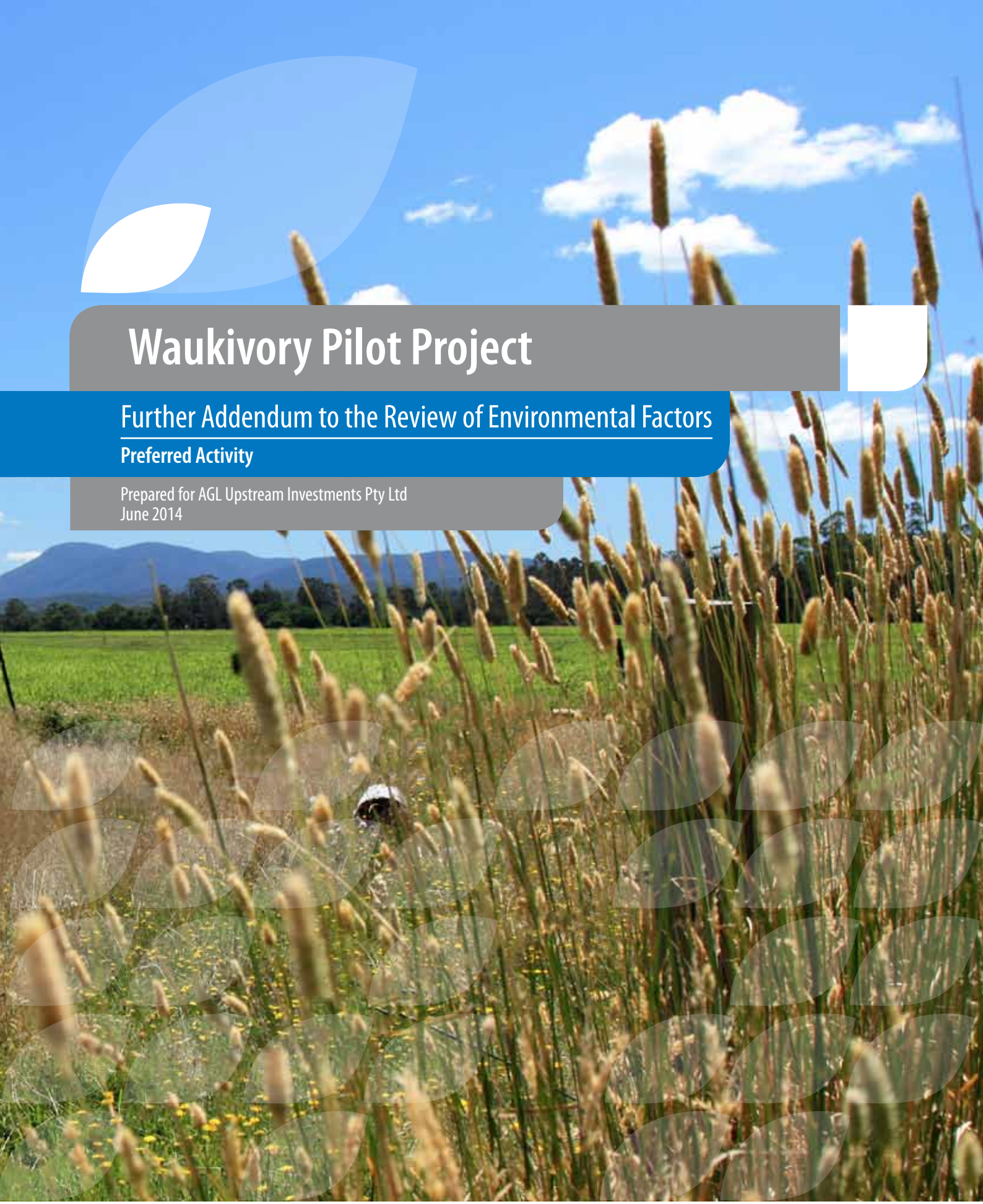

Waukivory Pilot Project

Further Addendum to the Review of Environmental Factors

Preferred Activity

Prepared for AGL Upstream Investments Pty Ltd
June 2014

AGL Energy in action.

EMM
EMGA Mitchell McLennan

Further Addendum to the Review of Environmental Factors

Waukivory Pilot Project

Prepared for AGL Upstream Investments Pty Ltd | 5 June 2014

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Further Addendum to the Review of Environmental Factors

Final

Report J13005RP3 | Prepared for AGL Upstream Investments Pty Ltd | 5 June 2014

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Date	05 June 2014	Date	05 June 2014

Document Control

Version	Date	Prepared by	Reviewed by
1	07 May 2014	R. Janssen	D. Peake
2	29 May 2014	R. Janssen	D. Peake
3	05 June 2014	R. Janssen	AGL

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1 Introduction

An activity application for the Waukivory Pilot Project (Waukivory Pilot) supported by a review of environmental factors (REF) (EMM 2013a) was submitted to the Department of Trade and Investment, Regional Infrastructure and Services – Office of Coal Seam Gas (OCSG) on 30 September 2013 under Part 5 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) by AGL Upstream Investments Pty Ltd (AGL). The proposed activity relates to:

- conversion of four existing exploration wells (WK11, WK12, WK13 and WK14) to pilot wells using perforation and fracture stimulation techniques;
- pilot testing of four wells;
- construction of water storages for flowback and produced water;
- construction of associated infrastructure including water and gas gathering lines and a water pipeline between the Tiedmans property and WK13;
- enclosed central gas flare/s;
- delivery of equipment (and water) to undertake the activity;
- lawful disposal of flowback water;
- lawful disposal of produced water;
- suspension of exploration wells following completion of pilot testing; and
- site rehabilitation.

The REF was prepared in accordance with *ESG2: Environmental Impact Assessment Guidelines* (Mineral Resources Environmental Sustainability Unit, 2012) (the ESG2 guidelines) and its draft supplement for petroleum prospecting, which came into force in April 2012.

The REF assessed different options for the location of ancillary infrastructure for the proposed activity, depending upon operational needs at the time of construction.

In response to comments on the REF by the OCSG and other regulatory agencies, a preferred activity report (PAR) (EMM 2013b) was prepared. The PAR presented a description of the preferred activity, its methods and environmental assessment. Additional information requested by the OCSG, Environmental Protection Authority (EPA), Office of Environment and Heritage (OEH) and NSW Office of Water (NOW) about the preferred activity were also included. The PAR was submitted to the OCSG on 4 December 2013, as an addendum to the REF.

The preferred activity relates to:

- conversion of four existing exploration wells (WK11, WK12, WK13 and WK14) to pilot wells using perforation and fracture stimulation techniques;
- pilot testing of the four wells;
- construction of a water storage area at WK13 for flowback and produced water, called the 'water staging point';
- construction of a buried water pipeline and water and gas gathering lines;
- construction of an enclosed central gas flare/s at WK12;
- delivery of equipment (and water) to undertake the activity;
- lawful disposal of flowback water;
- lawful re-use or disposal of produced water;
- suspension of exploration wells following completion of pilot testing; and
- site rehabilitation of disturbed land including construction laydown areas, access tracks and gas gathering pipeline verges.

Since the PAR was submitted, the Waukivory Pilot has undergone further consultation including with Gloucester Dialogue and Community Consultation Committee, and engineering review by AGL and AGL now seeks to update the description of the preferred activity (the Preferred Activity).

The purpose of this Further Addendum to the Review of Environmental Factors for the Waukivory Pilot Project (Further Addendum) is to provide a description of the Preferred Activity so that it can be considered in the assessment of the application for the Waukivory Pilot under Part 5 of the EP&A Act.

In summary, the proposed changes to the preferred activity referred to in the PAR are:

- water and gas gathering lines between WK13 and WK14 are to be installed by horizontal directional drilling (HDD) under Waukivory Creek rather than an above-ground crossing;
- in relation to WK13, two 1.5 ML above-ground tanks will be used at the water staging point rather than a turkeys nest dam and a 10 x 25 m area will be added to the 100 x 100 m footprint of WK13 to accommodate infrastructure during the perforation, fracture stimulation and initial flow testing phase; and
- in relation to WK12, three 20 foot flares will be used for flow testing all pilot wells, ie WK11, WK12, WK13 and WK14, rather than a single central flare (40 foot) and secondary flare (20 foot) (which would be installed beside the central flare in the event that initial flow from the pilot test identifies that gas production exceeds the central flare's operating capacity).

This Further Addendum includes:

- an overview of the Waukivory Pilot;
- a description of the Preferred Activity, focusing on the refinements AGL has made having regard to consultation activities and engineering review;
- environmental assessment of the proposed changes to the preferred activity and management measures;
- consideration of the proposed changes to the preferred activity and any impacts on matters of national environmental significance (MNES);
- consideration of any additional cumulative impacts to those reported in the REF and PAR; and
- conclusion.

2 The activity in the review of environmental factors and preferred activity report

The REF described the proposed activity as including:

- conversion of four existing exploration wells (WK11, WK12, WK13 and WK14) to pilot wells using perforation and fracture stimulation techniques;
- pilot testing of four wells;
- construction of water storages for flowback and produced water;
- construction of associated infrastructure including water and gas gathering lines and a water pipeline between the Tiedmans property and WK13;
- enclosed central gas flare/s;
- delivery of equipment (and water) to undertake the activity;
- lawful disposal of flowback water;
- lawful disposal of produced water;
- suspension of exploration wells following completion of pilot testing; and
- site rehabilitation.

The REF assessed different options for the location of ancillary infrastructure for the Waukivory Pilot. The preferred activity referred to in the PAR includes:

- conversion of four existing exploration wells (WK11, WK12, WK13 and WK14) to pilot wells using perforation and fracture stimulation techniques;
- pilot testing of the four wells;
- construction of a water storage area at WK13 for flowback and produced water, called the 'water staging point';
- construction of a buried water pipeline and water and gas gathering lines;
- construction of an enclosed central gas flare at WK12;
- delivery of equipment (and water) to undertake the activity;
- lawful disposal of flowback water;
- lawful re-use or disposal of produced water;
- suspension of exploration wells following completion of pilot testing; and

- site rehabilitation of disturbed land including construction laydown areas, access tracks and gas gathering pipeline verges.

3 The Preferred Activity

This section describes the proposed changes to the preferred activity described in the PAR. No change to the overall layout of the Preferred Activity is proposed. In summary, the proposed changes to the preferred activity referred to in the PAR are:

- water and gas gathering lines between WK13 and WK14 are to be installed by HDD under Waukivory Creek rather than an above-ground crossing;
- in relation to WK13, two 1.5 ML above-ground tanks will be used at the water staging point rather than a turkeys nest dam and a 10 x 25 m area will be added to the 100 x 100 m footprint of WK13 to accommodate infrastructure during the perforation, fracture stimulation and initial flow testing phase; and
- in relation to WK12, three 20 foot flares will be used for flow testing all pilot wells, ie WK11, WK12, WK13 and WK14, rather than a single central flare (40 foot) and secondary flare (20 foot) (which would be installed beside the central flare in the event that initial flow from the pilot test identifies that gas production exceeds the central flare's operating capacity).

The Preferred Activity (subject of AGL's application for activity approval) is:

- conversion of four existing exploration wells (WK11, WK12, WK13 and WK14) to pilot wells using perforation and fracture stimulation techniques;
- pilot testing of the four wells;
- construction of an above ground water storage area at WK13 for flowback and produced water, called the 'water staging point';
- construction of a buried water pipeline and water and gas gathering lines;
- construction of an enclosed central gas flares at WK12;
- delivery of equipment (and water) to undertake the activity;
- lawful disposal of flowback water;
- lawful re-use or disposal of produced water;
- routine daily operator inspections of wells, monitoring of water quality and quantity, and workover maintenance during the production testing phase;
- suspension of exploration wells following completion of pilot production testing; and
- site rehabilitation of disturbed land including construction laydown areas, access tracks and gas gathering pipelines verges.

Due to timing, the contractor for fracture stimulation may change. The Fracture Stimulation Management Plan, Human Health and Ecological Risk Assessment and Environmental Incident Response Plan will be updated to take into account any changes to the fracture stimulation program.

3.1 Water and gas gathering lines

The PAR states that the gathering lines will be buried, except across Waukivory Creek (between WK13 and WK14), where they will cross the existing road bridge above-ground.

Upon further engineering review, the condition of the existing road bridge was determined to be unsuitable for an above-ground crossing of Waukivory Creek. It is now proposed that the gathering lines in this location be installed by HDD under Waukivory Creek. The Waukivory Creek crossing will require an approximate 80 m underbore and will be more than 4.5 m below the bed of Waukivory Creek. The location of the drill entry and receiving pits will not require vegetation removal and will be near the existing track. The construction pads for these sites will be up to 40 x 40 m and 20 x 20 m respectively and the drill entry point, ie the 40 x 40 m construction pad, will be on the western side of the creek.

Site establishment for the underbore will include establishment of controls at the construction pads including (but not limited to) sediment control, site fencing, drill entry and receive pits, and controls to prevent water entering the site.

A detailed description of the HDD method and environmental management measures for the underbore activities required for the Waukivory Pilot are provided in the PAR. The PAR included an HDD – Fluid Management Plan. A cross section of the Waukivory Creek underbore is shown in Figure 3.1. As mentioned previously, the drill entry construction pad will be on the western side of the creek.

3.2 Well surface infrastructure

3.2.1 WK13 layout

The PAR states that each of the four pilot wells will cover an area of 100 x 100 m and a water staging point comprising a doubled-lined, dual compartment turkeys nest dam will be constructed at WK13.

Taking into account feedback from regulatory agencies, consultation with the landowners and the Gloucester Dialogue and Community Consultation Committee and upon further engineering review, the use of above-ground tanks is proposed to replace the in-ground turkeys nest dam.

Temporary above-ground tanks were considered more viable due to the limited area available at WK 13 for the water staging point, as well as having greater environmental benefits and less community concerns than the in-ground turkeys nest dam.

It is now proposed to use two temporary 1.5 ML above-ground tanks at the water staging point rather than a turkeys nest dam. One tank will be for the management of source water and produced water (1.5 ML; 2.3 m high x 30 m diameter), ie 1.5 ML source water/produced water tank and the second tank will be used for the management of flowback water (1.5 ML; 2.3 m high x 30 m diameter), ie 1.5 ML flowback tank. The 1.5 ML flowback tank will only be at the water staging point while flowback water is being managed in the initial flow testing phase, after which, it will be dismantled and removed from the site. Also due to the limited area available at WK13, an extension to the 100 x 100 m footprint measuring 10 x 25 m is now proposed. The 10 x 25 m extension area will accommodate infrastructure, ie water tanks, required for the fracture stimulation of this well and will be used for the short duration of that phase of the activities.

The 1.5 ML temporary above-ground tanks will be constructed with galvanised steel and designed and certified by a registered professional engineer based on site constraints such as geotechnical characteristics, location, topography and flood flows. The proposed design height of 2.3 m will provide at least 500 mm freeboard to the 1 in 100 year AEP flood level. At full capacity of 1.5 ML, the above-ground

tanks will have a freeboard of 200 mm. However, operating procedures for the above-ground tanks will include maintenance of approximately 500 mm freeboard at all times to allow for heavy rainfall event. The above-ground tanks will have a double liner system consisting of a polyethylene primary liner and a linear low density polyethylene secondary liner for leak detection and collection.

The 10 x 25 m extension area will require site preparation. Site preparation will include topsoil stripping and laying gravel to level the area. A containment bund will be installed around the outside of the 10 x 25 m extension area to ensure any spills are contained to the site.

There are no proposed changes to the source of water for fracture stimulation or the management of flowback water and produced water as described in the PAR.

The proposed above-ground tanks reduce potential environmental impacts by minimising the area of land disturbance required to establish the water staging point at WK13. Potential off site interactions with the community are also reduced as less truck movements will be required for the installation and decommissioning of the above-ground tanks compared to construction of the turkeys nest dam. In addition, potential impacts from flood obstruction which were previously assessed as negligible, will be further reduced as the combined dimensions of the 1.5 ML above-ground water tanks is less than the dual compartment turkeys nest dam.

i Layout during perforation and fracture stimulation phase

The conceptual layout of WK13 during the perforation, fracture stimulation and initial flow testing phase is shown on Figure 3.2.

During this phase a 1.5 ML source water/produced water tank will be at the water staging point. Source water for the fracture stimulation of each of the four wells will be supplied via this tank and the water gathering lines. Infrastructure required for fracture stimulation activities at the WK13 well will be located on the 10 x 25 m extension area during this phase. This infrastructure includes water tanks which will be used to manage water associated with the fracture stimulation equipment. A bund will be installed around the outer edge of this area to ensure any water spills from these tanks are contained to the site.

ii Layout during production testing phase

The conceptual layout of WK13 during the flow testing phase is shown on Figure 3.2.

During the flow testing phase, a second 1.5 ML above-ground tank will be installed at the water staging point for the management of flowback water, ie 1.5 ML flowback tank.

The 1.5 ML flowback tank will receive flowback water from the four wells via the water gathering lines. The tank will be removed from the water staging point when 100% of the volume of fracture fluid has been recovered from the wells and removed from the water staging point via trucks, as per the PAR.

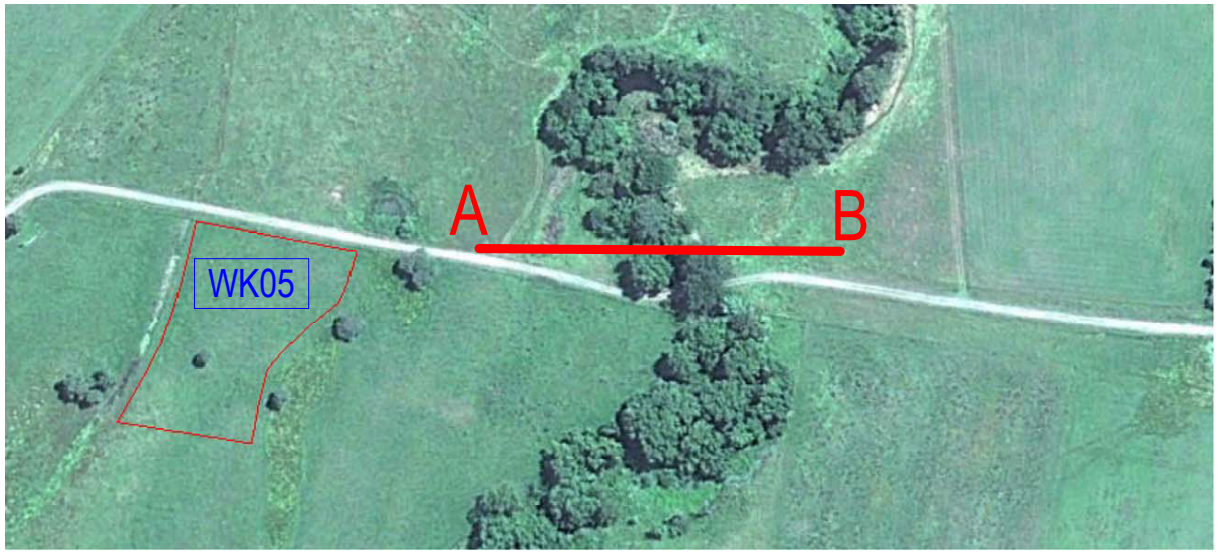
Produced water from the wells will then be pumped to the 1.5 ML source water/produced water tank at the water staging point via the water gathering lines. The 1.5 ML source water/produced water tank may be replaced by a smaller tank(s) during the flow testing phase as the volume of produced water being pumped from the wells decreases.

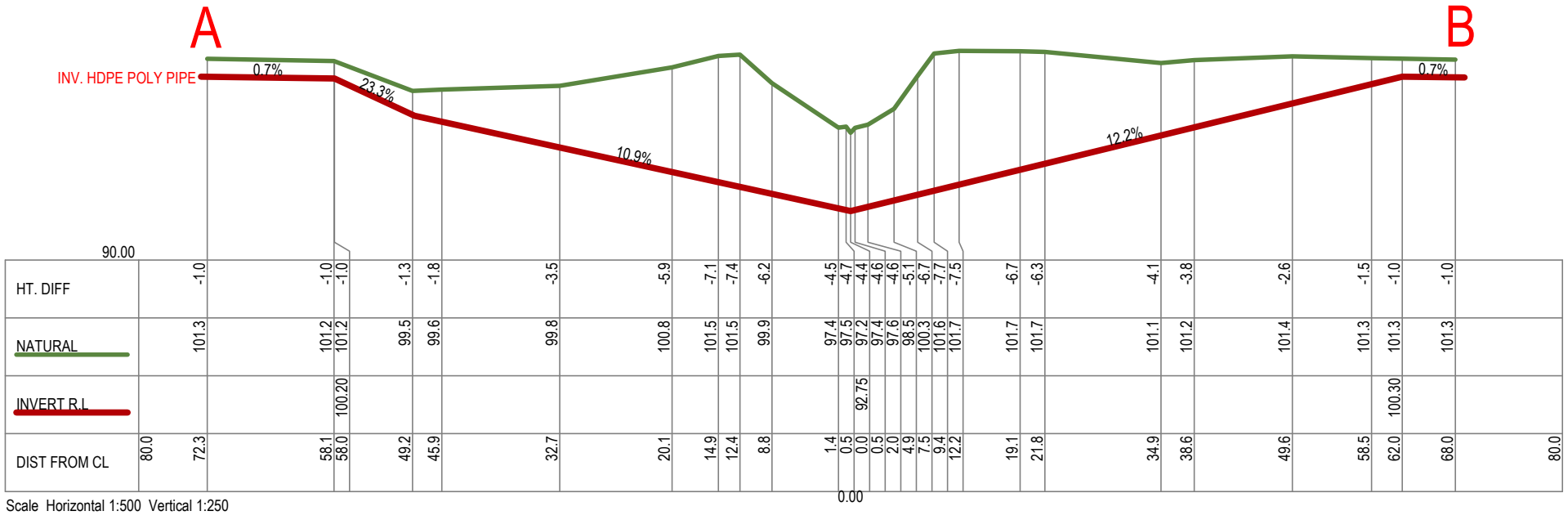
3.2.2 WK12 layout

The PAR stated that a central flare/s will be at WK12 for all pilot wells (WK11, WK12, WK13 and WK14) and in the event that initial flow from the pilot test identifies that gas production is likely to exceed the single 40 foot flare's operating capacity, a secondary smaller 20 foot flare would be installed beside the central flare at WK12.

Upon further engineering review, it is now proposed to install three 20 foot flares at WK12 rather than the two flares. Use of three 20 foot flares allows for greater operational efficiency with the ramping up of gas during the production testing phase, ie more tailored approach to the variability of gas flow in the initial flow testing period. Gas gathering lines will connect the flares and the pilot wells. The flares will be enclosed to mitigate noise and visual impacts. The three flares will have a small additional footprint of about 38 x 30 m and remain within the 100 x 100 m footprint of WK12.

The conceptual layout of WK12 during the production testing phase is shown on Figure 3.3. The proposed changes to the preferred activity provides a benefit by improving operational efficiency during the production testing phase, ie flares can be staged as gas production increases across the four wells.





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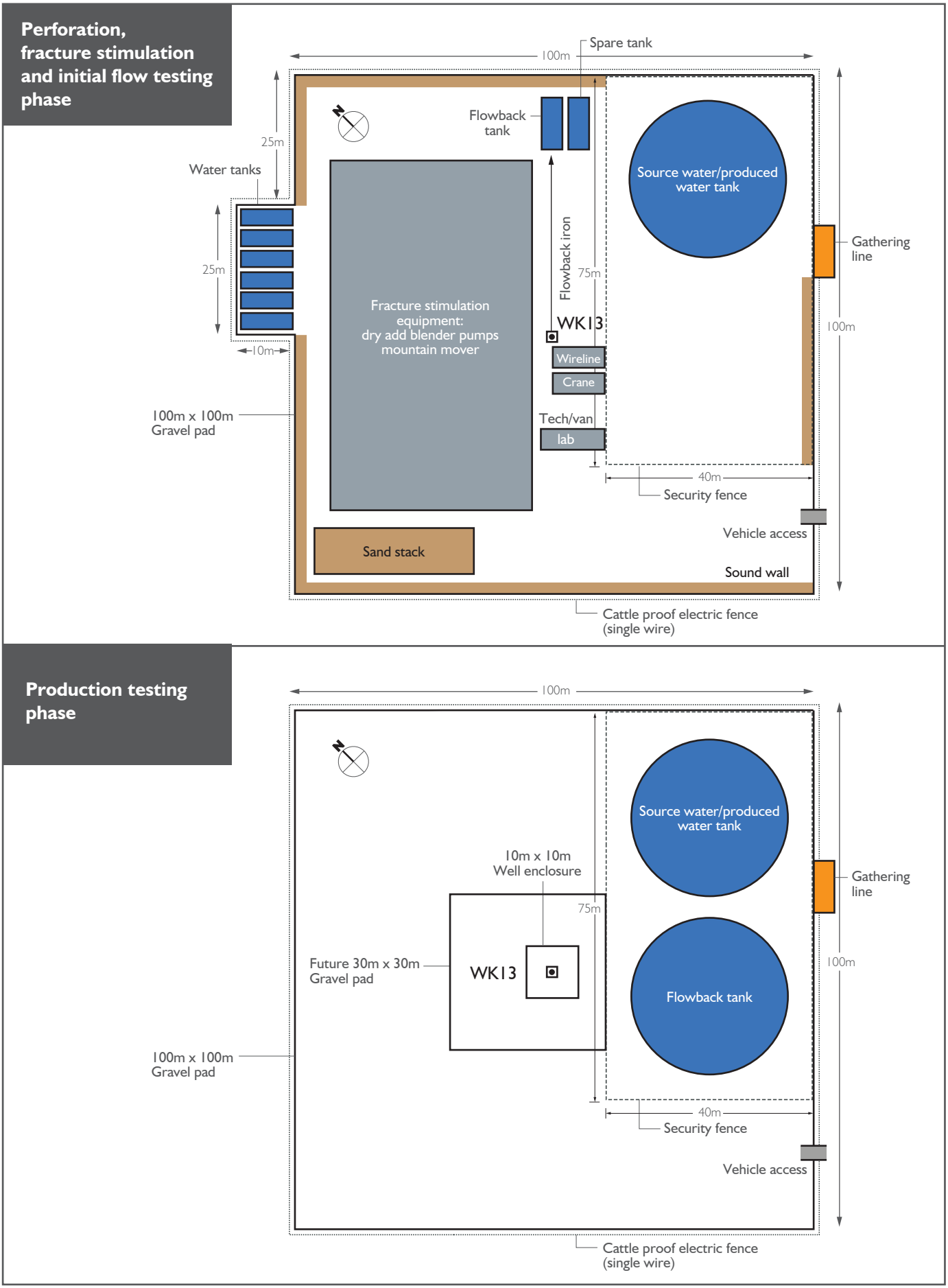
Cross section of proposed Waukivory Creek underbore

Proposed change to the preferred activity
Waukivory Pilot Project

Figure 3.1



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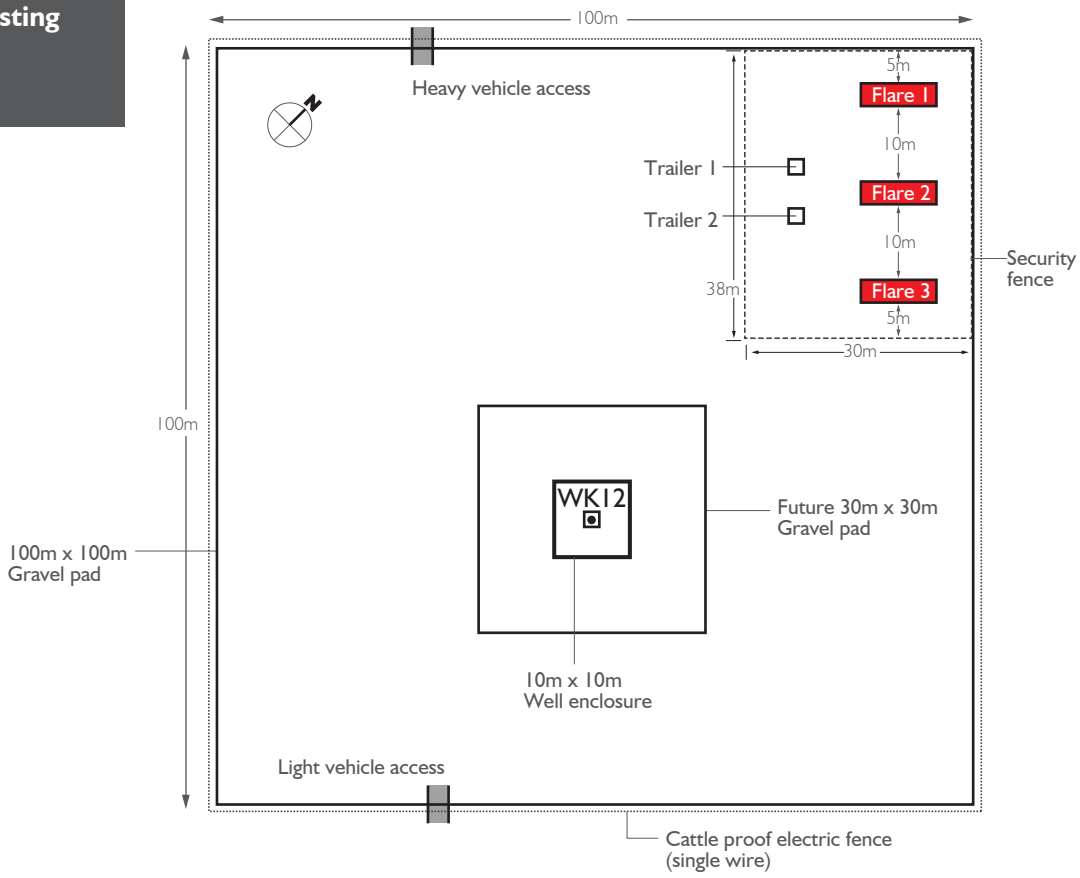
WK13 conceptual site layout
Proposed change to the preferred activity
Waukivory Pilot Project
Figure 3.2

Perforation, fracture stimulation and initial flow testing phase

The conceptual site layout is unchanged.
Refer to Figure 2.4 in the Addendum to the Review of Environmental Factors.

Production testing phase



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WK12 conceptual site layout
Proposed change to the preferred activity
Waukivory Pilot Project
Figure 3.3

4 Impact assessment

Chapters 6 to 12 of the REF include an analysis of the environmental impacts of the proposed activity in accordance with section 111 of the EP&A Act, clause 228 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) and the ESG2 guidelines and the draft supplement. The extent, size, scope, intensity and duration of each impact was assessed in the REF so that the responsible determining authority, in this case the OCSG, can examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity in determining the proposal.

Chapters 3 to 10 of the PAR include an assessment of the impacts of the preferred activity.

This Further Addendum has been prepared for the purpose of assessing the environmental impacts of the proposed changes to the preferred activity.

To support the assessment of environmental impacts, two specialist studies were undertaken including an ecological assessment and Aboriginal heritage assessment of potential new disturbance areas including the underbore of Waukivory Creek and the 10 x 25 m extension of the footprint at WK13. These studies are presented in Appendix A and Appendix B respectively.

5 Physical and chemical impacts

5.1 Soil quality and land stability

Effects on soil quality and land stability were assessed in Section 6.1 of the REF and Section 4.1 of the PAR, and aspects relevant to the changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

5.1.1 Impact assessment

i Water and gas gathering lines

There will be a small area of additional soil disturbance for the underbore of Waukivory Creek. To enable the underbore to occur, construction pads at the HDD entry and exit points will be established on each side of Waukivory Creek. Site establishment for the HDD crossing will include establishment of controls at the construction pads including (but not limited to) sediment control, site fencing, drill entry and receive pits, and controls to prevent water entering the site.

The implementation of the mitigation strategies outlined in the REF, the PAR and the HDD - Fluid Management Plan for the proposed underbore of the Avon River between WK11 and WK12 is considered appropriate to manage and minimise impacts to soil quality and land stability for the underbore of Waukivory Creek.

ii Well surface infrastructure

The 100 x 100 m area of each well has been previously assessed and approved with the drilling of the well (EMM 2011).

The above-ground tanks at the water staging point at WK13, ie source water/produced water tank and flowback tank will be located in an approximate area of 40 x 75 m. As shown on Figure 3.2, this area is fully contained in the previously approved 100 x 100 m footprint for the drilling of the well.

During the perforation and fracture stimulation phase an area of 10 x 25 m will be added to the 100 x 100 m footprint at WK13. Topsoil will be stripped from this area and gravel laid in preparation for water tanks which will feed water to the fracture stimulation equipment. A bund will be installed around the outer edge of this area to ensure any water spills from these tanks are contained to the site.

The three 20 foot flares at WK12 will be in an approximate secured area of 30 x 38 m. As shown on Figure 3.3 this area is fully contained in the previously approved 100 x 100 m footprint for the drilling of the well.

The implementation of the mitigation strategies outlined in the REF is considered appropriate to manage and minimise impacts to soil quality and land stability.

5.1.2 Summary

Impacts to soil quality and land stability from the proposed changes to the preferred activity are considered to be negligible. The mitigation strategy in the REF and the PAR has been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.2 Surface water

Effects on surface water have been considered in Section 6.2 of the REF and Section 4.2 of the PAR, and aspects relevant to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

5.2.1 Impact assessment

i Water and gas gathering lines

Installation of water and gas gathering lines to connect WK13 with the other wells, ie WK11, WK12 and WK14, will now involve underboring Waukivory Creek east of WK13 by HDD.

The drill will start at the entry point and drill about 80 m under Waukivory Creek to the exit point on the other side of the creek. Pipe lengths are prefabricated and then pulled through the completed bore hole. The depth of underboring will be more than 4.5 m below the bed of Waukivory Creek as shown on Figure 3.1.

There will be no disturbance of the bed or banks of Waukivory Creek or the natural movement of water in the watercourse.

The underboring entry and exit points will be securely bunded to prevent the release of drilling fluid from excavated material or spills entering the surrounding environment.

The bed of the watercourse lies in the alluvium and not bedrock. However, in the unlikely event that the underbore intersects with a natural fracture in the bed of the watercourse, a potential release of drilling fluid could occur. This would have the potential to impact the watercourse, ie turbidity and contamination, until the drilling fluid is contained and the leak is sealed. The risk of such an event occurring is unlikely, and will be managed through implementation of measures outlined in the PAR, ie the HDD - Fluid Management Plan. The HDD method is itself a mitigation to avoid impacts to sensitive watercourse and riparian vegetation. In addition, geotechnical assessment of the underbore alignment will be done and the underbore will be designed to avoid any potential geotechnical issues, eg fractures in the bed of the watercourse.

The HDD - Fluid Management Plan in the PAR outlines safeguards to prevent drilling fluids being lost to the environment, inspection procedures and volumetric drilling fluid tracking procedures. It also includes the requirement for site-specific geotechnical investigations to be undertaken prior to underboring to identify the geology, potential issues and to select appropriate underboring equipment. The underbored pipe is a sufficient depth beneath the watercourse to minimise the risk of contamination associated with natural faults in the riverbed.

The implementation of the mitigation strategy outlined in the REF (EMM 2013) and the PAR including the HDD - Fluid Management Plan is considered appropriate to manage and minimise impacts to water bodies, watercourses, wetlands and natural drainage systems for the proposed changes to the preferred activity, that is, the underbore of Waukivory Creek.

ii Well surface infrastructure

One of the proposed changes to the preferred activity is the replacement of the turkeys nest dam at the WK13 water staging point with two 1.5 ML above-ground tanks measuring 2.3 m high x 30 m diameter. One dam will be used for the storage of source water and produced water and the second dam will be used for the storage of flowback water.

The above-ground tanks will be constructed with galvanised steel and designed and certified by a registered professional engineer based on site constraints such as geotechnical characteristics, location, topography and flood flows. The proposed design height of 2.3 m will provide at least 500 mm freeboard to the 1 in 100 year AEP flood level. At full capacity, 1.5 ML, the above-ground tanks will have a freeboard of 200 mm. However, operating procedures for the above-ground tanks will include maintenance of approximately 500 mm freeboard at all times to allow for heavy rainfall events. The above-ground tanks will have a double liner system consisting of a polyethylene primary liner and a linear low density polyethylene secondary liner for leak detection and collection.

Construction of the above-ground tanks requires limited site preparation, ie no significant excavation. Therefore there is limited potential for construction to significantly impact on surface water quality.

Water tanks will be in the 10 x 25 m extension area at WK13. These water tanks will be used to store source water and will feed into the fracture stimulation equipment. A containment bund will be constructed around the 10 x 25 m extension area to capture any spills from the water tanks. Therefore, there is limited potential for the water tanks in the 10 x 25 m extension area at WK13 to significantly impact surface water quality.

A footprint of about 38 x 30 m will be required for the three 20 foot flares at WK12. Minimal site preparation will be required, ie no significant excavation, and the area will be in the previously approved 100 x 100 m footprint for the drilling of the well. Therefore there is limited potential for three 20 foot flares at WK12 to significantly impact on surface water quality.

The implementation of the mitigation strategy outlined in the REF is considered appropriate to manage and minimise impacts to surface water of the replacement of the turkeys nest dam with the above-ground tanks.

5.2.2 Summary

Impacts to surface water from the proposed changes to the preferred activity are considered to be negligible. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.3 Groundwater

Effects on groundwater levels and quality have been assessed in Section 6.2 of the REF and Section 4.3 of the PAR, and aspects relevant to the changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

In addition, an assessment of potential impacts to groundwater dependent ecosystems (GDEs) was done for the ecological assessment of the changes to the preferred activity (Appendix A).

5.3.1 Impact assessment

i Water and gas gathering lines

Potential impacts on the shallow alluvial aquifer could include groundwater mixing with drilling fluid and fuel, oil and grease as a result of the underbore of Waukivory Creek. These impacts could result from groundwater ingress to the drilling annulus or encountering underlying cracks or fissures in the underlying geological formation.

A HDD - Fluid Management Plan has been developed for the underbore which outlines safeguards to prevent drilling fluids being lost to the environment, inspection procedures and volumetric drilling fluid tracking procedures. It also includes the requirement for site-specific geotechnical investigations to be undertaken prior to underboring to identify the geology, potential issues and to select appropriate underboring equipment.

The ecological assessment (Appendix A) identified River Oak and Swamp Oak as native species being indicative of the River-flat Eucalypt Forest endangered ecological community which has high potential to be a GDE. The underbore at Waukivory Creek will not require the removal of any native vegetation and only minimal disturbance to the root zone of some remnant trees. It is unlikely that the HDD would result in significant impacts to vegetation that may rely on shallow alluvial groundwater resources, ie native species indicative of a potential GDE.

The implementation of the mitigation strategies outlined in the REF and the HDD - Fluid Management Plan are considered appropriate to manage and minimise impacts to shallow beneficial aquifers of the Preferred Activity.

ii Well surface infrastructure

The 10 x 25 m extension to the 100 x 100 m footprint of WK13 will have no additional impact to the shallow beneficial aquifers to those already assessed in the REF.

The proposed replacement of the turkeys nest dam at WK13 with temporary above-ground water tanks means no deep excavation at WK13, ie for the construction of the turkeys nest dam, will be required.

The above-ground tanks will be designed to minimise the risk of leaching and potential contamination of the alluvial aquifer. They will have a double liner system consisting of a polyethylene primary liner and a linear low density polyethylene secondary liner for leak detection and collection.

The flares at WK12 will have no additional impact on the shallow beneficial aquifer.

The implementation of the mitigation strategy outlined in the REF is considered appropriate to manage and minimise impacts of the proposed replacement of the turkeys nest dam with the temporary above-ground water tanks to shallow beneficial aquifers.

5.3.2 Summary

Impacts to groundwater from the proposed changes to the preferred activity are considered to be negligible. The mitigation strategy in the REF and the PAR has been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.4 Flooding

A qualitative assessment of flooding was presented in Section 6.4 of the REF.

A quantitative assessment of floodplain obstruction and contingency management of the preferred activity has been completed by WRM and is provided in the PAR.

5.4.1 Impact assessment

i Water and gas gathering lines

The proposed installation of water and gas gathering lines by HDD under Waukivory Creek effectively removes the interaction between the gathering lines and flood water at Waukivory Creek. Therefore, flood impacts are expected to be negligible.

The implementation of the mitigation strategy outlined in the REF is considered appropriate to manage flood impacts for the Preferred Activity.

ii Well surface infrastructure

The WRM flood assessment in the PAR concluded that the risk of flooding from the Waukivory Pilot is negligible.

Well surface infrastructure at WK12, WK13 and WK14 is within the 1 in 100 year AEP flood level. The proposed changes involve some minor changes to well surface infrastructure at WK12 and WK13. Well surface infrastructure including the temporary above-ground water tanks at WK13 and the three 20 foot flares at WK12 are relatively small and were considered by the WRM flood assessment to be insignificant from a flood impact point of view.

The proposed changes to the preferred activity do not include any significant change to the noise barriers assessed in the PAR. WRM considered noise barriers to be the most significant infrastructure from a flood impact point of view.

The risk of a significant flood event resulting in the mixing of flowback water or produced water with flood waters is also very small. The well heads are fully enclosed and water gathering lines buried. The above-ground water tanks at WK13 will be constructed to have 500 mm freeboard above the 1 in 100 year AEP flood level and an operating freeboard of 500 mm will be maintained in the water tanks at all times to allow for heavy rainfall. The maintenance of an operating freeboard will be monitored through the AGL 'daily environmental checklist' procedure and remotely monitored and alarmed continuously through telemetry. The water tanks will be designed and flood certified by a registered practicing engineer.

The implementation of the mitigation strategy outlined in the REF and the PAR are considered appropriate to manage flood impacts and minimise the impacts of floodplain obstruction arising from the Preferred Activity.

Measures to protect the flood plain, as stated in the REF and PAR, include:

- the 1.5ML above-ground water tanks at the water staging point will be designed to have 500 mm freeboard above the 1 in 100 year AEP flood level to prevent overtopping during a flood event. This will prevent the mixing of flowback water and produced water with flood waters;

- the operating procedure for the 1.5ML above-ground water tanks at the water staging point will include maintaining 500 mm freeboard in the tanks at all times. The level of freeboard in the tanks will be monitored through the AGL 'daily environment checklist' procedure;
- weather will be monitored, and in the event of a flood pumping will cease and any flowback water levels will be decreased through transportation to appropriate facilities;
- measures in the AGL procedure DCS_GLO_DC_PR_010 Exploration Drilling Flood Management relevant to the pilot program will be implemented;
- noise barriers will only be installed on site for the duration of fracturing, ie 14 days; and
- if enough time is allowed prior to a flood, noise barriers will either be dropped flat or opened to allow water flow through the area.

5.4.2 Summary

Impacts from flood and flood obstruction resulting from the proposed changes to the preferred activity are considered to be negligible. Construction of above-ground storage tanks provides a benefit to the overall flood risk. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.5 Fracture stimulation chemicals and flowback water

Hazardous materials and chemical use have been assessed in Section 6.5 of the REF. Disposal of flowback water was assessed in Section 6.6.1 of the REF. For further detailed information, please refer to the REF and the PAR.

5.5.1 Impact assessment

There is no change to hazardous materials and chemical use or the disposal of flowback water. The implementation of the mitigation strategy outlined in the REF is considered appropriate to manage and minimise impacts to human health and ecology of the Preferred Activity.

If the contractor for fracture stimulation changes, the Fracture Stimulation Management Plan, Human Health and Ecological Risk Assessment and Environmental Incident Response Plan will be updated to take into account any changes to the fracture stimulation program.

5.5.2 Summary

The proposed changes to the preferred activity will not result in any change to the management and handling of fracture stimulation chemicals or flowback water. The potential impacts to the environment remain low adverse. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.6 Emissions

Emissions were assessed in Section 6.7 of the REF and Section 4.6 of the PAR, and aspects relevant to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

5.6.1 Impact assessment

i Well surface infrastructure

Gas from WK11, WK12, WK13 and WK14 will be directed to three 20 foot enclosed flares at WK12. There is no change to the estimated gas flow from the Waukivory Pilot which will be monitored by telemetry during the program.

The air quality assessment in the REF predicted that low emissions are expected with a minor amount of pollutants escaping to the atmosphere. It also predicted that potential air quality emission concentrations at receivers from the flares at WK12 would not approach EPA air quality criteria, particularly given the distance of flares to identified sensitive receivers (greater than 500 m).

5.6.2 Summary

The proposed changes to the preferred activity will not result in any change to emissions from the flaring of gas at WK12. The potential impacts to the environment remain negligible adverse. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

5.7 Noise and vibration

Noise and vibration were assessed in Section 6.8 of the REF and Section 4.7 of the PAR, and aspects relevant to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

5.7.1 Impact assessment

i Water and gas gathering lines

The nearest sensitive receivers are more than 500 m from the Waukivory Creek underbore. The underbore activity will be temporary, lasting approximately 14 days. Potential impacts at sensitive receivers from noise associated with trenching and pipeline construction activities were assessed in the REF and considered to be low adverse. Construction of the underbore will be done Monday to Friday 7 am – 6 pm and Saturday 8 am – 1 pm. No construction work will take place on Sundays or public holidays.

With the implementation of the mitigation strategy outlined in the REF and the PAR impacts of noise on sensitive receivers from trenching and pipeline construction including underboring activities are considered to be negligible.

ii Well surface infrastructure

Purpose built 20 foot horizontal enclosed flares (type B compliant) will be used at WK12. The noise and vibration assessment in the REF states that enclosing the flares reduces the noise level of each flare by at least 5 dB. The noise assessment in the REF modelled the predicted noise levels for the combined noise

levels of all four wells flaring simultaneously, as a worst-case scenario. The results show that the predicted noise from flaring at WK12 satisfies noise criteria at all receivers. Therefore, noise impacts from flaring at WK12 are considered to be negligible.

5.7.2 Summary

The proposed changes to the preferred activity will not result in any significant change to noise impacts on sensitive receivers. The potential impacts to sensitive receivers remain negligible. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

6 Biological impacts

Biological impacts were assessed in Section 7 of the REF and the PAR with relevant aspects to the proposed changes to the preferred activity summarised in this section. For further detailed information, please refer to the REF and the PAR.

In addition, an ecological assessment was done for the proposed changes to the preferred activity (Appendix A). This assessment included a further ecological assessment of the Avon River underbore.

6.1 Impact assessment

6.1.1 Water and gas gathering lines

The proposed route of the underbore at Waukivory Creek will not require the removal of any native vegetation and will avoid the tree protection zone of any remnant native trees. The tree protection zone is the minimum area around a tree that must be left undisturbed to protect the root system and maintain the health and stability of the tree. Therefore, it is unlikely the underbore will significantly impact on any native trees or cause a decline in health or stability of the trees present.

Construction pads for drill entry and receiving pits, measuring 40 x 40 m and 20 x 20 m respectively, will be constructed. The construction pads will be in ploughed fields dominated by exotic grasses and no native vegetation clearing will be required. No threatened plants, threatened ecological communities or threatened fauna species were recorded in proximity to the Waukivory Creek underbore location.

Exotic grassland habitat is likely to provide potential foraging habitat for the threatened Grass Owl (*Tyto longimembris*), listed as a vulnerable species under the *Threatened Species Conservation Act 1995* (TSC Act), and migratory birds including the Cattle Egret (*Ardea ibis*), Great Egret (*Ardea alba*) and Lathams's Snipe (*Gallinago hardwickii*) listed as MNES under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). As there is an abundance of similar habitat available for fauna in the area, clearing of the exotic grassland habitat will not significantly impact on any threatened or migratory species listed under the TSC Act or the EPBC Act.

The potential for indirect impacts from inappropriate sediment and erosion control, spills or pollution will be minimised through the implementation of the mitigation measures in the REF and the PAR which includes a HDD - Fluid Management Plan.

6.1.2 Well surface infrastructure

The 10 x 25 m extension of the 100 x 100 m footprint of WK13 is dominated by exotic species Kikuyu (*Pennisetum clandestinum*) and White Clover (*Trifolium repens*) and removal of native vegetation will not be required. No threatened plants, threatened ecological communities or threatened fauna species were recorded in proximity to WK13. The implementation of the mitigation strategy outlined in the REF and the PAR is considered appropriate to manage and minimise impacts to biological values of the Preferred Activity.

6.2 Summary

The proposed changes to the preferred activity will not result in any significant change to biological impacts. The potential impacts to biological values remain negligible. The mitigation strategy in the REF (EMM 2013) and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

7 Community impacts

Community impacts were assessed in Section 8 of the REF and Section 6 of the PAR. Relevant aspects to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

7.1 Impact assessment

7.1.1 Well surface infrastructure

The three smaller 20 foot flares, which are proposed to replace the central and secondary flare at WK12, are the same size as the contingency flare discussed in the REF, which would be introduced if the initial flow from the pilot test identified that gas production was likely to exceed the central flare's operating capacity.

The enclosure around the flares will act as a visual barrier to the gas flame and will be disguised in the landscape by using natural mid-green tones or similar colour on the walls. The flares will require a small additional area within the 100 x 100 m footprint of WK12. They will be in a 30 x 38 m section of the WK12 in the same location as previously proposed. The flares will be spaced about 10 m apart within this area, meaning there will be less visual obstruction to the landscape than if the containers were placed close together. The potential impact on visual amenity as a result of flaring gas during the night time is considered to be low adverse as the flame in each unit will be enclosed and direct views will not be possible.

The potential visual and scenic impacts of flaring at WK12 are discussed in Section 6.7 of the REF. The mitigation strategy outlined in the REF is considered appropriate given the nearest receiver is over 500 m away, the activity is temporary and the impact is negligible.

7.2 Summary

The proposed changes to the preferred activity will not result in any significant change to community resources including visual and scenic values. The potential impacts to community resources remain negligible. The mitigation strategy in the REF (EMM 2013) and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

8 Natural resource impacts

Natural resources impacts were assessed in Section 9 of the REF and Section 7 of the PAR. Relevant aspects to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

8.1 Impact assessment

8.1.1 Water and gas gathering lines

Soil will be disturbed for the underbore of Waukivory Creek. Areas of soil disturbance will be stabilised once construction is complete.

Site establishment for the HDD crossing will include establishment of controls at the construction pads including (but not limited to) sediment control, site fencing, drill entry and receive pits, and controls to prevent water entering the site.

Potential impacts of the proposed changes to the preferred activity are consistent with those assessed in the PAR for the preferred activity which is expected to have a negligible impact on land and soil following implementation of measures in the EMP included with the REF.

8.1.2 Well surface infrastructure

An additional area of soil disturbance would occur at WK13 for the preparation of the 10 x 25 m extension area. Soil would be disturbed to level the ground for the installation of water tanks and for the construction of a containment bund around this area. Areas of soil disturbance will be stabilised once construction is complete.

Potential impacts of the proposed changes to the preferred activity are consistent with those assessed in the PAR for the preferred activity which is expected to have a negligible impact on land and soil following the implementation of measures in the EMP included in the REF.

8.2 Summary

The proposed changes to the preferred activity will not result in any significant change to natural resource impacts. The potential impacts to natural resources remain negligible. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

9 Aboriginal and cultural heritage impacts

Aboriginal and cultural heritage impacts were assessed in Section 10 of the REF and Section 8 of the PAR, and relevant aspects to the proposed changes to the preferred activity are summarised in this section. For further detailed information, please refer to the REF.

An additional due diligence assessment was done for the proposed changes to the preferred activity in accordance with the NSW Minerals Council's 2010 code of practice: *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects*. The Aboriginal heritage assessment report is provided at Appendix B. The assessment involved a site inspection of the areas impacted by the proposed changes to the preferred activity. The water and gas gathering line between WK12 and WK13 via WK14 were also surveyed.

9.1 Impact assessment

9.1.1 Water and gas gathering lines

Construction pads for drill entry and receiving pits at the Waukivory Creek underbore are in ploughed fields dominated by exotic grasses. Although the construction pads will be close to Waukivory Creek, their landform context is not distinguishable from the surrounding area and the sites have evidence of previous ploughing. These areas were assessed as having low archaeological potential and no previously recorded Aboriginal sites will be impacted in these areas.

The impact areas for the water and gas gathering lines between WK12 and WK13 via WK14 are directly adjacent to existing access tracks. These areas were assessed to have very low archaeological potential and no previously recorded Aboriginal sites will be impacted in these areas by the proposed changes to the preferred activity.

No further Aboriginal heritage investigations are considered necessary for these areas. However, Aboriginal heritage management measures outlined in the EMP in the REF, ie for unexpected finds, will have to be implemented accordingly when required.

9.1.2 Well surface infrastructure

The 10 x 25 m extension of WK13 is in a highly disturbed grass paddock and was previously assessed in the REF (EMM 2011) as having low archaeological potential and the proposed extension will not change the outcomes of the original assessment.

No further Aboriginal heritage investigations are considered necessary. However, Aboriginal heritage management measures outlined in the EMP in the REF, ie for unexpected finds, will have to be implemented accordingly when required.

9.2 Summary

The proposed changes to the preferred activity will not result in any significant change to Aboriginal heritage impacts. The potential impacts to Aboriginal heritage remain negligible. The mitigation strategies in the REF and the PAR have been designed to manage and minimise impacts from the activity. These measures are considered appropriate and sufficient for the nature and duration of the Preferred Activity.

10 Impacts to matters of national environmental significance

The proposed changes to the preferred activity and the Preferred Activity itself do not have and are not likely to have a significant impact on any MNES.

11 Cumulative impacts

The cumulative environmental impacts of the preferred activity were assessed in Section 12.1 of the REF and section 10 of the PAR.

A number of environmental investigations were completed as part of the REF and consideration has been given to the wider area within the environmental assessments prepared as part of the REF and in the environmental investigations prepared as part of AGL's wider PEL 285 area.

It is considered that if the recommendations of the REF and appropriate controls are in place during the works, the proposed changes to the preferred activity and the Preferred Activity itself are unlikely to have any cumulative environmental impact.

12 Summary of impacts

The REF assessed the potential environmental impacts of the activity in accordance with section 111 of the EP&A Act, clause 228 of the EP&A Regulation and the ESG2 guidelines and its supplement. The factors to be taken into consideration by the determining authority under clause 228 of the EP&A Regulation and the assessment outcomes with regards to these factors were reported in the REF. As presented in Table 12.1, potential environmental impacts of the proposed changes to the preferred activity do not change the assessment outcomes and, in some cases, provide a reduction in impacts.

Table 12.1 Assessment outcomes with regards to Clause 228 of the EP&A Regulation

Factors that must be taken into consideration	Assessment of the preferred activity	Assessment of the proposed changes to the preferred activity
(1) For the purposes of Part 5 of the Act, the factors to be taken into account when consideration is being given to the likely impact of an activity on the environment include:		
(a) for activities of a kind for which specific guidelines are in force under this clause, the factors referred to in those guidelines, or	The activity is a petroleum prospecting (exploration) activity subject to assessment under Part 5 (and has not been approved under Parts 3A or 4). The activity has been assessed in accordance with ESG2 guidelines and its draft supplement for petroleum prospecting, as well as the CoPs (fracture stimulation activities and well integrity).	No change.
(b) for any other kind of activity:	N/A	No change.
(i) the factors referred to in the general guidelines in force under this clause, or	N/A	No change.
(ii) if no such guidelines are in force, the factors referred to subclause (2)	The proposed activity has been assessed in accordance with the guidelines and the factors referred to in the subclause (2) as indicated below.	No change.
(2) The factors referred to in subclause (1) (b) (ii) are as follows:		
(a) any environmental impact on a community,	The proposed activity was assessed in Chapter 8 and found to result in low adverse to positive impacts. The proposed activity will be short-term and can co-exist with existing agricultural practices and will result in minimal transformation to the locality.	No change. Environmental impacts on the community were assessed in Section 7 and remain unchanged.
(b) any transformation of a locality,	The proposed activity is complementary to the current landuse of the locality and is temporary. Section 2.8 describes proposed rehabilitation activities and rehabilitation objectives.	No change. No change in the layout of the preferred activity reported in the PAR.
(c) any environmental impact on the ecosystems of the locality,	Negligible biological impacts were assessed to result from the proposed activity.	No change. Negligible biological impacts were assessed to result from the proposed changes to the preferred activity.
(d) any reduction of the aesthetic, recreational, scientific or other	A visual and scenic assessment (Section 8.7) was undertaken and	No change. Visual impacts from flaring at WK12 remain temporary and

Table 12.1 Assessment outcomes with regards to Clause 228 of the EP&A Regulation

Factors that must be taken into consideration	Assessment of the preferred activity	Assessment of the proposed changes to the preferred activity
environmental quality or value of a locality,	assessed the proposed activity would have low adverse impacts and be short term. Nature heritage assessment (Section 9.2) concluded that the Stroud Gloucester Valley would also not be significantly affected by the proposed short-term activity.	negligible.
(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations,	Aboriginal and cultural heritage impacts have been assessed in Chapter 10. The assessment found the proposed activity will result in negligible impacts on aboriginal cultural heritage and negligible impacts on places, buildings, landscapes or moveable historic heritage items.	No change. An Aboriginal heritage assessment of the proposed changes to the preferred activity indicated negligible impacts on Aboriginal cultural heritage.
(f) any impact on the habitat of protected fauna (within the meaning of the NPW Act),	The biological impacts of the proposed activity are assessed in Chapter 7. As the proposed activity will occur in previously disturbed or cleared areas negligible impacts are expected on the habitat of protected fauna. Negligible impacts are expected (if any) to any matters of national environmental significance including threatened species, populations, communities or Ramsar wetlands.	No change. The proposed changes to the preferred activity will occur in previously disturbed or cleared areas and there is an abundance of similar habitat in the area. An ecological assessment of the proposed changes to the preferred activity indicates that negligible impacts are expected on the habitat of protected fauna. No MNES will be significantly impacted including species, populations, communities or Ramsar wetlands.
(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air,	The proposed activity will include several security and safety measures (ie telemetry system and SDV geophone and VWP) with regard to the environment and community. Further, a HHERA was undertaken and in accordance with relevant risk assessment methodologies to inform the proposed activities. The implementation of these safeguards as well as the ERP will ensure the appropriate and necessary requires levels of safety to the environment and community.	No change. The proposed changes to the preferred activity do not change the security and safety measures in the REF and the PAR.
(h) any long-term effects on the environment,	Physical and chemical impacts of the proposed activity including soil quality and land stability, water bodies, coastal processes, flooding, chemical use, waste and emissions and noise and vibration were discussed and assessed in Chapter 6. The impact level was assessed as negligible to low adverse.	No change. Physical and chemical impacts of the proposed changes to the preferred activity were assessed in Section 5.
(i) any degradation of the quality of the environment,	A visual and scenic assessment (Section 8.7) was undertaken and	No change. The overall layout of the preferred activity assessed in the REF

Table 12.1 Assessment outcomes with regards to Clause 228 of the EP&A Regulation

Factors that must be taken into consideration	Assessment of the preferred activity	Assessment of the proposed changes to the preferred activity
	assessed the proposed activity would have low adverse impacts and be short term. Nature heritage assessment (Section 9.2) concluded that the Stroud Gloucester Valley would also not be significantly affected by the proposed short-term activity.	and the PAR remains unchanged.
(j) any risk to the safety of the environment,	The proposed activity will include several security and safety measures (ie telemetry system and SDV geophone and VWP) with regard to the environment and community. Further, a HHERA was undertaken and in accordance with relevant risk assessment methodologies to inform the proposed activities. The implementation of these safeguards as well as the ERP will ensure the appropriate and necessary requires levels of safety to the environment and community.	No change. The proposed changes to the preferred activity do not include any change to the security and safety measures in the REF and the PAR.
(k) any reduction in the range of beneficial uses of the environment,	Community impacts including community services and infrastructure and visual and scenic impacts were assessed in Chapter 8. The proposed activity will have low adverse to positive impacts on beneficial uses of the environment by the community.	No change. Community impacts of the proposed changes to the preferred activity were assessed in Section 7.
(l) any pollution of the environment,	The disposal of wastes and emissions including flowback water is addressed in Section 6.6 and Section 6.7 respectively. Risks to human health and the environment were considered to be negligible to low adverse.	No change. The proposed changes to the preferred activity do not change the disposal of flowback water. The proposed changes to the preferred activity will not result in any change to emissions from the flaring of gas at WK12. The potential impacts to the environment from flaring remain negligible.
(m) any environmental problems associated with the disposal of waste,	As above.	No change, as above.
(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply,	Impacts on community resource use is addressed in Section 9.2 and will have negligible adverse impacts on roads, power, water, drainage, waste management, or education, medical and social services.	No change. The proposed changes to the preferred activity will not result in additional demand for community resources.
(o) any cumulative environmental effect with other existing or likely future activities.	Cumulative impacts have been addressed in Chapter 12 and were found to have a negligible to low adverse impact.	No change, refer to Section 11.

13 Conclusion

This Further Addendum describes the proposed changes to the preferred activity described in the PAR and the Preferred Activity subject of this Further Addendum. The Further Addendum also includes an environmental assessment of the proposed changes to the preferred activity.

There are community, operational and environmental benefits of the proposed changes to the preferred activity. The replacement of the turkeys nest dam with the temporary above-ground tanks at WK13 will reduce traffic movements for construction, result in less ground disturbance and reduce potential flood impacts (although they were already considered to be negligible). Replacement of the flares at WK12 with three smaller flares allows the activation of flares in stages as gas production increases during the production testing phase. By installing the water and gas gathering lines via an underbore at Waukivory Creek, the proposed change removes the interaction between the pipeworks and flood water, and any potential for flood impacts.

The environmental assessment concluded the proposed changes to the preferred activity will not result in any change to the impacts already reported in the REF and the PAR. The proposed changes to the preferred activity and the Preferred Activity itself do not have and are not likely to have a significant impact on any MNES. No additional cumulative impacts were identified.

The environmental assessment determined the proposed changes to the preferred activity do not change the assessment outcomes of the factors to be taken into consideration by the determining authority under clause 228 of the EP&A Regulation, nor the measures contained within the mitigation strategy.

Following the implementation of the mitigation strategy in the REF and the measures in the PAR, all impacts for the proposed changes to the preferred activity and the Preferred Activity itself are expected to remain negligible to low adverse.

References

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

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

EMGA Mitchell McLennan (EMM) 2013b, *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred Activity Report*, prepared for AGL Upstream Investments Pty Ltd.

Appendix A

Ecological assessment

Memorandum

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29 May 2014

To AGL
From Cassandra Thompson

Subject Waukivory Pilot ecological assessment of the changes to the preferred activity.

Dear Toni,

1 Introduction

This memorandum provides an updated ecological assessment in response to changes to the preferred activity presented in the report *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred activity report,* prepared in November 2013. The assessment has been undertaken by EMGA Mitchell McLennan (EMM) on behalf of AGL Upstream Investments Pty Ltd (AGL).

2 Background and method

A Review of Environmental Factors (REF) was completed by EMM for the Waukivory Pilot Project in 2011 (EMM 2011). Alison Hunt and Associated was commissioned to complete an ecological assessment of the exploration drilling at Waukivory.

A subsequent REF was completed by EMM in late 2013 for the pilot testing of these exploration sites (EMM 2013a). The information gathered by Alison Hunt and Associates formed a basis for the REF, with EMM completing additional surveys for the water pipeline route between the Tiedmans property and WK13. An addendum, the Preferred Activity Report (EMM 2013b), was prepared to the REF which included additional information requested by the Department of Trade and Investment, Regional Infrastructure and Services – Office of Coal Seam Gas. No additional ecological surveys were completed for this addendum.

This letter details the assessment for changes to the preferred activity outlined in the Preferred Activity Report. The assessment covers the following activities:

- The construction of water and gas gathering lines crossing Waukivory Creek by horizontal directional drilling (HDD). This activity includes the installation of drill rig construction pads covering an approximate area of 40 x 40 m on the western side of the creek and 20 x 20 m on the eastern side. This option will supersede the construction of hanging water and gas gathering pipelines that were proposed in the Preferred Activity Report.

- The north-western extension of the existing 100 x 100 m drill pad at WK 13 by an area of 10 x 25 m. This extension is required to accommodate above ground storage tanks.

In addition, this letter assesses the potential for impacts to riparian vegetation along the Avon River from proposed under-boring activities covered in the Preferred Activity Report, which were not previously assessed.

This memorandum is based on existing information and surveys completed for the project. Updated threatened species database searches (NPWS Atlas and SPRAT database) were completed to ensure any newly listed or recorded species were captured.

3 Existing environment and impact assessment

3.1 Vegetation communities and flora

The proposed activity is in a highly modified environment largely cleared of native vegetation and revegetated with introduced pasture species and used for the grazing of stock over a considerable number of years.

Database searches show that a number of threatened flora species have previously been recorded in the locality (ie within a 10 km radius). An assessment of likely occurrence was completed based on the habitat present (Appendix A). No threatened flora species are likely to occur in proximity to the changes to the preferred activity.

Entry pad A on the western side of Waukivory Creek is within 50 m of the water course and located in a ploughed field dominated by exotic grasses. Exit pad B on the eastern side of Waukivory Creek is within 50 m of the water course and located in a paddock with evidence of previous ploughing. Entry pad A on the western side of the Avon River is within 20 m of the water course is dominated by exotic grasses, as is the exit pad B.

Both the Avon River and the Waukivory Creek contains remnant vegetation which has been mapped as Weeping Lilly Pilly/Water Gum riparian warm temperate rainforest (Peake 2006). Weeping Lilly Pilly/Water Gum riparian warm temperate rainforest is estimated to be cleared by 75% from its original distribution in the catchment management authority (CMA) area (Biometric vegetation types database). The Lowland Rainforest on Floodplain in the NSW North Coast Bioregion critically endangered ecological community (CEEC), listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act), is associated with this vegetation community in the Hunter-Central Rivers catchment management authority area (CMA).

The HDD area at both Waukivory Creek and the Avon River will extend through an area which is dominated by exotic species, mainly Willow (Salix spp.). Some remnant native trees, including River Oak (*Casuarina cunninghamia*) and Swamp Oak (*Casuarina glauca*), and understorey vegetation including Water Gum (*Tristaniopsis laurina*) and Spiny-headed Mat Rush (*Lomandra longifolia*), occur in this area. These species are representative of the community that would have occurred prior to disturbance and weed invasion. Rather than being representative of the mapped vegetation at the site (Weeping Lilly Pilly/Water Gum riparian warm temperate rainforest), it is likely that the previous vegetation community in this area would have been representative of the River-flat Eucalypt Forest EEC.

The following 'key Indicators' were used to identify if the vegetation present at Waukivory Creek and the Avon River met the description of River-flat Eucalypt Forest EEC (DECC 2007):

- Is the site south of Port Stephens in the NSW North Coast, Sydney Basin or South East Corner bioregions?

Yes

- Is the site on the coastal floodplain?

Yes

- Is the site on silty, clay or sandy loam soil with a lack of deep humic layers and has little or no saline (salt) influence?

Yes

- Is the site located on a river flat or terrace in an upper part of the Coastal Floodplain (check for active or dormant drainage lines in the area)?

Yes

- Does the site consist of an open forest or woodland with a mixture of Eucalypt or Angophora trees, particularly Forest Red Gum, Cabbage Gum or Broad-leaved Apple?

  No – however characteristic species River Oak and Swamp Oak occur.

- Are there any characteristic shrub and/or groundlayer species present?

  Yes Water Gum and Spiny-headed Mat Rush occur.

- Are there relatively low numbers of She-oaks, Paperbarks or Swamp Mahogany trees?

  No - River Oak and Swamp Oak are the dominant native canopy species.

Based on the key indicator assessment, it is considered that the vegetation at both Waukivory Creek and the Avon River does not meet the description of the River-flat Eucalypt Forest EEC in its present state.

The north-western extension of WK13 is located in a paddock dominated by exotic species Kikuyu (*Pennisetum clandestinum*) and White Clover (*Trifolium repens*) (EMM 2011).

3.1.1 Potential impacts

The main potential for impacts from the changes to the preferred activity, are associated with the HDD at Waukivory Creek and the Avon River. The establishment of drill rig layouts in these areas will not impact on any native vegetation. However, the drilling under the watercourse which contains some remnant native species has the potential to cause impacts.

The depth of the HDD under the areas containing riparian vegetation varies between 4 - 6 m. The alluvial water table is less than 5 m from the surface. The rooting depth of the dominant canopy species in this area vary, with the River She-oak up to approximately 20 - 30 m and Water Gum approximately 5 – 10 m (Water Corporation 2010). As such, it is likely that some tree roots will be encountered and damaged at the point where the pipeline is horizontally directionally drilled as part of the changes to the preferred activity in this area. The pipeline will extend approximately 25 m under riparian vegetation at each HDD site with a diameter of up to 0.5 m, however the proposed route has been situated to avoid the tree protection zone (TPZ) (the minimum area around a tree that must be left undisturbed to protect the root system and maintain the health and stability of the tree) of any remnant native trees. Therefore it is unlikely to significantly impact on any native trees our cause a decline in health or stability of the trees present.

The potential for indirect impacts from inappropriate sediment and erosion control, spills or pollution will be minimised through the implementation of the Environmental Management Plan in the REF (EMM 2013a), and the management measures in the Preferred Activity Report (EMM 2013b) which includes a HDD drilling fluid management plan.

3.2 Fauna and fauna habitat

The area of the proposed changes contains exotic grassland, which provides only limited potential foraging resources for most fauna species. However, as this area may be subject to inundation as it occurs on the floodplain of the Avon River and Waukivory Creek, it may provide habitat for species that forage in floodplains after rainfall.

Database searches show that a number of threatened fauna species have previously been recorded in the locality (ie within a 10 km radius). Potential habitat for the Grey-crowned Babbler and Grass Owl and Black-necked Stork has been identified in the locality in previous studies (EMM 2013a). In addition, the migratory species the Cattle Egret and Great Egret would occur when the grassland is flooded after heavy rain, and that the Rainbow Bee-eater may occasionally forage at the site as it is known to frequently use disturbed areas and creeks (EMM 2013a).

An assessment of likely occurrence was completed based on the habitat present (Appendix A). The area of the proposed changes is likely to provide potential foraging habitat for the threatened Grass Owl (*Tyto longimembris)*, listed as a vulnerable species under the *Threatened Species Conservation Act 1995* (TSC Act), and migratory birds including the Cattle Egret (*Ardea ibis),* Great Egret (*Ardea alba)* and Lathams's Snipe (*Gallinago hardwickii)* listed as matters of national environmental significance under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

3.2.1 Potential impacts

The proposed changes to the preferred activity will remove a small area of disturbed grassland habitat. Given the agricultural setting and the abundance of similar habitat available for fauna in the locality, any potential impacts will be minor.

Assessments of significance under Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act), and the Significant Impact Guidelines under the EPBC Act were completed for the threatened and migratory species considered likely to occur in the area (Appendix B and Appendix C). The assessments concluded that the proposed changes to the preferred activity will not significantly impact on any threatened or migratory species listed under the TSC Act or EPBC Act.

3.3 Groundwater dependent ecosystems

The Groundwater Dependent Ecosystem (GDE) Atlas (Bureau of Meteorology 2012) identifies some vegetation ecosystems that rely on the subsurface presence of groundwater within the Mannering Park Basin. An area identified as potentially containing a GDE is on the Tiedmans property and relates to natural vegetation cover.

River-flat Eucalypt Forest EEC has been identified as having high GDE potential under the *Risk assessment guidelines for groundwater dependent ecosystems* (Kuginis *et al* 2012). As some species indicative of this community remain along Waukivory Creek and the Avon River at the HDD sites, it is possible that where present, native species including River Oak and Swamp Oak may rely on the shallow water table, particularly in drier periods.

Groundwater resources in the area of the proposed activity are associated with the alluvial groundwater of the tributaries of the Avon River. The alluvial aquifers in the Waukivory Pilot area are approximately 15 m below ground level (mBGL). The alluvial water table is less than 5 m from the surface in this area. The root zone for remnant native species such as River She-oak is up to 20 - 30 m and therefore groundwater may be available to these species.

3.3.1 Potential impacts

The proposed changes to the preferred activity only require the extension of a pad site, HDD and installation of pads for the HDD. These works are unlikely to cause any impacts on the accessibility or quality of groundwater resources available to terrestrial vegetation which may be representative of groundwater dependent ecosystems.

AGL have established a groundwater monitoring network around the Waukivory pilot site and will continue to monitor groundwater at the site. The potential for indirect impacts to groundwater from HDD will be minimised through the implementation of the Environmental Management Plan in the REF (EMM 2013a) and management measures in the Preferred Activity Report (EMM 2013b) which includes a HDD drilling fluid management plan.

4 Conclusion

This ecological assessment has been completed for the changes to the preferred activity to the preferred activity presented in the report *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred activity report.* No threatened plants, threatened ecological communities or threatened fauna species were recorded in proximity to the area. However the area contained potential foraging habitat for the threatened Grass Owl and migratory birds.

The proposed changes to the preferred activity will not require the removal of any native vegetation and only minimal disturbance of the root zone of some remnant trees. It is also unlikely that the HDD would result in significant impacts to vegetation that may rely on shallow alluvial groundwater resources. Assessments of significance were completed for threatened fauna species with the potential to occur and concluded that the changes to the preferred activity will not have a significant impact.

5 References

Department of Environment and Climate Change (DECC) 2007, *Identification guidelines for endangered ecological communities: River-flat Eucalypt Forest on Coastal Floodplain*, DECC NSW

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

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

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

Kuginis L Byrne G Serov P Williams JP 2012, *Risk assessment guidelines for groundwater dependent ecosystems, Volume 3 – Identification of high probability groundwater dependent ecosystems on the coastal plains of NSW and their ecological value*, NSW Department of Primary Industries, Office of Water, Sydney

Water Corporation 2010, *Protect your home select the right tree*, Water Corporation WA

Appendix A: Likelihood of occurrence criteria

The likelihood of occurrence for each threatened species previously recorded within 10 km of the study area was assessed against the criteria in Table A.1.

Table A.1 Assessment criteria

Likelihood	Description	Further assessment required?
Recorded	The species was observed in the study area during the current survey.	Yes
High	It is highly likely that a species inhabits the study area due to the presence of suitable habitat, and has been recorded recently in the study area or the surrounding area.	Yes
Moderate	Potential habitat is present in the study area, although it has not been recorded recently in the study area and surrounds. The species is unlikely to be dependent (ie for breeding) on habitat in the study area.	Yes
Low	It is unlikely that the species inhabits the study area, and may be an occasional visitor. Habitat similar to the study area is widely distributed in the local area, meaning that the species is not dependent (ie for breeding) on it.	No
None	Suitable habitat is absent from the study area.	No

Table A.2 Threatened species recorded within 10 km of the area

Species/community	Conservation status		Habitat	Likelihood of occurrence
	TSC Act	EPBC Act		
FLORA				
Dwarf Heath Casuarina (*Allocasuarina defungens)*	E	E	Occurs in tall heath on sand, but can also occur on clay soils and sandstone.	None
Euphrasia arguta	CE	CE	Occurs in the open forest country around Bathurst in sub humid places, on the grassy country near Bathurst, and in meadows near rivers.	None
Leafless Tongue-orchid (*Cryptostylis hunteriana)*	V	V	Does not have well defined habitat preferences and is known from a range of communities, including swamp-heath and woodland.	None
Siah's Backbone (*Streblus pendulinus)*	-	E	Grows chiefly along watercourse in warmer rainforests.	Low. None identified during the survey.
Slaty Red Gum (*Eucalyptus galucina)*	V	V	Grows in grassy woodland and dry eucalypt forest.	Low. None identified during the survey.
Tall Velvet Sea-berry (*Haloragis exalata subsp. velutina)*	V	V	Grows in damp places near watercourses.	None
White-flowered Wax Plant (*Cynanchum elegans)*	E	E	Occurs on the edge of dry rainforest and littoral rainforest.	Low. None identified during the survey.
FAUNA				
Frogs				
Booroolong Frog (*Litoria booroolongensis)*	E	E	Found along the western-flowing streams of the Great Dividing Range.	Low. Not recorded in the study area.
Green & Golden Bell Frog (*Litoria aurea)*	E	V	Marshes, dams & stream-sides particularly those containing *Typha* or *Eleochairs*.	Low
Stuttering Frog (*Mixophyes balbus)*	E	V	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range.	Low. Not recorded in the study area.
Birds				
Australasian Bittern (*Botaurus*	V	-	Found in emergent vegetation in freshwater & brackish wetlands.	None

Table A.2 Threatened species recorded within 10 km of the area

Species/community	Conservation status		Habitat	Likelihood of occurrence
	TSC Act	EPBC Act		
poiciloptilus)				
Australian Painted Snipe (*Rostratula australis)*	E	E	Found in swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber.	None
Black-faced Monarch (*Monarcha melanopsis)*	-	Mi	Occurs in rainforest.	Low. Not recorded in the study area.
Black-necked Stork (*Ephippiorhynchus asiaticus)*	E	-	Occupies permanent freshwater wetlands. Feeds on fish, frogs, eels, turtles, crabs and snakes.	Low
Cattle Egret (*Ardea ibis)*	-	Mi	High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass.	Moderate. May forage in the pasture within the floodplain. **See Appendix C: Significant impact assessment against the EPBC Act significance criteria.**
Eastern Bristlebird (*Dasyornis brachypterus)*	E	E	Occurs in open forest with a heath or tussocky understorey	None
Fork-tailed Swift (*Apus pacificus)*	-	MI	Occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh.	None
Grass Owl (*Tyto longimembris)*	V	-	Inhabits tall grass, including grass tussocks in swampy areas, grassy plains, swampy heath, and cane grass, or sedges on flood plains.	Moderate. May occasionally forage across wetter paddock areas. This species may be indirectly impacted by the project. **See Appendix B: assessments of significance against TSC Act seven-part test.**
Great Egret (*Ardea alba)*	-	Mi	Occurs over a wide range of wetland habitats including marshes, margins of rivers and flooded grasslands.	Moderate. May forage in the pasture within the floodplain. **See Appendix C: Significant impact assessment against the EPBC Act significance criteria.**
Grey-crowned Babbler (*Pomatostomus temporalis temporalis)*	V	-	Found in open woodlands.	Low. Recorded in study area but no suitable habitat in the area.
Lathams's Snipe (*Gallinago hardwickii)*	-	Mi	Occur in permanent and ephemeral wetlands.	Moderate. May forage in the pasture within the floodplain. **See Appendix C: Significant impact assessment against the EPBC Act significance criteria.**

Table A.2 Threatened species recorded within 10 km of the area

Species/community	Conservation status		Habitat	Likelihood of occurrence
	TSC Act	EPBC Act		
Rainbow Bee-eater (*Merops ornatus)*	-	Mi	Occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats.	Low. Not recorded in the study area.
Regent Honeyeater (*Xanthomyza Phrygia)*	E	E	Inhabits dry open forest and woodland, particularly Box-Ironbark woodland, and riparian forests of River She-oak.	None
Rufous Fantail (*Rhipidura rufifrons)*	-	Mi	Mainly inhabits wet sclerophyll forests, often in gullies dominated by eucalypts.	None
Satin Flycatcher (*Myiagra cyanoleuca)*	-	Mi	Inhabits heavily vegetated gullies in eucalypt-dominated forests and taller woodlands.	None
White-bellied Sea Eagle (*Haliaeetus leucogaster)*	-	Mi	Occurs mostly in coastal lowlands and is characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea).	Low
White-throated Needletail (*Hirundapus caudacutus)*	-	Mi	Most often occur above wooded areas, including open forest and rainforest.	Low. Not recorded in the study area.
Spectacled Monarch *Monarcha trivirgatus*	-	Mi	Occurs in thick understorey in rainforest, wet gullies and waterside vegetation.	Low. Not recorded in the study area.
Swift Parrot (*Lathamus discolour)*	E	E	Occur in areas where eucalypts are flowering profusely or where there are abundant lerp infestations.	None
Mammals				
Brush-tailed Rock-wallaby (*Petrogale penicillata)*	E	V	Inhabits rocky escarpments, outcrops, steep slopes or cliffs – especially those with caves, ledges or overhangs & shrub cover.	None
Brush-tailed Phascogale (*Phascogale tapoatafa)*	V		Occurs in dry sclerophyll open forest with sparse groundcover. The species also is found in health, swamps, rainforest & wet sclerophyll forest.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.
Eastern Bent-wing Bat (*Miniopterus schreibersii oceanensis)*	V		Roosts in caves, derelict mines, storm-water tunnels, buildings. Forages in forested areas.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.
Eastern Freetail-bat (*Mormopterus norfolkensis)*	V		Found in dry sclerophyll forest & woodland. The species roosts in hollows & under bark or man-made structures.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.

Table A.2 Threatened species recorded within 10 km of the area

Species/community	Conservation status		Habitat	Likelihood of occurrence
	TSC Act	EPBC Act		
Greater Broad-nosed Bat (*Scoteanax rueppellii)*	V		Found in woodland, moist and dry eucalypt forest and rainforest but prefers tall wet forest.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.
Grey-headed Flying-fox (*Pteropus poliocephalus)*	V	V	Found in subtropical & temperate rainforests, tall sclerophyll forests & woodlands, heaths & swamps.	Low. Not recorded in the study area.
Hastings River Mouse (*Pseudomys oralis)*	E	E	Found in dry open forest.	None
Koala (*Phascolarctos cinereus)*	V		Inhabits eucalypt forests and woodlands.	None
Large-eared Pied Bat (*Chalinolobus dwyeri)*	V	V	Roosts in caves, derelict mines frequenting low to mid elevation dry open forests and woodland close to these features.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.
Large-footed Myotis (*Myotis macropus)*	V		Forages over streams and pools catching insects and small fish by raking their feet across the water surface.	Low. Recorded in the study area but no suitable habitat in the area of proposed changes.
Long-nosed Potoroo (*Potorous tridactylus)*	V	V	Inhabits coastal heaths and dry and wet sclerophyll forests.	None
New Holland Mouse (*Pseudomys novaehollandiae)*	-	V	Found in open woodland with a heathland understorey or vegetated sand dunes.	None
Spotted-tailed Quoll (*Dasyurus maclatus)*	V		Occupies forests and heathlands.	None

Note: TSC Act – Threatened Species Conservation Act 1995; EPBC Act – Environmental Protection and Biodiversity Conservation Act 1999; V – vulnerable; E – endangered; pop – population.

Appendix B: NSW assessments of significance

Significant impact criteria in accordance with the TSC Act

Section 5A of the EP&A Act provides the criteria that must be considered in the assessment of the significance of potential impacts on all threatened species listed under the TSC Act. An Assessment of Significance (known as the seven-part test) is made up of the following seven questions:

1. In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction;

2. In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction;

3. In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

    i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

    ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction;

4. In relation to the habitat of a threatened species, population or ecological community:

    i) the extent to which habitat is likely to be removed or modified as a result of the action proposed;

    ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action;

    iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality;

5. Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly);

6. Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan; and

7. Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The following assessments of significance have been undertaken in accordance with *Threatened species assessment guidelines: The assessment of significance* (DEC 2007).

Threatened Owls: Eastern Grass Owl (Tyto longimembris)

The **Eastern Grass Owl** is listed as a vulnerable species under the TSC Act and has not been recorded in the area or the Waukivory pilot testing area. This species is found in areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in sedges on floodplains. Potential foraging and limited potential breeding habitat is present in the tall grass around the Waukivory Creek and Avon River floodplains in the area.

An assessment of impact criteria under Section 5a of the EP&A Act has been completed to assess the potential impacts of the changes to the preferred activity on the Eastern Grass Owl (Table B.1).

Table B.1 Assessment of impact criteria for Eastern Grass Owl

Criteria	Discussion
1. Life cycle of threatened species	The Eastern Grass Owl requires a trampled platform in a large tussock or heavy vegetative growth for breeding and tall grassland for foraging. There is the potential for breeding habitat for this species at the area within the floodplain of the Waukivory Creek; however land use such as grazing has reduced the quality of habitat present. Therefore any potential breeding habitat is considered to be limited and of low quality given the availability of more suitable habitat in the locality and away from existing disturbances. It is possible that the area provides potential foraging habitat for this species, with rodents likely to inhabit the area. The removal of 2,250 m^2 of pasture, which provides sub-optimal breeding and potential foraging habitat, will not impact the lifecycle of this species as substantial similar habitat areas remain widely available throughout the locality.
2. Life cycle of endangered population	This question refers to endangered populations, therefore is not relevant to this assessment.
3. EEC extent and changes to the preferred activity	This question refers to TECs, therefore is not relevant to this assessment.
4. Habitat removal, fragmentation, isolation and importance	The changes to the preferred activity will remove 2,250 m^2 of potential habitat for the Eastern Grass Owl. The quality of habitat present fluctuates periodically, with the onset of rain events and vegetation growth, grazing and rodent population eruptions. The removal of potential foraging and breeding habitat will not fragment or isolate any local population of the Eastern Grass Owl, as the area lies on the western edge of its geographic range and the works will be temporary in nature.
5. Critical habitat	Critical habitat has not been listed for the Eastern Grass Owl.
6. Consistency with recovery or threat abatement plans	Action statements for these species aim to ensure the species' security in the wild in NSW and to maintain or extend geographic ranges. The changes to the preferred activity do not interfere with these objectives because it will not significantly reduce the geographic range of the Eastern Grass Owl.
7. Key threatening processes (KTPs)	The changes to the preferred activity do not constitute any KTPs.
Conclusions	The changes to the preferred activity will not have a significant impact on the Eastern Grass Owl as: • only small areas of low quality potential breeding and foraging habitat will be removed; • the impacts will be temporary in nature; and • alternate habitat is widely available in the locality.

Appendix C: Significant impact criteria in accordance with the EPBC Act

The following sections provide the criteria that must be considered in the assessment of all threatened species listed under the EPBC Act. There are separate criteria for each listing category under the EPBC Act, in accordance with 'EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance' (DEH, 2006).

Significant impact criteria for listed migratory species

An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will:

- substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

5.1.1 Threatened fauna

i Migratory birds: Cattle Egret (*Ardea ibis*), Great Egret (*Ardea alba*), Lathams' Snipe (*Gallinago hardwickii*)

The **Cattle Egret** is listed as a migratory species under the EPBC Act and has not been recorded in the area. In Australia, the Cattle Egret breeds on the central east coast and inland wetlands of NSW. The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It is occasionally seen in arid and semi-arid regions; however, this is extremely rare. The area provides foraging and breeding habitat in the floodplain of Waukivory Creek and the Avon River.

The **Great Egret** is listed as a migratory species under the EPBC Act and has not been recorded in the area. The Great Egret is widespread throughout Australia and also occurs throughout Australasia and southeast Asia. The Great Egret has been reported in a wide range of wetland habitats (eg inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial). Potential breeding and foraging habitat is present in the floodplain pasture areas of Waukivory Creek and the Avon River.

The **Latham's Snipe** is listed as a migratory species under the EPBC Act and has not been recorded in the area. In Australia, Latham's Snipe occurs in permanent and ephemeral wetlands up to 2,000 m above sea-level, in open, freshwater wetlands with low, dense vegetation. As a migratory species, it is known to breed in Japan and Russia during the northern hemisphere summer and then migrate south to Australia following the breeding season. As such, the area does not provide breeding habitat for this species. The area provides foraging habitat any areas inundated by flood waters periodically.

An assessment of significance has been completed to assess potential impacts on migratory species (Table C.1).

Table C.1 Assessment of significance for migratory bird

Assessment part	Discussion
1: Substantially modify important habitat	The area does not constitute an area of important habitat for these species, as an ecologically significant proportion (as defined under the guidelines (DEH, 2006)) of their populations do not reside in the area, no important breeding populations reside in the area, it is not at the limit of their range and they are not known to be declining.
2: Result in invasive species	These migratory species are known to be subject to predation by the European Red Fox. The changes to the preferred activity are unlikely to result in the spread of this invasive species.
3: Disrupt lifecycle of ecologically significant proportion of population	An ecologically significant proportion of these species do not reside in the area. In addition, foraging habitat is seasonal and the changes to the preferred activity are unlikely to disrupt their migration patterns.
Conclusion	The changes to the preferred activity are not expected to result in significant impacts to migratory bird species as: • an ecologically significant proportion of the species is not known to reside in the area; and • the areas subject to changes to the preferred activity do not contain important habitat for the species.

Appendix B

Aboriginal heritage assessment

Memorandum

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29 May 2014

To AGL
From Ryan Desic
Subject Waukivory Pilot Project - Aboriginal heritage assessment of the proposed changes to the preferred activity

Introduction

This letter provides an updated Aboriginal cultural heritage due diligence assessment in response to proposed changes to the preferred activity presented in the report *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred activity report,* prepared in November 2013. The assessment was undertaken by EMGA Mitchell McLennan (EMM) on behalf of AGL Upstream Investments Pty Ltd (AGL).

Background and method

In 2011, an Aboriginal cultural heritage assessment was prepared for the establishment of the exploration wells WK11, WK12, WK13 and WK14 and their respective access tracks 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). In 2013, a further two due diligence assessments were undertaken for the Waukivory Pilot Project. One assessment was completed in August 2013 for the construction of a water pipeline between WK13 and the Tiedmans' property (EMM 2013a). In November 2013 an assessment as part of a Preferred Activity Report was undertaken (EMM 2013b) which covered the construction of water and gas gathering lines joining WK11 to the main water and gas gathering lines between WK12 and WK13, and drill rig pads for the underboring of the Avon River.

This letter details the assessment of proposed changes to the preferred activity outlined in the Preferred Activity Report. The assessment covers the following activities:

- The construction of water and gas gathering lines crossing Waukivory Creek by horizontal directional drilling (HDD). This activity includes the installation of drill rig construction pads covering an approximate area of 40 x 40 m on the western side of the creek and 20 x 20 m on the eastern side. This option will supersede the construction of hanging water and gas gathering pipelines that were proposed in the Preferred Activity Report.

- The north-western extension of the existing 100 x 100 m drill pad at WK 13 by an area of 10 x 25 m. This extension is required to accommodate above ground storage tanks.

No assessment was done for the proposed change to the layout of infrastructure at WK 12 because it will be within the previously assessed 100 x 100 m footprint.

The assessment involved a pedestrian site inspection of the proposed HDD construction pads adjacent to Waukivory Creek. The northern extension area for WK13 was also inspected. A pedestrian site inspection of the water and gas gathering line between WK12 and WK13 via WK14 was also undertaken because it had not been previously inspected.

The inspection was undertaken by EMM archaeologist, Ryan Desic, on 22 April 2014. The results of previous site inspections along with landscape and background archaeological information are provided in Section 4.4 of the August 2013 REF (EMM 2013a). This information was considered in the preparation of this letter. The Aboriginal Heritage Information Management System (AHIMS) search conducted for the August 2013 due diligence assessment was also used for this assessment.

Results

No Aboriginal objects were identified in the area of the HDD construction pads adjacent to Waukivory Creek, the northern extension area for WK13 or the water and gas gathering line between WK12 and WK13 via WK14. The site inspection also aimed to identify archaeologically sensitive landforms that may indicate the presence of unexposed or subsurface Aboriginal objects. No potential archaeological deposits were indentified at the HDD construction pads adjacent to Waukivory Creek, the northern extension area for WK13 or the water and gas gathering line between WK12 and WK13 via WK14.

Entry pad A on the western side of Waukivory Creek is within 50 m of the water course and located in a ploughed field. The pad was moderately grassed, but the ground surface was visible in most areas. The area was not elevated against the surrounding terrain and is likely to be moderately to poorly drained. Although the construction pad will be located close to Waukivory Creek, its landform context is not distinguished from the surrounding area and therefore does not suggest a potential archaeological deposit (PAD). This, combined with moderate disturbance levels caused by ploughing, indicates that the pad has low archaeological potential.

Exit pad B on the eastern side of Waukivory Creek is within 50 m of the water course and located in a thickly grassed paddock with evidence of previous ploughing. Although ground exposure was less than 5%, the pad has the same landform context as entry pad A and is considered to have low archaeological potential.

The north-western extension of WK13 is in a thick grassed paddock within a poorly drained alluvial flat. WK13 was previously assessed in the 2011 REF having low archaeological potential, and the proposed extension would not change the outcomes of the original assessment.

The impact areas for the water and gas gathering lines between WK12 and WK13 via WK14 were located directly adjacent to existing access tracks. These areas were within a poorly drained alluvial flat that had been recently ploughed for farming. Vegetation coverage was minor and ground exposure was approximately 80% with visibility levels slightly lower (approximately 70%). These areas were assessed to have very low archaeological potential.

Conclusion

The activity areas associated with the proposed changes to the preferred activity are assessed to be of low archaeological potential due to the moderate levels of previous disturbance in the area from ploughing in conjunction with their location on a poorly drained alluvial flat. Although close to Waukivory Creek, areas of PAD would typically be designated to elevated, gently inclined landforms adjacent to creeks with a good outlook over the surrounding environment. The proposed activity areas are indistinguishable low lying points in the landscape that would be susceptible to water inundation during wet weather. Furthermore, no previously recorded Aboriginal sites will be impacted. Therefore no further Aboriginal heritage investigations are considered necessary, unless in conjunction with Aboriginal heritage management measures outlined in the environmental management plan (EMM 2013b) (unexpected finds).

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: Review of Environmental Factors,* prepared for AGL Upstream Investments Pty Ltd

EMGA Mitchell McLennan (EMMb) 2013, *Waukivory Pilot Project: Addendum to the Review of Environmental Factors - Preferred activity report,* 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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