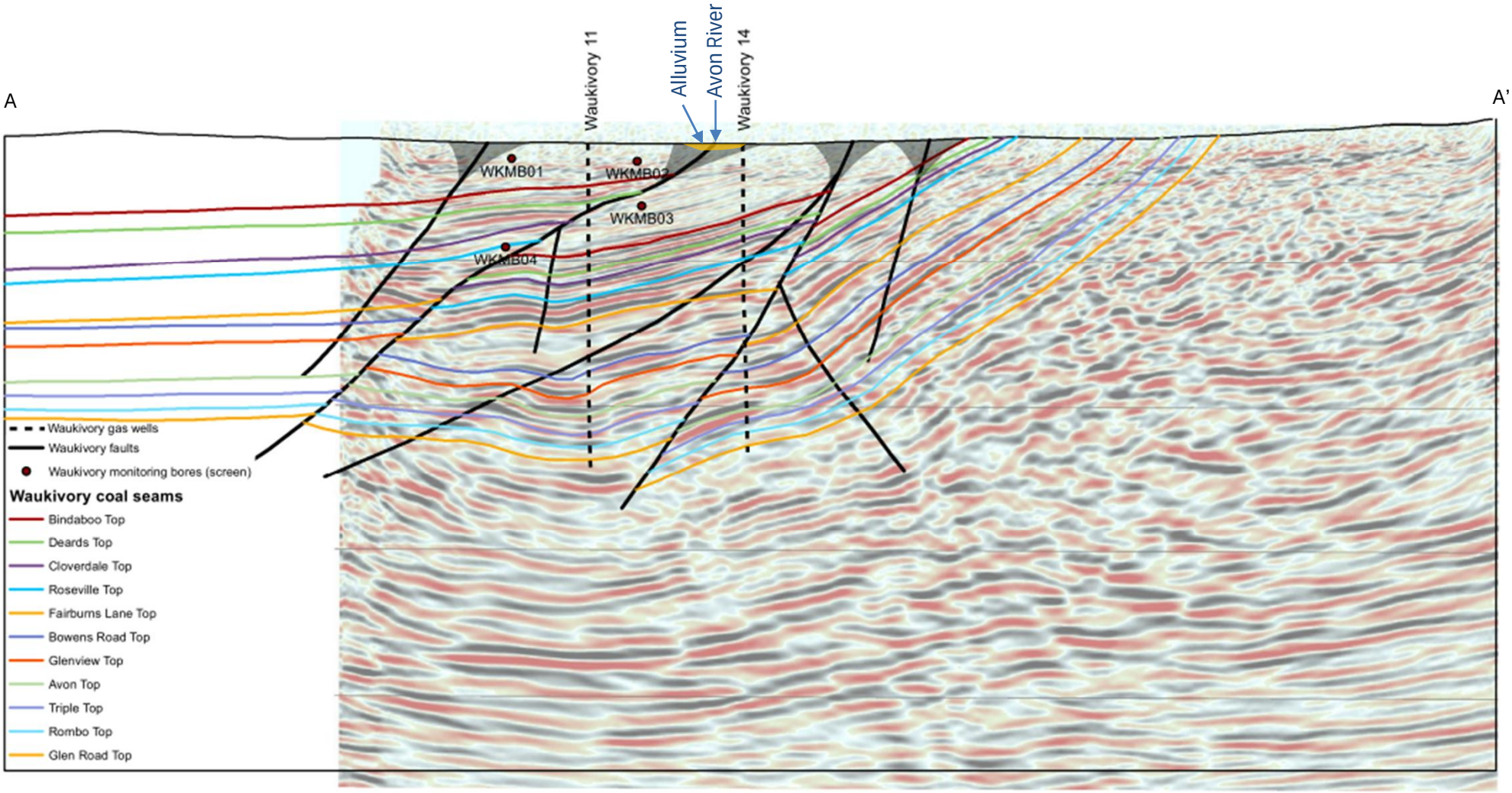
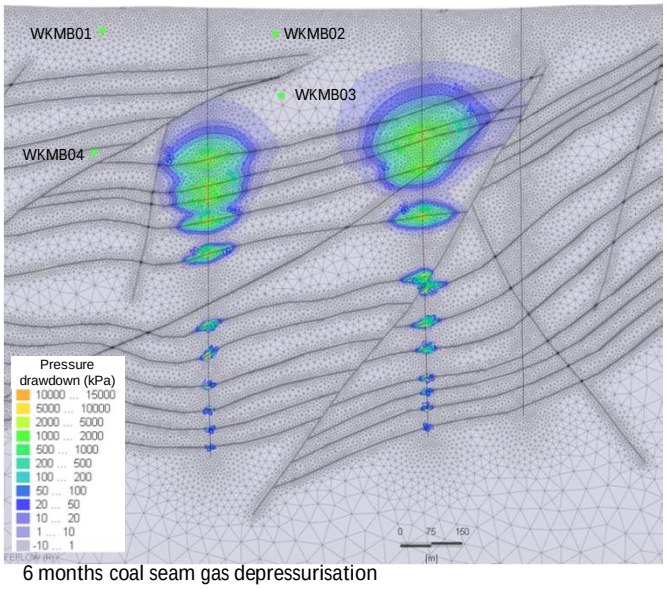
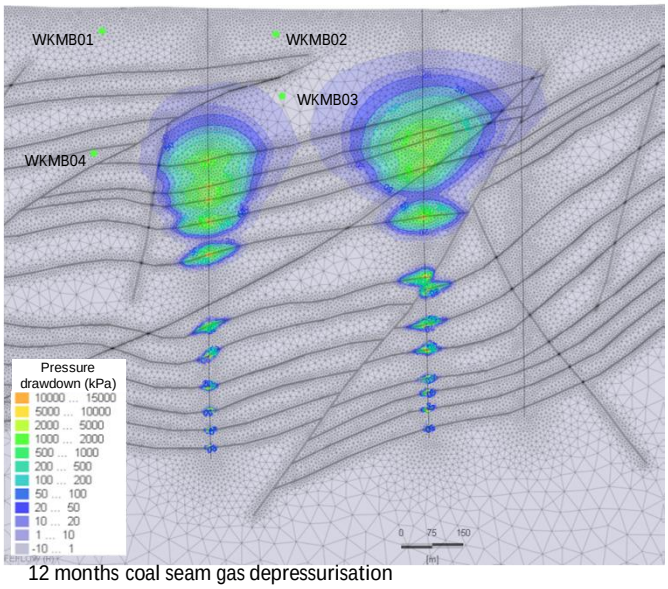


Figure 2 Waukivory interpreted seismic section

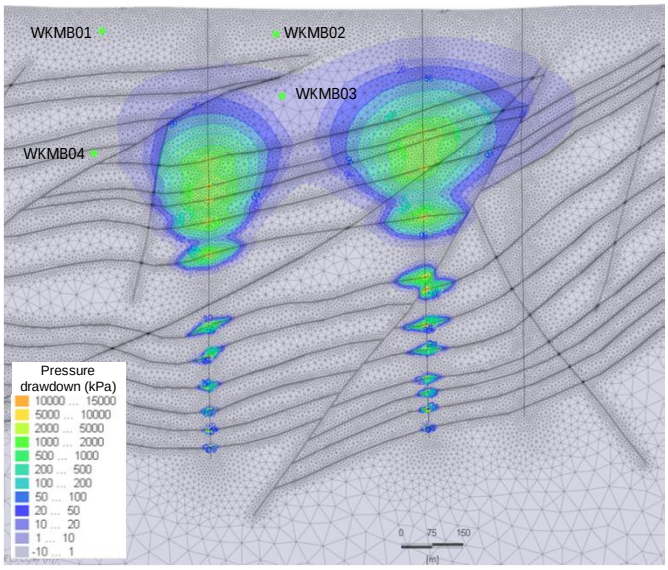
Faults transmissive in shallow rock and barriers at depth



6 months coal seam gas depressurisation



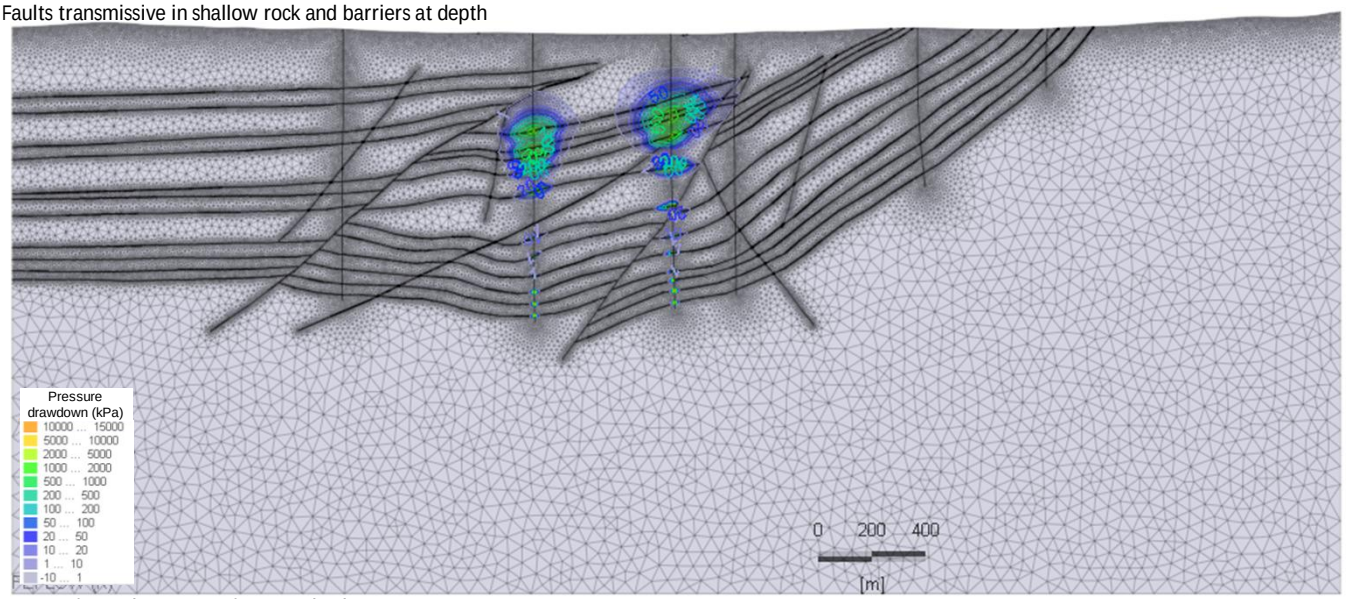
12 months coal seam gas depressurisation



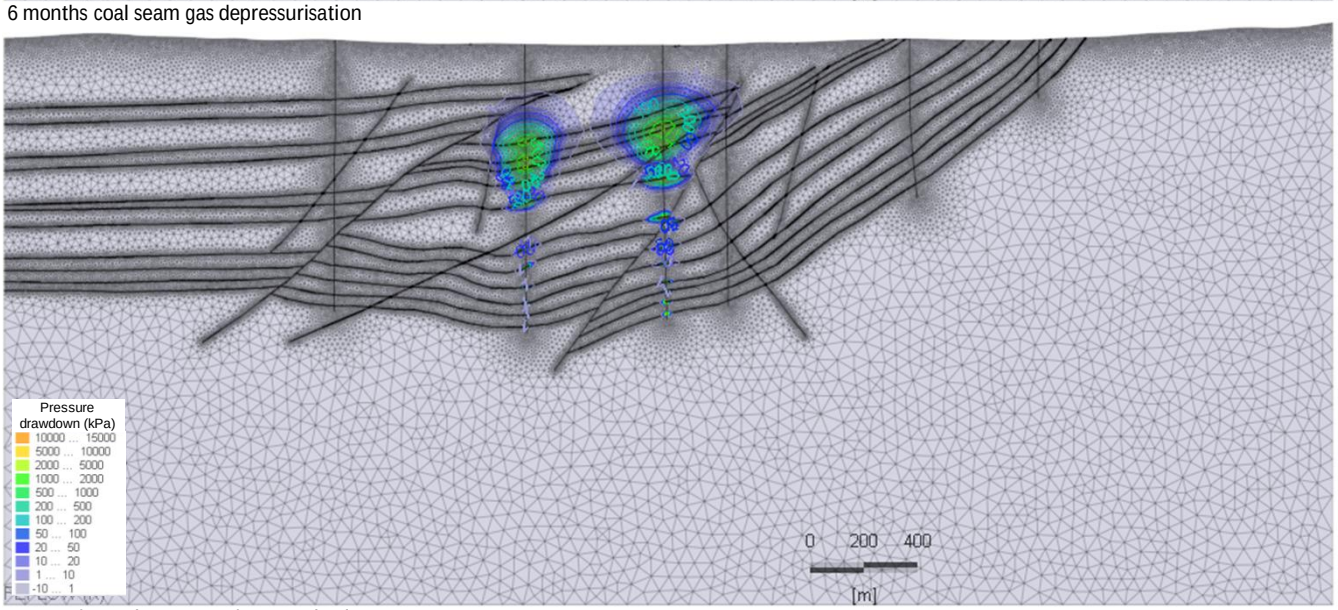
24 months coal seam gas depressurisation

Figure 3 Waukivory pressure drawdown (kPa) after 6, 12 and 24 months of coal seam gas depressurisation

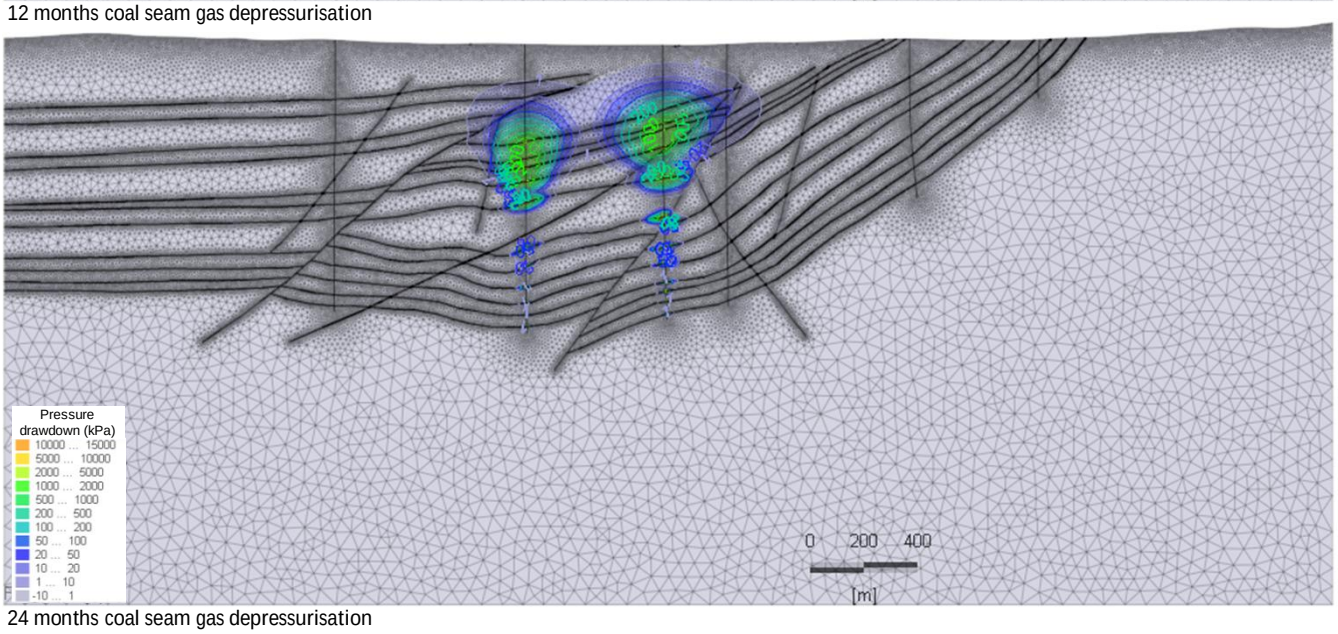
Faults transmissive in shallow rock and barriers at depth



6 months coal seam gas depressurisation



12 months coal seam gas depressurisation



24 months coal seam gas depressurisation

Figure 4 Waukivory pressure drawdown (kPa) after 6, 12 and 24 months of coal seam gas depressurisation

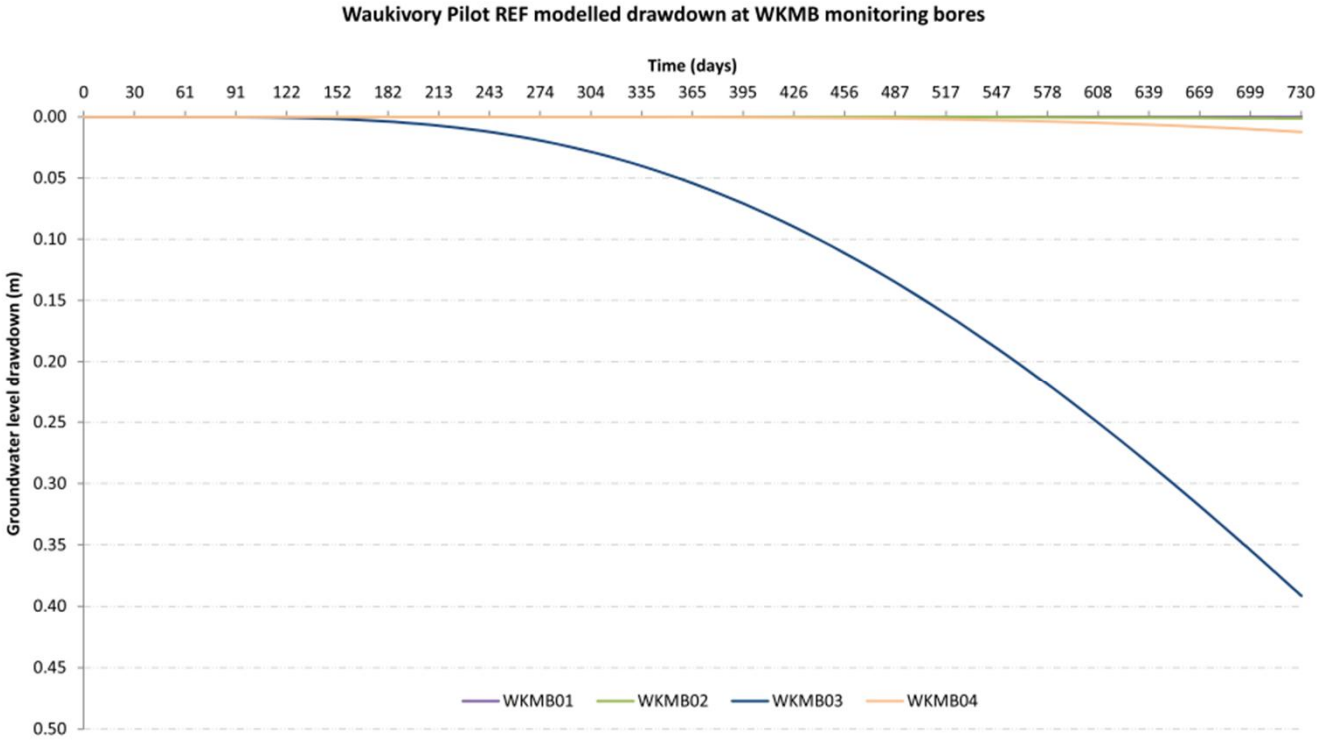


Figure 5 Waukivory Pilot REF drawdown hydrographs

Appendix D

Flood plain obstruction and contingency management

1019-01-A1
26th November 2013

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Duncan Peake
Associate Director
EMGA Mitchell
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Dear Duncan,

SUBJECT: WAUKIVORY PILOT TESTING PROJECT – ASSESSMENT OF FLOODPLAIN OBSTRUCTION AND CONTINGENCY MANAGEMENT

AGL has lodged an application and supporting environmental assessment (REF) for the pilot testing of four existing gas wells to the south of Gloucester NSW. The NSW Office of Coal Seam Gas has requested AGL provide '*additional information relating to the risk of floodplain obstruction and flood contingency management at WK12 and WK14*'. AGL engaged WRM to undertake a flood assessment of the proposed project to inform the response to the request for information.

1 DESCRIPTION OF EXISTING CASE FLOOD MODEL

WRM developed flood models of the Avon River and Waukivory Creek floodplains for Gloucester Resources Limited's (GRL's) Rocky Hill Coal Project Environmental Impact Statement (RHCP EIS). The proposed pilot testing project is located within the extent of these models.

The Avon River flood model is described in detail in *Part 5 of the Specialist Consultant Studies Compendium of the Rocky Hill Coal Project EIS*. A hydrological model of the catchment was prepared using the URBS software and calibrated to conditions observed during the June 2011 and February 2012 flood events. Design discharge hydrographs derived using the URBS model were used as inputs to a hydrodynamic model of the floodplain developed using the TUFLOW model software. The hydraulic model was also calibrated to flood levels surveyed during the June 2011 flood event. For the Rocky Hill Coal Project EIS, the TUFLOW model was used to assess existing flood conditions and the impact of the works proposed as part of the project.

2 DESCRIPTION PROPOSED WORKS

AGL provided the following extract from the REF – which describes the footprint of the proposed works:

> *The pilot testing compound surrounding the existing exploration wells requires a maximum area of 100 x 100 m. A previously assessed (EMM 2011) activity footprint of 100 x 100 m is allowed for manoeuvring and placement of construction plant around each of the existing exploration wells.*
>
> *The central flare at WK12 will have a small additional footprint of 10 x 10 m and remain within the 100 x 100 m allowed. Gas will be delivered to the flare/s from the pilot wells via buried gathering lines. Water will be managed by pumping flowback and produced water in buried gathering lines from WK12 and WK14 to a double-lined dual compartment turkeys nest dam or temporary above-ground water storage tanks at the water staging point at WK13. Water will be transported from WK13 by either truck or buried water pipeline to the Tiedmans property. The water pipeline from WK13 to the Tiedmans property would be buried to a depth of 450 mm to 1,000 mm for a distance of approximately 3.5 km. The pipeline traverses the Waukivory Pilot site and AGL owned properties with an underbore section across of Fairbairns Road.*
>
> *Some minor levelling activities will occur in the vicinity of the drilled wells to ensure stability of equipment and plant. The equipment to be delivered and installed at each of the pilot test wells includes:*
>
> - *wellhead equipment, gas and water separator;*
> - *a pump lowered into the well;*
> - *gas and water gathering lines; and*
> - *an acoustically treated hydraulic power unit (HPU) with hospital grade noise suppression to run the pump, to ensure that noise from this unit is as low as practicably possible.*
>
> *Equipment and supplies required for well maintenance, including tubing and replacement items would also be delivered at this stage. A transportable laboratory/office (approximately 2.4 x 3.6 m) will be placed onsite within the previously assessed 100 m x 100 m footprint.*
>
> *The water staging point will include the construction of either a double lined dual compartment turkeys nest dam or a temporary above ground water storage within the 100 x 100 m footprint at WK13. The turkeys nest dam will be constructed with insitu materials and dual lined in accordance with the requirements of DTIRIS-OCSG. Alternatively a temporary above ground water storage facility will be constructed to a high level specification (generally using high density polyethylene (HDPE)) to ensure safety and the integrity of the structure. The turkeys nest dam/storage facility will have a capacity of 5 ML (3ML and 2ML compartments) (or 5,000 m^3).*

In addition to the above infrastructure, noise barriers will be provided at key locations at the perimeter of the proposed compounds. From a flood impact assessment perspective, these barriers are the most significant works. The locations of the proposed wells are shown in Figure 1.

3 PROPOSED DEVELOPMENT HYDRAULIC FLOOD MODEL

The proposed noise barriers are planned to be in place for approximately 4 weeks, and are likely to be decommissioned before the Rocky Hill Project construction commences. The cumulative impact of the two projects has therefore not been assessed.

The existing case hydraulic model was modified by blocking out those sections of the model domain where infrastructure is proposed. This is consistent with all proposed infrastructure being constructed to crest levels above the level of flooding, and presenting an impermeable barrier to flow.

Based on advice from AGL, the compound pads and associated access roads would not be significantly raised above existing ground levels, and have not been included in the model assessment. The modelled infrastructure is shown in Figure 1, which shows that the noise barriers have the most significant footprint at the sites, while the other installed equipment is relatively small and would therefore be expected to be insignificant from a flood impact point of view.

4 MODEL RESULTS

The modelled 1 in 100 Annual Exceedance Probability (AEP) flood conditions are also shown in the attached figures. The impacts of the project if a 1 in 100 AEP flood occurred while all wells were in place are as follows:

Flood levels

- WK11 is located well above the 1 in 100 AEP peak flood level;
- Flood levels are increased by between 1cm and 5cm over a large area upstream of WK12. Floodplain flow depths generally exceed 1.5m over this area;
- Flood level impacts are greatest in the vicinity of WK12, where the floodplain is narrowest. The largest modelled increase in flood level is approximately 30cm immediately upstream of the WK12 noise barrier. Impacts greater than 15cm are restricted to an area within the proposed compound;
- The works at WK13 and WK14 result in very small localised impacts on flood levels.

Flood Velocities

- At WK12, WK13, and WK14, there are localised flood velocity increases in excess of 0.2m/s;
- At WK13 and WK14 resultant velocities are less than 1.1m/s, and do not present a high scour risk;
- At WK12, existing velocities are high, especially at the proposed north-eastern end of the noise barrier, where they exceed 3.0m/s. Such velocities would be expected to pose a risk of localised scour if a large flood occurred. The proposed works would create localised velocity increases of over 1m/s, and this would exacerbate scour if a large flood occurred while the noise barrier was in place;
- At WK12, appropriate evacuation procedures should be in place to ensure that personnel are not present when large floods arrive, as exit routes may become impassable.
- Water velocity increases along the waterway are small, such that the resulting velocities are well within the envelope of those occurring naturally, and as such no impact on the channel geometry would be expected.

5 POTENTIAL MITIGATION

The works are temporary, and AGL proposes that noise barriers will only be on site for the immediate duration of fracturing (up to 14 days). The potential impacts will only result if a large flood coincides with this short period. AGL proposes that if warning time allows, the walls will be opened or dropped to the ground prior to inundation so that flow is not obstructed. The risk of significant impacts occurring is therefore very small.

Please do not hesitate to contact me if you have any queries.

For and on behalf of
WRM Water & Environment Pty Ltd

Michael Batchelor
Director

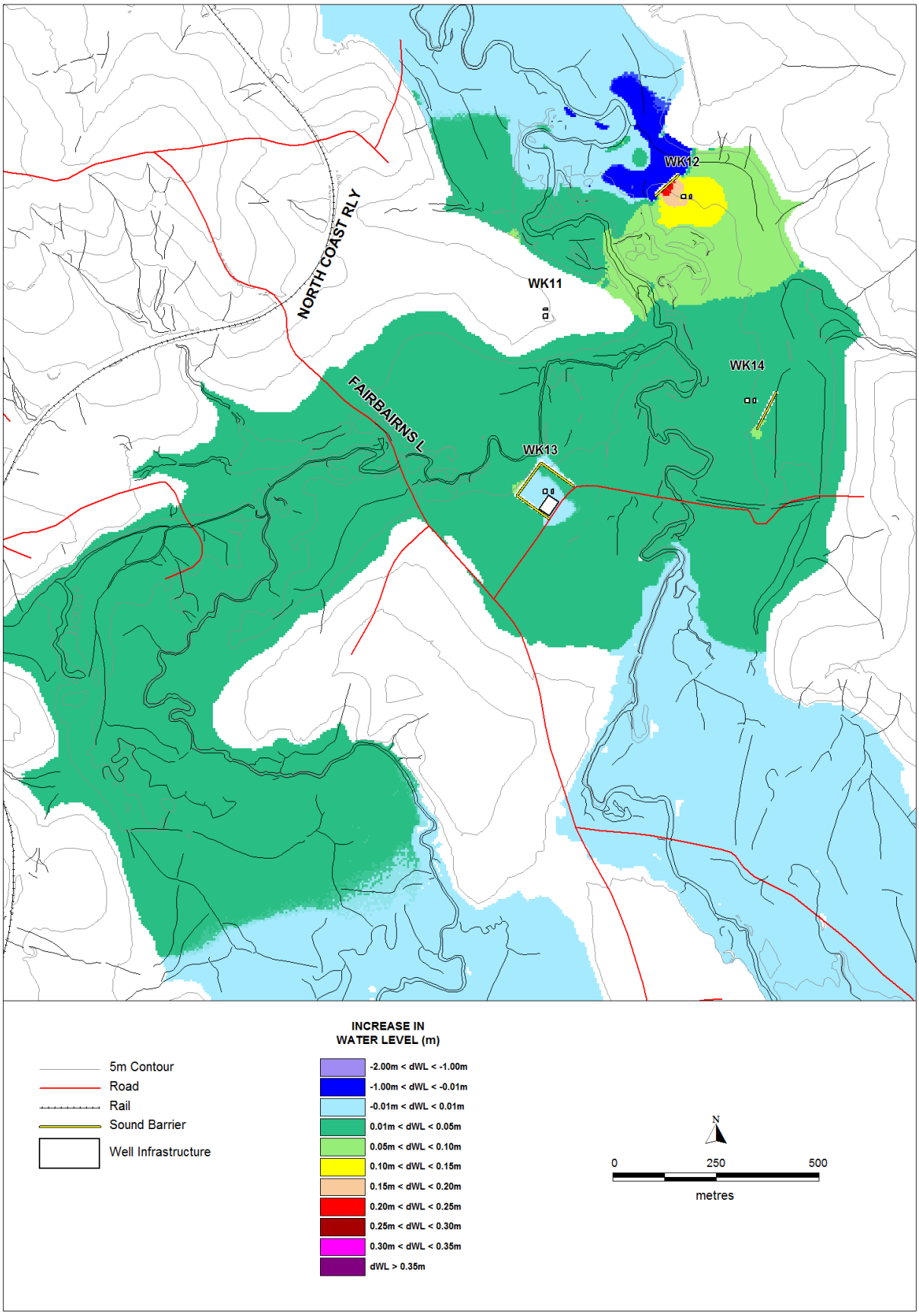

Figure 1 Impacts of AGL Pilot Project on 1 in 100 AEP Flood Level

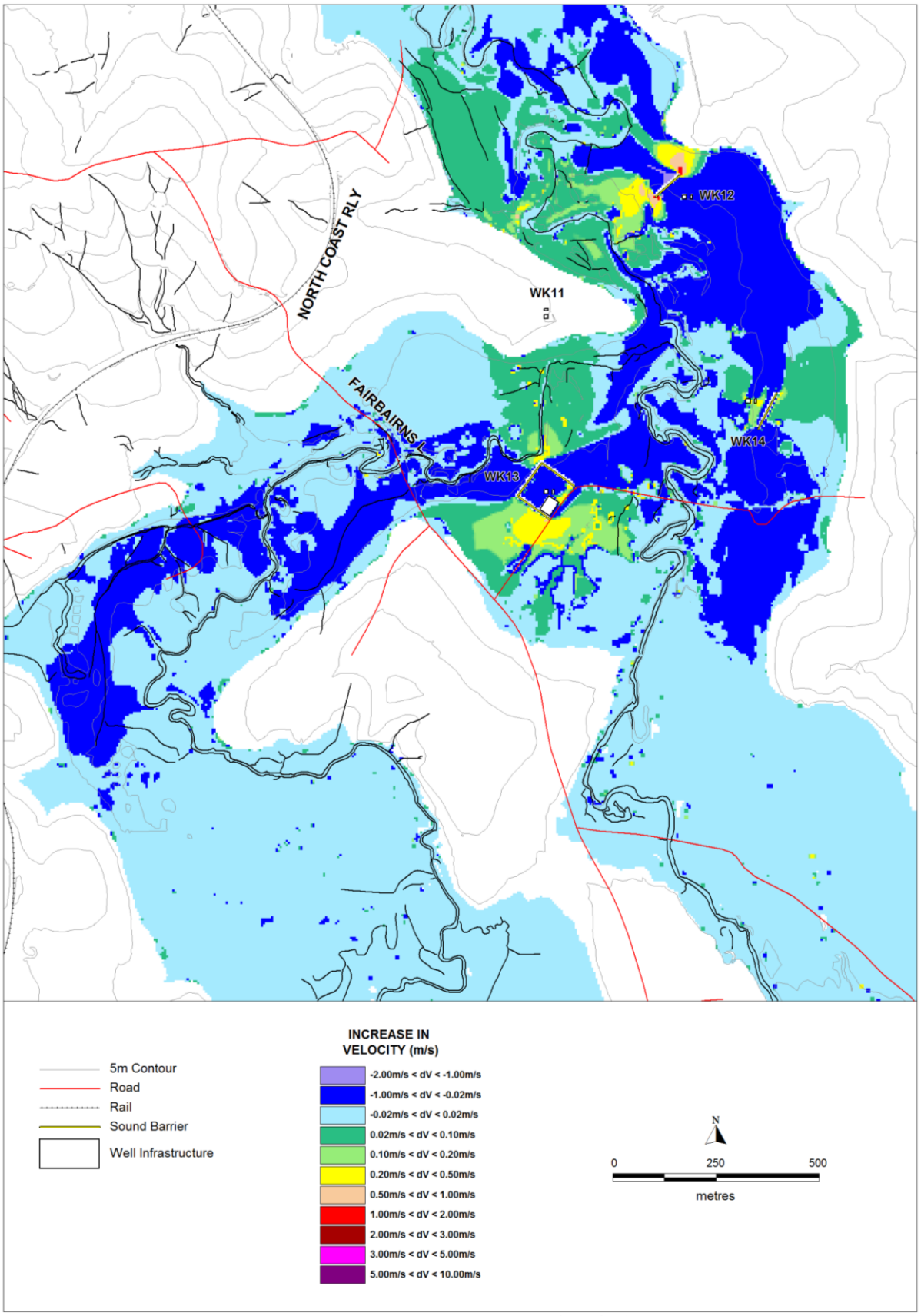

Figure 2 Impacts of AGL Pilot Project on 1 in 100 AEP Flood Velocities

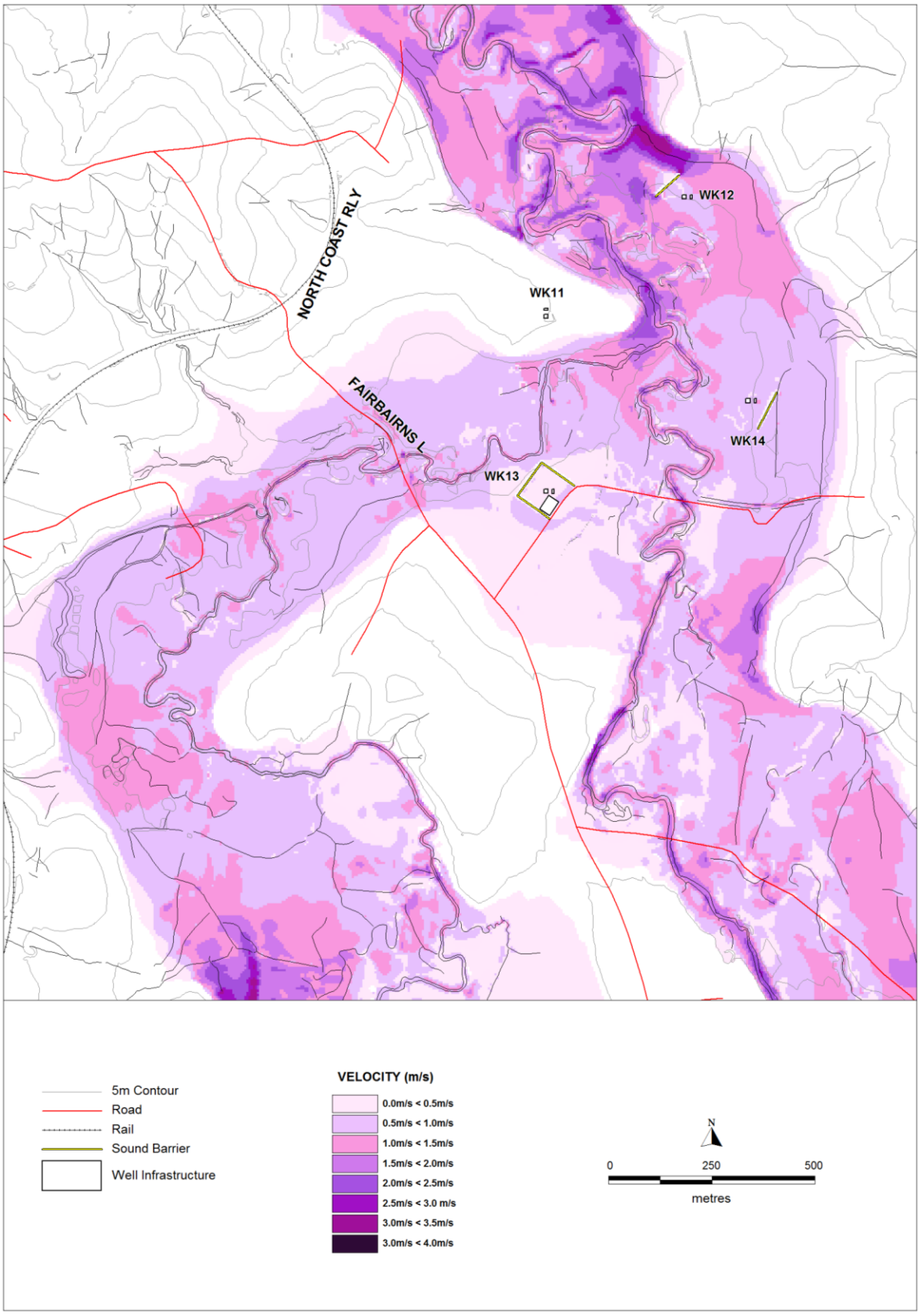

Figure 3 1 in 100 AEP Flood Velocities with AGL Pilot Project in Place

Appendix E

Aboriginal heritage assessment

Memorandum

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26 November 2013

To AGL
From Ryan Desic
Subject Waukivory Pilot preferred activity Aboriginal heritage assessment

Introduction

This letter corresponds to the Aboriginal cultural heritage due diligence assessment undertaken by EMGA Mitchell McLennan (EMM) on behalf of AGL Upstream Investments Pty Ltd (AGL) for a review of environmental factors (REF) for Waukivory Pilot Testing Program.

An Aboriginal cultural heritage assessment was prepared in accordance with the *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (due diligence) (NSW Minerals Council 2010) in support of the Review of Environmental Factors (REF) (EMM 2011) for the establishment of the exploration wells WK11, WK12, WK13 and WK14 and their respective access tracks. An additional due diligence assessment was undertaken in August 2013 for the water pipeline between WK13 and Tiedmans property. This letter details the assessment of the preferred activity shown on Figure 2.1 in the Preferred Activity Report (EMM 2013a).

The preferred activity includes:

- water and gas gathering lines joining WK11 to the main water and gas gathering lines between WK12 and WK13;
- construction pads for the underboring of the Avon River; and
- construction pads for the underboring of Fairbairns Road road.

The assessment involved a due diligence site inspection of the preferred activity by an EMM archaeologist on 25 November 2013. The results of previous site inspections along with landscape and background archaeological information are provided in Section 4.4 of the REF (EMM 2013b). Furthermore a search of the Aboriginal Heritage Information Management System (AHIMS) was conducted for the REF (EMM 2013b) and was used for this assessment.

Results

The site inspection involved traversing the preferred activity areas. Available ground exposures were inspected for the presence of Aboriginal objects, but none were identified. The site inspection also aimed at identifying archaeologically sensitive landforms that may indicate the presence of unexposed or subsurface Aboriginal objects. None of the preferred activity areas were identified to be potential archaeological deposits.

The preferred activity areas largely occur on grassed paddocks that have been used for cattle grazing. The exception to this is the underbore construction pad on the eastern side of the Avon River (including the water and gas gathering pipelines as they extend east from this point), which is within a ploughed paddock. This area was observed to be on a poorly drained alluvial flat; a landform type that is not typically archaeologically

sensitive. The majority of the preferred activity areas, including the underbore pads at Fairbairns Road, will occur on this landform type.

The exit pad on the western of side the Avon River (including the water and gas gathering lines as they extend west and connect to WK11) is on a gentle slope that becomes level as it approaches WK11 on the top of a low spur. A potential archaeological deposit (PAD) was previously identified on the eastern end of the low spur, with 20 m of elevated flat area behind the spur being defined as archaeologically sensitive (EMM 2013b). The preferred activity areas are at least 50 m north of the PAD and will occur on sloping land and on not elevated flat areas associated with the PAD.

A review of the AHIMS search did not identify any registered Aboriginal objects within the preferred activity areas.

An isolated artefact (WK-IF-1) was previously identified within the PAD on a rehabilitated access track (EMM 2011). It was noted that the artefact may have been imported from introduced gravels. Nevertheless, this isolated artefact will not be impacted by the preferred activity areas.

A potential scarred tree has also been recorded near the Waukivory Pilot (EMM 2011). However, the potential scar tree is located more than 100 m south of the water and gas gathering lines joining WK11 to the main water and gas gathering lines between WK12 and WK13 and will not be impacted by the preferred activity areas.

Conclusion

The preferred activity areas are assessed to be of low archaeological potential due to their location on landform types not typically associated with past Aboriginal occupation. Furthermore, no previously recorded Aboriginal sites will be impacted. Therefore, the preferred activity may proceed without Aboriginal heritage constraints. It is assumed the Aboriginal heritage management measures outlined in the environmental management plan (EMM 2013b) will be applied.

References

EMGA Mitchell McLennan (EMM) 2011, *Proposed Exploration Well: Waukivory Review of Environmental Factors,* prepared for AGL Upstream Investments Pty Ltd

EMGA Mitchell McLennan (EMMa) 2013, *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred activity report,* prepared for AGL Upstream Investments Pty Ltd

EMGA Mitchell McLennan (EMMb) 2013, *Waukivory Pilot Project: Review of Environmental Factors,* prepared for AGL Upstream Investments Pty Ltd

NSW Minerals Council 2010, *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects.*

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