DETAILED WATER RESOURCE OPERATING STRATEGY

SHAMROCK STATION IRRIGATION PROJECT – STAGE 1 DEVELOPMENT

A report prepared for Argyle Cattle Company Pty Ltd

A subsidiary of Consolidated Australian Pastoral Holdings Pty Ltd

REVISED FINAL VERSION

16 July 2019

Name of water licence applicant/licensee: Consolidated Australian Pastoral Holdings Pty Ltd

Name of development project or purpose: Shamrock Station Irrigation Project – Stage 1

Legal description and address of land where (a) water is taken, and (b) water is used (if different)

(a) Shamrock Station, Lot 590, Great Northern Highway, La Grange WA

(b) As Above

"I understand that the commitments given in the attached operating strategy will be a condition of an associated water licence if approved and that a breach of a commitment or any licence condition may be an infringement of the Rights in Water and Irrigation Act 1914":

Signatures:

Person legally responsible for water licence:

..... Date 17.7.19

Printed name: Dale Champion

Approved by Department of Water and Environmental Regulation delegated authority:

..... Date 17/7

Printed name: GARY HUMPHREYS
REGIONAL MANAGER

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Preface

Consolidated Australian Pastoral Holdings (CAPH) purchased an aggregation of stations in the Kimberley region of Western Australia in November 2016. This acquisition was based on the promotion of the La Grange area, located south of Broome, and the possibilities of developing a value-added supply chain through one of the stations, being "Shamrock Station", which overlies the Broome Sandstone aquifer. This aquifer represents a groundwater resource that is being actively promoted as an agricultural development area in the La Grange area.

The project aligns closely with the Australian Government's White Paper "Our North, Our Future: White Pater on Developing Northern Australia" (the White Paper), which specifically mentions the West Kimberley (which La Grange area is a part of) as a focus area for development, and the Western Australian Government's Water for Food programme with La Grange identified as a Kimberley Water for Food Precinct. This is recognised in the Kimberley Development Commission's Regional Investment Blueprint for the Kimberley (2036 and Beyond).

Argyle Cattle Company Pty Ltd (ACC) a subsidiary of CAPH proposes to develop Irrigation Project on Shamrock Station. The project is based on a staged approach with the first stage modelled for an abstraction of 9.5 GL based on development of approximately 12 x 40 ha pivots.

The fodder produced will be used to enhance the capacity of ACC's aggregation of stations to maximise weight gain for livestock exported from the region, increase flexibility of operation and ensure security of both fodder and livestock supply through seasonal variations.

On 5 December 2016, Consolidated Australian Pastoral Holdings Pty Ltd (CAPH) applied to the WA Government Department of Water and Environmental Regulation (DWER) for a groundwater extraction licence under the under the *Rights in Water and Irrigation Act 1914* (RIWI Act) of 22 GL, which fits within the allocation limit for the La Grange North subarea set out in the La Grange groundwater allocation plan. DWER subsequently requested that ACC provide additional information in the form of a detailed H3 Hydrogeological Assessment report (IGS, 2017) and a Detailed Water Resources Operating Strategy. This report (the DWROS) constitutes the latter.

The H3 hydrogeological assessment demonstrated, using best available science, that Stage 1 of the Shamrock Station Irrigation Project (the Stage 1 Project) could sustainably extract 9.5 GL/annum from the Broome Sandstone aquifer to support the proposed 12 production bores each capable supplying a centre pivot of area approximately 40 hectares. The location of the Stage 1 Project is on the northern boundary of the station immediately east of the Great Northern Highway (Figure 1).

Both CAPH and ACC are aware this project falls under the RIWI Act and will ensure all staff working within the operation are aware of all water licence obligations and management plans associated with the project development and operations.

Water licences relevant to this DWROS are:

- Licence (insert number when issued): Licence to take water
- Licence (insert number when issued): Licence to construct or alter well.

1 Administrative requirements

This section outlines the administrative arrangements necessary to ensure the DWROS is adhered to.

1.1. Existing water licences relevant to strategy

There are no other relevant water licences issued that are relevant to this DWROS.

1.2. Requirement for DWROS

In accordance with DWER Operational Policy 5.08: *Use of operating strategies in the water licencing process* (DoW 2011), a detailed operating strategy is required under a range of circumstances, including when the water licence meets a combined threshold for several categories. Specifically, a detailed operating strategy is required when the cumulative number of points assigned to the categories (i) volume of water to be taken, (ii) level of allocation, (iii) potential for impacts on other users and (iv) potential for impacts on ecosystems and (v) existing salinity, yield greater than 12 points (Table 1, Section 3.5 of the policy).

The Stage 1 Project achieves a score of more than 12 points for the following three reasons:

a. Volume of sustainable abstraction has been calculated at greater than 5 GL/annum.

b. Potential for impacts to existing groundwater users is likely albeit low in magnitude. Shamrock Gardens is the nearest existing licensed user located approximately 6 km south south-west of the proposed Stage 1 development area. Nygah Nygah community is the nearest unlicensed user located approximately 11 km to the west.

c. Potential for impacts to ecosystems is possible. Injudinah Swamp is a groundwater dependent ecosystem (GDE) listed as a wetland of State significance in the La Grange Groundwater Allocation Plan; it is located approximately 15 km south-west of the proposed Stage 1 development area.

1.3. Staging of development

The 22 GL/annum development is scheduled to be staged over a 3-year period, with Stage 1 usage calculated at 9.467 GL/annum as indicated in the H3 Hydrogeological Assessment report developed for Stage 1.

Annual volumes for Stages 2 and 3 will be determined by further hydrogeological modelling; however, each are estimated to be 6 GL/annum.

If hydrogeological modelling proves that either future stage can handle more than the other or either can handle the remainder of the allocation without environmental impacts, then future applications will be lodged accordingly.

1.4. Summary of hydrogeological investigations

A H3 Hydrogeological Assessment (H3 report) has been developed for the Stage 1 Project (IGS 2017).

The aquifer of interest for the proposed Shamrock Station development is the unconfined Broome Sandstone. This is the uppermost major aquifer in the La Grange Groundwater Sub-Area and forms part of the Canning Basin. Groundwater flows from east to west in the Broome Sandstone aquifer, towards the coast, and groundwater depth is <1 m to around 158 m.

The H3 report synthesised a variety of recent hydrogeological data collected during the DAFWA Royalties for Regions (*La Grange Agriculture Opportunities*) project, and then used that data in groundwater models to establish how many centre-pivot irrigators could be confidently installed and operated without causing deleterious impacts to existing users and known sites of ecological/cultural importance. Key datasets used in the H3 Hydrogeological Assessment included:

- baseline water quality
- airborne electromagnetics (AEM)
- drilling and downhole geophysical records
- aquifer pumping test analysis
- groundwater level monitoring and depth to water mapping (following previously sporadic monitoring of the groundwater levels, routine monitoring of has occurred since 2013)
- Hydrochemistry and environmental tracers to support groundwater recharge and flow analysis.

The H3 report details the development of a suite of complimentary analytical and numerical groundwater models that address a range of objectives and provide added confidence to model outcomes.

For more detailed description of hydrogeological conditions related to the Stage 1 Project, refer to the H3 report (IGS 2017).

1.5. Water resource management area

The Stage 1 Project falls within the area covered by the La Grange Groundwater Allocation Plan (DoW 2009a). The Stage 1 Project comes under the La Grange North Sub-Area of this plan.

Specific water resource management issues identified under the La Grange Groundwater Allocation Plan include:

- impact on other users including community supplies
- impact on GDEs or cultural sites
- impact on the salt water interface
- the allocation limit for the La Grange North Sub-Area is 35 GL/annum. The Stage 1 Project has calculated 9.467 GL/annum can be sustainably extracted from the Broome Sandstone aquifer. This volume, in addition to existing allocations, will instigate a management trigger in the La Grange Groundwater Allocation Plan, with the following response:
    - DWER to assess the need for a regional monitoring program, and
    - DWER to consult with stakeholders to evaluate if further work needs to be undertaken to improve knowledge of in-situ water dependant values.

1.6. Person/position responsible for implementing operating strategy

Name: Cameron McDonald

Position: Project Manager, Australian Standard Agriculture

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1.7. Reporting dates

Water use year monitoring and DWROS compliance reporting will be negotiated at licence issue but will likely be 28 February each year for consistency with most other irrigators in the region, also reflecting the irrigation season.

1.8. Review date

Major review of this DWROS is required on July 2029 (assumes water licence is granted July 2019 and water licence period is 10 years).

2 Water source description

Groundwater used for irrigation, stock and domestic supply in the La Grange region is mostly sourced from the Broome Sandstone aquifer. The Broome Sandstone is a regionally extensive, generally unconfined aquifer forming part of the Canning Basin. The Cretaceous Broome Sandstone sits unconformably above the upper Jurassic Jarlemai Siltstone. The Jarlemai Siltstone forms an aquitard confining the Jurassic Wallal Sandstone aquifer and effectively separates the two aquifer systems. Groundwater salinity is generally fresh inland grading to saline towards the coast where the aquifer salinity is controlled by the salt water interface.

Groundwater abstraction for Shamrock Station Irrigation Project – Stage 1 will occur from existing production bore PB1 and up to 11 new production bores. The exact number and distribution of new production bores is to be determined in consultation with the irrigation engineer, however groundwater modelling undertaken for the H3 report has indicated an optimum number of 12 production bores including PB1.

2.1. Groundwater

A description of production and monitoring bore details is provided in Table 1. It should be noted that:

a. Bore locations provided for new production bores are estimated as the final number and distribution of production bores are to be determined in consultation with the irrigation engineer. The design of bore distribution will also be constrained by drawdown impacts on the agreed sensitive receptors and cross-boundary impact (i.e., beyond the boundary of Shamrock Station).

b. Bore locations provided for new monitoring bores are estimated with final site selection contingent on clearances and approvals.

Details on the purpose of each monitoring bore are outlined in the Shamrock Station Irrigation Project Stage 1 Monitoring and Management Response Plan (Monitoring and Management Plan) at Attachment 1.

2.2. Water distribution network

As previously mentioned, final design is yet to be determined and will be based on final allocation, environmental buffer zones, cultural areas of interest, surface water hydrology and, where possible, fit within the approved development envelope.

A separate stock water system will supply each pivot with stock water, through a network of pipes, tanks and troughs.

Table 1 Production bore and monitoring bore details

Bore Name (production or monitoring)	Location coordinates (Zone 51)		Aquifer name	Elevation (m AHD)	Depth (m bgl)	Screened interval (m bgl)	Construction details (bore logs to be provided to the department)	Depth of monitoring (pressure / salinity logger) (m bgl)	Comment
	Northing	Easting							
PRODUCTION BORES									
1. PB1	7952893	404449	Broome Sandstone	TBA	153	95-153	0-95 m, 250 mm (ID) PVC casing 95-153 m, 250 mm (ID) slotted PVC 0.5mm 75-153 m, gravel pack 0-75 m, cement grout	N/A	
2. S1PB01	7955350	400900	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
3. S1PB02	7955350	402160	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
4. S1PB03	7955350	403050	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
5. S1PB04	7954500	400900	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
6. S1PB05	7954500	401725	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
7. S1PB06	7954500	403050	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
8. S1PB07	7954300	399800	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
9. S1PB08	7953700	401725	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
10. S1PB09	7953700	402550	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
11. S1PB10	7953500	399375	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
12. S1PB11	7953500	400225	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	N/A	
MONITORING BORES									
1. 17MB001S	7950880	396485	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure /salinity logger. Sampling depth to be located within the screened/slotted interval.
2. 17MB001I	7950855	396470	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure /salinity logger. Sampling depth to be located within the screened/slotted interval.
3. 15LAG08S	7952722	404769	Broome Sandstone	55.82	47.59	44.59-47.59	PVC – Class 18	46	Currently installed with DWER pressure logger. To be replaced with a pressure/salinity logger when it fails, located at a depth of 46 m bgl.
4. 15LAG08I	7952719	404773	Broome Sandstone	55.90	102	96-102	PVC – Class 18	98	Currently installed with DWER pressure logger. To be replaced with a pressure/salinity logger when it fails, located at a depth of 98 m bgl.
5. 17MB002S	7952050	391070	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure logger only. Sampling depth to be located nominally 5 – 10 m below the water level
6. 17MB002D	7952050	391050	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure logger only. Sampling depth to be located nominally 5 – 10 m below the water level
7. 17MB003S	7948350	387300	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure /salinity logger. Sampling depth to be located within the screened/slotted interval.
8. 17MB003I	7948350	387280	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure /salinity logger. Sampling depth to be located within the screened/slotted interval.

Bore Name (production or monitoring)	Location coordinates (Zone 51)		Aquifer name	Elevation (m AHD)	Depth (m bgl)	Screened interval (m bgl)	Construction details (bore logs to be provided to the department)	Depth of monitoring (pressure / salinity logger) (m bgl)	Comment
	Northing	Easting							
9. 17MB004	7961790	395540	Broome Sandstone	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure logger only. Sampling depth to be located nominally 5 – 10 m below the water level
10. 15LAG6S	7955345	393478	Broome Sandstone	29.796	40.5	36.94-39.94	PVC – Class 18	38	Currently installed with DWER pressure logger. To be replaced with a pressure logger when it fails. Sampling depth to be located nominally 5 – 10 m below the water level
11. 15LAG6D	7955354	393486	Broome Sandstone	29.804	216	198-210	PVC - Class 18		Pressure logger only. Maintained by DWER.
12. 15LAG7S	7955172	399587	Broome Sandstone	34.97	31.73	28.73-31.73	PCV – Class 18	30	Currently installed with DWER pressure logger. To be replaced with a pressure/salinity logger when it fails, located at a depth of 30 m bgl.
13. 15LAG7I	7955169	399584	Broome Sandstone	34.994	71.36	65.36-71.36	PVC – Class 18	68	Currently installed with DWER pressure logger. To be replaced with a pressure/salinity logger when it fails, located at a depth of 68 m bgl.
14. Injudinah Swamp Claypan	7945750	384350	Surface water	TBA	TBA	TBA	TBA, not yet constructed	TBA	Pressure /salinity logger. Sampling depth to be determined following construction.

3 Identifying and managing impacts

The key issues that must be closely managed for the Stage 1 Project are:

1. over abstraction
2. drawdown impacts on other users
3. drawdown impacts on groundwater dependent ecosystems
4. groundwater salinity including movement of the salt water interface
5. changes to water quality due to abstraction and/or use.

The Monitoring and Management Plan (Attachment 1) details:

- management objectives related to each key issue
- a monitoring program that will provide baseline and ongoing water level and quality data against which early warning and immediate management intervention triggers will ensure compliance with the management objectives
- a two-tiered response plan stipulating actions if either an early warning or immediate management intervention trigger are exceeded for each management objective.

4 Operating rules

The operating rules for the proposed groundwater production bores for the Stage 1 Project are specified in Table 2. Pending the final design, 12 production bores are anticipated to be drilled and constructed in a staged approach over the next 1-3 years (including one existing bore - PB01, see Figure 1 in Section 8). Annual abstraction from any one of the 12 production bores is anticipated to be approximately 1/12th of the total licenced volume. Accordingly, the volume of cumulative abstraction during the bore construction phase will gradually increase up to the total licenced volume (9.467 GL/annum) as each production bore / pivot is commissioned. Pumping will occur predominantly throughout the dry season months from April to November, with an annual demand of up to approximately 20 ML/Ha/year. The staged bore construction phase will provide an opportunity to a establish water level and water quality baseline at dedicated monitoring bores as any drawdown impacts during construction/commissioning are likely to be very localised.

Groundwater modelling as described in the H3 report identified a low risk of drawdown impacts to Injudinah Swamp and the saltwater interface. To minimise potential impacts, the use of moisture meters will reduce the risk of overwatering and monitoring bores will provide baseline and ongoing water level and water quality data against which early warning and immediate management intervention triggers will ensure compliance with the management objectives. Extensive details on both the monitoring requirements and management responses are provided in Attachments 1A and 1B respectively.

Table 2 Operating rules for production bores

Bore name	Installed pumping capacity*	Indicative annual abstraction per bore	Operating protocols	Bore abstraction strategy
EXISTING BORE				
1. PB1	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
PROPOSED BORES				
2. S1PB01	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
3. S1PB02	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
4. S1PB03	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
5. S1PB04	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
6. S1PB05	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
7. S1PB06	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
8. S1PB07	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
9. S1PB08	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
10. S1PB09	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
11. S1PB10	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations
12. S1PB11	70-90 L/sec	791,666 kL	Principal	Seasonal variations, crop use will determine monthly variations

* final pump capacity will be informed by aquifer pumping test results.

5 Monitoring and reporting

The Monitoring and Management Plans (Attachment 1) have been developed in close consultation with DWER.

5.1. Purpose

Argyle Cattle Company (ACC) recognise the importance of establishing and maintaining a comprehensive groundwater-monitoring program. Meaningful data collected from production bores and monitoring bores not only provides evidence that development is occurring within predicted levels of impact, but also provides business confidence that the resource is capable of sustaining development over the long-term.

Specifically, the purpose of the monitoring program is to:

- record the volumes of groundwater abstracted and characterise any spatial or seasonal abstraction trends
- identify and quantify any drawdown impacts from abstraction
- identify and quantify any groundwater quality changes due to abstraction and irrigation.

The general approach will involve manual measurements on production bores and both automated and manual measurements on monitoring bores. The Stage 1 monitoring network will include all production bores; coupled with six existing bores, seven new dedicated monitoring bores and one surface water monitoring station as outlined in the Monitoring Plan (Attachment 1A).

Commitments

- The licensee will carry out and report to the department on the monitoring program outlined in sections 5.2 – 5.6.
- An annual water monitoring summary will be prepared at the end of each water use year in accordance with DWER Operational Policy 5.12 *Hydrogeological reporting associated with a groundwater well licence* (DoW 2009a, 2012).

5.2. Sub-stages of Development

Stage 1 itself will be developed over a number of years; therefore, installation and operation of the Stage 1 monitoring bore network will also be staged commensurate with expansion of the irrigation footprint. Table 3 outlines the various sub-stages of development and monitoring as Stage 1 expands in a south-westerly direction. These sub-stages are also distinguished via highlighted text in the Monitoring Plan (Attachment 1A).

Table 3 Sub-staging of production bores, irrigation development and monitoring

Sub-stage	No. production bores	Locations	Monitoring
1A	1 - 4	PB1, S1PB001, S1PB02, S1PB03	all existing monitoring bores listed in Attachment 1A
1B	5 - 8	S1PB04, S1PB05, S1PB06, S1PB09	as above + 17MB001S/MB001I + 17MB003S/MB003I + MB004
1C	9 - 12	S1PB07, S1PB08, S1PB10, S1PB11	as above + "Injudinah Swamp Claypan"

DWER requires installation of 17MB003S/17MB003I at commencement of sub-stage 1B or earlier if water level or water quality impacts greater than those predicted through the H3 assessment are observed at existing bores 15LAG06S/15LAG06D as determined by the Department's regional hydrogeologist.

It is understood that DWER and DPIRD are currently planning the drilling and construction of several deep Salt Water Interface Monitoring (SWIM) bores to the west of the Great Northern Highway in LaGrange. Accordingly, ACC will use any suitable SWIM bores established by WA Government and commence monitoring of MB002S/MB002I (or nearest available site) as soon as these bores have been installed by DPIRD/DWER. In the event that DWER do not establish a SWIM site at MB004, ACC will commit to installing MB004 at sub-stage 1B provided that Thangoo Station grants permission for ACC to (i) drill and construct a bore, and (ii) access the site for monitoring purposes on a regular and ongoing basis.

Likewise, ACC's commitment to install and monitor the MB003S/MB003I bores and the "Injudinah Swamp Claypan" site on Frazier Downs Station is conditional on Karajarri traditional owners granting permission for these activities.

If permission from third party land owners is not granted, then alternative monitoring arrangements will need to be developed and agreed between ACC and DWER for inclusion in a revised Operating Strategy. Such arrangements may include WA Government using its powers to install and access the required infrastructure, or moving the monitoring bore sites to more accessible sites such as road reserves etc.

5.3. Water use measurement

The make and model of the water meters for production bores is yet to be determined; however, will be a certified water meter that meets Australian Standards. Frequency of recording will be monthly (Table).

This section will be updated once water meter details are available.

Table 4 Water meter details for production bores

Draw point (production bore number)	Description of meter installed (make, serial no. installation date)	Meter maintenance/ Calibration schedule	Frequency of recording data (e.g. same day every month)
1. PB1	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
2. S1PB01	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
3. S1PB02	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
4. S1PB03	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
5. S1PB04	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
6. S1PB05	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
7. S1PB06	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
8. S1PB07	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
9. S1PB08	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
10. S1PB09	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
11. S1PB10	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly
12. S1PB11	Make & model TBC however will be a certified water meter that meets with Australian Standards	determined by make/model and Australian standards.	Monthly

Commitments

- Install a meter on each water draw-point through which water is taken under the licence
- When installing meters ensure compliance with the *Rights in Water and Irrigation (Approved Meters) Order 2009;*

and for each meter installed

- maintain the meter in good condition and ensure that it is operating within a range of plus or minus 5% of the quantity of water that passes through it when tested in field conditions
- notify DWER within 7 days of detecting a malfunction of the meter
- record the meter reading at the end of each month and provide a copy of the meter readings to DWER within 30 days of the water year (see water year condition on licence)
- submit meter reads to DWER via the online system called Water Online
- within 30 days of the installation of meters, submit to DWER the information listed in section 41C(2) of the Rights in Water and Irrigation Amendment Regulations 2018

5.4. Water level monitoring

Refer to Table 1 for the location of existing and proposed new monitoring bores and the Monitoring and Management Plan (Attachment 1) for details regarding the frequency of water level monitoring.

5.5. Water quality monitoring

Refer to Table 1 for the location of existing and proposed new monitoring bores and the Monitoring and Management Plan (Attachment 1) for details regarding the frequency of water quality monitoring. Comprehensive chemistry analysis will be carried out in accordance with Appendix C4, Operational policy 5.12 (DoW 2009c).

5.6. Environmental monitoring

Vegetation health monitoring is to be conducted at Injudinah Swamp if water level triggers are exceeded. The purpose of the monitoring is to determine if the exceedance of water level triggers has impacted the health of groundwater dependent vegetation.

Two baseline vegetation health monitoring transects have been established in groundwater dependent vegetation at Injudinah Swamp, one 'impact' site located at the northern end of the swamp, closest to the Project, and one control site located near 15LAG09S&I (Phoenix 2018).

Meandering transects were installed at both the control and impact site, with 30 individuals each of phreatophytic tree species *Sesbania formosa* and *Melaleuca cajuputi* subsp*. cajuputi* selected for health monitoring and permanently tagged. The health of the tree was recorded utilising the scale of Casson *et al.* (2009), as well as the three-part assessment scale of Department of Water (2017) to provide equivalent data for vegetation health transects monitored by DWER. At either end of each transect, 20 x 20 m plots were installed and a health rating, count of canopy species present and visual estimate of canopy foliage cover recorded. Depth to groundwater was measured at three points along each transect. Refer to '*Injudinah Swamp baseline vegetation assessment and installation of vegetation health monitoring transects for the Shamrock Station Irrigation Project*' (Attachment 2).

Where future vegetation monitoring is triggered, methods will entail re-assessment of each transect and plot in accordance with the methods listed above and comparison of results between sampling events. All other

observable disturbances (e.g. fire, storm damage, grazing, weed infestation) will be noted and considered in relation to the potential cause of any identified decline in vegetation health.

Commitments

- Baseline vegetation condition established prior to Stage 1 abstraction commencing.
- Bi-annual (end of dry season and during irrigation season, e.g., July) for early detection where groundwater level trigger exceeded.

6 Environmental impact management

The Stage 1 Project was referred to the Environmental Protection Authority (EPA) under Part IV of the *Environmental Protection Act 1986* (EP Act) on 21 September 2017 and subsequently assessed by EPA at the level of Assessment on Referral Information. The EPA released its report in May 2018 (Report 1615) recommending approval for the Stage 1 Project. Ministerial approval was subsequently granted on 19 November 2018 (Statement No. 1086) subject to the implementation of a number of conditions.

Of relevance to this DWROS, this includes the requirement to develop and implement an Operational Environmental Management Plan (EMP) that demonstrates the following environmental objectives will be met:

- Avoid, where possible, and minimise direct and indirect impacts so that the proposal does not cause long term impacts on the values of Injudinah Swamp and on the hydrological regime and water quality of the Broome Sandstone Aquifer.

- Avoid, where possible, and minimise direct and indirect impacts so that the proposal does not cause significant change in the location of the saltwater interface due to the abstraction of water for the proposal.

The EMP will reflect and be consistent with the monitoring and management commitments specified in this DWROS.

The Stage 1 Project was referred to the Australian Government Minister for the Environment and Energy under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) on 7 August 2017 (EPBC 2017/8004). The Project was deemed a controlled action on 2 February 2018 due to potential impacts on matters of national environmental significance (MNES). Level of assessment was set at Assessment on Preliminary Documentation on 13 June 2018. Of relevance to this DWROS, the Commonwealth Department of the Environment and Energy (DoEE) had concern for potential impacts from groundwater abstraction on Roebuck Bay RAMSAR site, West Kimberley National Heritage area and migratory species.

The EPBC Act assessment is still underway; however, extensive consultation has been undertaken between DoEE, ACC, DWER to incorporate DoEE's requirements into the monitoring and management response plans in this DWROS to ensure groundwater abstraction for the Stage 1 Project does not have a significant impact on any MNES.

Adaptive management is a systematic process for improvement and is critical to leading – practice water management. Adaptive management works by evaluating how effective a process or strategy is in meeting a defined objective. Monitoring data submitted in annual reports will be reviewed and evaluated against management objectives, and recommendations made to modify monitoring and management plans will be provided with the reports. Proposed changes to the operating strategy and related water management objectives and outcomes are reviewed and approved by DWER.

The annual monitoring report will contain a section with any recommended changes to the monitoring program for the department's consideration. Changes to conditions/commitments in an operating strategy can be approved by an addendum to the operating strategy (see Appendix C of Operational policy 5.08). A Groundwater Monitoring review will be due in 12 months' time and baseline monitoring data will advise the setting of management trigger levels discussed in the management response plan, Attachment 1.

Commitments

- The licensee will carry out and report to the department on the following management program:
    - Attachment 1B: Shamrock Station Irrigation Project Stage 1 Management Response Plan

- A triennial water monitoring review will be prepared in accordance with DWER Operational Policy 5.12 and due 3 months following the end of the water year, beginning in 2020 and every 3 years after. A water monitoring summary will not be due in this year.

6.1. Environmental values

Injudinah Swamp, a groundwater dependant ecosystem (GDE) listed in the La Grange Groundwater Allocation Plan as a wetland of State significance, is located approximately 15 km south-west of the proposed Stage 1 development area.

Potential impacts include:

- reduction in groundwater level of the shallow water table
- reduction in ecosystem health associated with reduced groundwater input to the GDE.

The Monitoring and Management Plan (Attachment 1) details early warning and immediate management intervention triggers and associated operational responses to ensure minimal impact to the ecological health of Injudinah Swamp.

The management response plan states that trigger levels will be set in consultation with DWER following one year of continuous baseline monitoring to assess natural variation. Trigger level is to be set 0.25m below the long-term dry season average minimum groundwater level at each bore. The long-term dry season average minimum is calculated from annual minimum groundwater levels recorded at the end of each dry season.

6.2. Existing users

Shamrock Gardens is located approximately 6 km south south-west of the proposed Stage 1 development area with the nearest community, Nygah Nygah, located approximately 11 km to the west. Potential impacts to the existing users include:

- reduction in ability to abstract groundwater
- increased salinity.

The Monitoring and Management Plan (Attachment 1) provides details of existing and new proposed monitoring bores, including 17MB001S/I, 15LAG07S/1, 15LAG06S/D and 17MB002S/D, which will be monitored between the irrigation development and neighbouring existing users to provide early warning of drawdown and water quality impacts. The plan states that trigger levels will be set in consultation with DWER following one year of continuous baseline monitoring to assess natural variation.

6.3. Surface water

No surface water will be taken for the Stage 1 Project, therefore there will be no impacts to environmental values associated with surface water systems. As per the management response plan, surface water levels at PEC will not be set before a reliable baseline is acquired. External variables including climatic conditions and water consumption by stock may preclude adoption of surface water levels as triggers for management action.

6.4. Social values

Groundwater is being used for this development and it is acknowledged that groundwater dependent ecosystems in the La Grange area (e.g., Injudinah Swamp) have social and recreational and cultural values that will be explicitly protected through the Monitoring and Management Plan (Attachment 1). Traditional owners of the land are responsible for the co-management of the Injudinah Swamp and maintaining good relationships via regular communication will ensure access to monitoring sites and compliance with this operating strategy.

6.5. Groundwater quality and the salt water interface

As stated in section 3, there is a risk that groundwater abstraction in this location may have a very minor influence on the position of the coastal saline wedge. Little is understood about the relationship between fresh groundwater expression offshore and sea grass beds in this location. A change in the salinity of the groundwater has the risk of impacting GDE and other groundwater users and will be managed by monitoring and setting water quality trigger levels. The management response plan sets trigger levels to detect change in groundwater salinity to ensure the saltwater interface remains within the predicted range and this should be evaluated continuously as more data becomes available.

The take of groundwater for this project will enable the irrigation of crops and this activity has associated potential impacts to the groundwater resource. Fertiliser application will be managed so as to not contaminate the groundwater and cause unacceptable change in water quality. Best practice recommended fertiliser application rates will be applied to this project, crops will not be over irrigated, and a nutrient irrigation management plan will be developed. Monitoring bores will be sampled to detect any potential adverse water quality impacts.

7 Contingency program

Contingency planning is a component of good business practice. For developments with a water use licence, contingency planning is important to prepare for change in water use operations to prevent a breach of a water licence condition or commitment. Not all components of contingency programs will involve a breach of a water licence condition. For example, the issue of a water licence does not guarantee a reliable water supply. Argyle Cattle Company has therefore planned for circumstances when there may be a shortfall in water supply due to either natural or mechanical reasons (e.g. bores fail to deliver required volume, or a drought occurs).

With seasonal groundwater level and salinity response not well known, the Monitoring and Management Plan (Attachment 1) has been designed to safeguard the groundwater resource, environment and existing users via a network of dedicated early warning monitoring bores. This data will provide temporal groundwater level and salinity data across Shamrock Station and in the adjacent coastal area. Although routine groundwater level monitoring at three to six monthly intervals has occurred in the La Grange area over the past four to five years, including on Shamrock Station, Frazier Downs, Shamrock Gardens and from Main Roads WA bores along the Great Northern Highway, the magnitude of groundwater level change in response to seasonal conditions is relatively unknown. Further analysis of seasonal response is required to accurately assess seasonal baseline condition.

Similarly, baseline salinity condition in response to seasonal stresses imposed by pumping is unknown. Groundwater salinity status on Shamrock Station was established in 2013 during a water quality survey of the La Grange area (refer to Section 4 of the H3 report); however, no temporal groundwater salinity data has been routinely recorded.

Management triggers, as described in the Monitoring and Management Plan (Attachment 1), will be adopted following an assessment of natural variation during the first year of operation to establish a reliable baseline.

The assessment of management trigger levels will be undertaken across the water use year to avoid misinterpretation of seasonal variation throughout each year. This relies on establishing a meaningful long-term baseline for both groundwater level and salinity.

7.1. Management response

The Monitoring and Management Plan (Attachment 1) provides details of Level 1 and Level 2 management responses to early warning Level 1 triggers and intervention Level 2 triggers.

Level 1 responses may include:

- Reassessment of drawdown predictions
- Review of climatic influences
- Repeat measurement
- Review of seasonal EC trends
- Internal investigations
- Development of an abstraction plan
- Development of a water quality plan
- Annual vegetation condition monitoring.

A Level 2 response may include:

- Ceased abstraction (Abstraction greater than the annual water entitlement)
- Management actions stipulated in the abstraction plan developed following a Level 1 response
- Management actions stipulated in the water quality plan developed following a Level 1 response
- Vegetation condition and stress assessment.

Establishing baseline water level and water quality data prior to full abstraction of the licenced volume sets a benchmark against which appropriate trigger levels can be determined. If an early warning Level 1 trigger is exceeded, the Level 1 response provides scope for additional/repeat measurements, investigations and assessment and development of abstraction or water quality plans. Therefore, it is anticipated that all management actions will be effective in limiting detrimental impacts due to the scientific rigour applied in developing the abstraction/water quality plans.

7.2. Non-compliance

Contingency responses for non-compliance of water licence terms and conditions are outlined in Table 5.

Table 5 Contingency responses for non-compliance

Non-compliance Issue	Contingency Program	Comment
Water meter breaks down	Monitor meter through technology were possible on a daily basis and visual inspections on a weekly basis. Spare meters will be held onsite	Technology will be used where possible to signal if/when any component of the pumping system is malfunctioning
Over abstraction	Monthly flowmeter readings and volume calculations	Refer attachment 1B for level 2 response.

7.3. Limited water supply

Contingency responses for limited water supply are outlined in Table .

Contingency responses are to be identified after test drilling occurs and better understanding of water depth and flow at each site is determined.

Table 6 Contingency responses for limited water supply

Reason for limited water supply	Contingency Program	Comment
Water level in bore drops below total depth of bore	Utilise other production bore(s) whilst remedy is being organised	Possible in the event of successive poor wet seasons limiting aquifer recharge/recovery; also, potential if bore silting or clogging (biofouling) occurs

7.4. Flooding

Investigations have not been undertaken to determine flood risk, but this is considered to be low due to the proposed development area's position within the catchment area.

7.5. Unexpected aquifer response

Refer to the Monitoring and Management Plan Attachment 1 and Section 7.1.

7.6. Unexpected water quality trends

Refer to the Monitoring and Management Plan Attachment 1 and Section 7.1.

7.7. Unexpected environmental impacts

Refer to the Monitoring and Management Plan Attachment 1 and Section 7.1.

8 Associated maps

The location of the Stage 1 Project and proposed bore network relative to Injudinah Swamp, existing users and groundwater depth is shown in Figure 1.

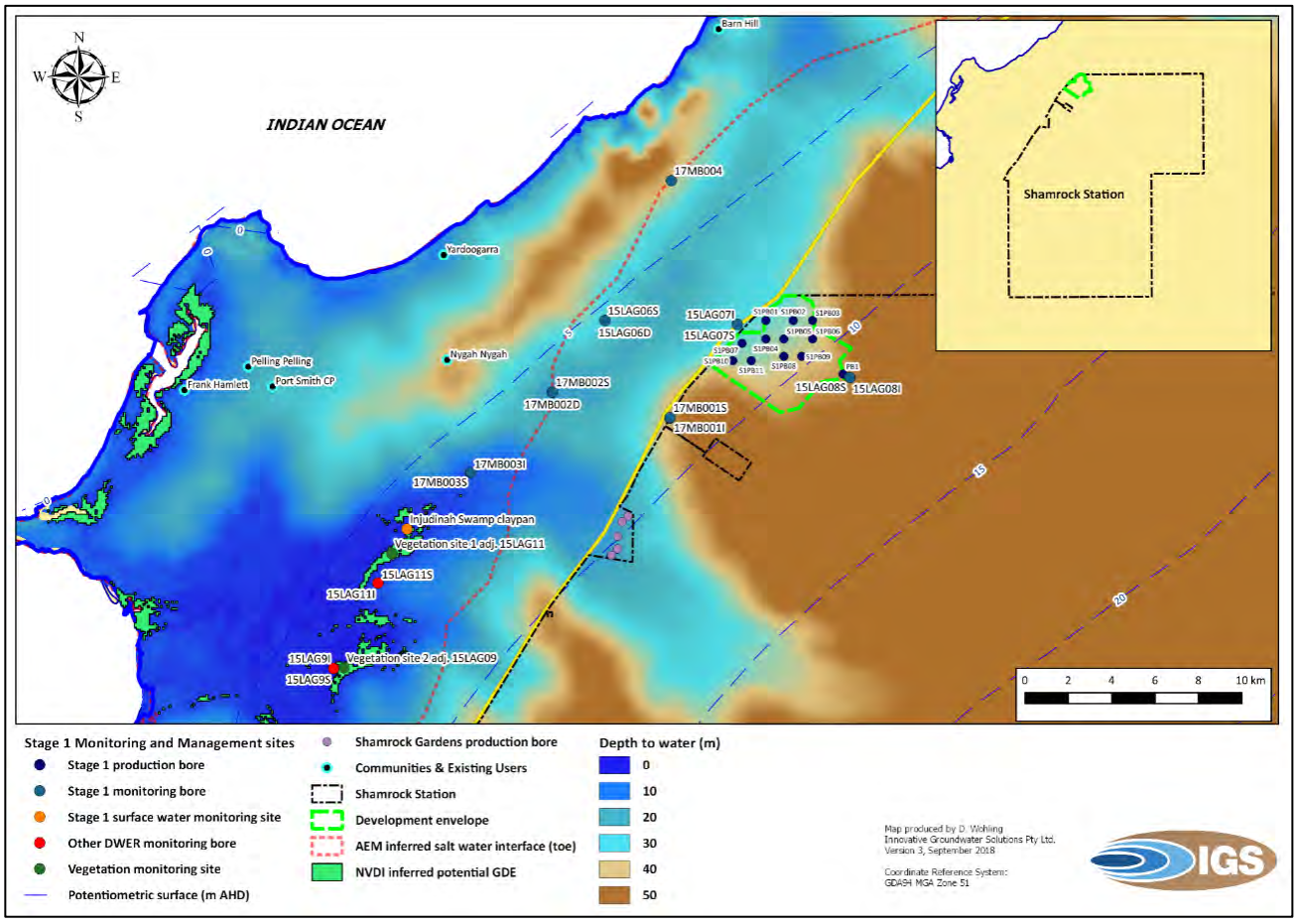

Figure 1 Shamrock Station – Stage 1 development envelope, proposed bore locations, water values and existing users

9 Water use efficiency

In accordance with DWER's Operational Policy 1.02 *Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing* (DoW 2009b), water licensees must take appropriate measures to ensure water is used effectively and efficiently.

The use of centre pivots enables the precise management of water application to be applied in an efficient manner. Run-off from this system is minimal as the water is distributed at the rate required for optimum plant production by considering soil moisture requirements, evaporation and transpiration rates.

Technology will be utilised where possible in the Stage 1 Project to monitor and control water application frequency and volume. The project will adapt to best practice learnings from the industry that is developing in the region.

The irrigation schedule will be modified according to data generated from regular monitoring of crop water usage and soil moisture status with irrigation volumes calculated according to plant requirements and soil moisture content for each individual pivot.

The aims of this system are to optimise plant uptake and minimise waste. This is achieved by:

- Weekly field inspections and monitoring.
- Basing irrigation duration on a Crop Factor as a percentage of daily evaporation (refined by crop type and condition categorisation by actual soil moisture response).
- Regular monitoring of soil moisture in the top 150 cm of the profile with the use of moisture probes.
- Measuring pasture production, utilising where possible an irrigation program for precision application, programmed according to local temperature, rainfall and plant needs.
- The water frequency, rates and watering days will be matched to the evaporation rates, soil moisture reserves and plant health needs.
- Watering cycles will be varied based on both weather conditions and the growth requirements of the pastures and crops.
- Application rates will be adjusted by monitoring of root zone moisture, which will reflect the evapotranspiration rate and therefore plant requirements.
- The daily irrigation program will be altered to allow for climatic changes that occur throughout the year. Bureau of Meteorology forecasts and weather will be used to assist in determining irrigation requirements in conjunction with the growth stage of the pastures and crops.
- Irrigation will cease in the event of any surface run-off occurring or rainfall events that are expected to result in surface run-off occurring. This will minimise both run off and nutrient loss through leaching.
- Further potential for improved water efficiency may be gained from implementation of best practice farming approaches to minimise soil disturbance and associated increases in evaporation, for example, by operating with minimum tillage for ongoing improvement of organic matter and soil structure.

10 Summary of Commitments

1. The licensee will carry out and report to the department on the following:

- Attachment 1A: Shamrock Station Irrigation Project Stage 1 Monitoring Plan, and
- Attachment 1B: Shamrock Station Irrigation Project Stage 1 Management Response Plan

2. Install a meter on each water draw-point through which water is taken under the licence

    a. When installing meters ensure compliance with the *Rights in Water and Irrigation (Approved Meters) Order 2009;* and for each meter installed

    b. maintain the meter in good condition and ensure that it is operating within a range of plus or minus 5% of the quantity of water that passes through it when tested in field conditions

    c. notify DWER within 7 days of detecting a malfunction of the meter

    d. record the meter reading at the end of each month and provide a copy of the meter readings to DWER within 30 days of the water year (see water year condition on licence)

    e. submit meter reads to DWER via the online system called Water Online

    f. within 30 days of the installation of meters, submit to DWER the information listed in section 41C(2) of the Rights in Water and Irrigation Amendment Regulations 2018

3. Baseline vegetation condition established prior to Stage 1 abstraction commencing.

4. Bi-annual vegetation monitoring (end of dry season and during irrigation season, e.g., July) for early detection where groundwater level trigger exceeded.

5. An annual water monitoring summary will be prepared at the end of each subsequent water use year in accordance with DWER Operational Policy 5.12 *Hydrogeological reporting associated with a groundwater well licence* (DoW 2009a, 2012).

6. A triennial water monitoring review will be prepared in accordance with DWER Operational Policy 5.12 and due 3 months following the end of the water year, beginning in March 2022 and every 3 years after. A water monitoring summary will not be due in these years.

11 References

Relevant documents to this DWROS include:

DoW. 2009a. *La Grange Groundwater Allocation Plan. Water resource allocation and planning series. Report no. 25*. Department of Water, Perth, WA. Available at: http://www.water.wa.gov.au/planning-for-the-future/allocation-plans/north-west-region-allocation-plan/la-grange-groundwater-allocation-plan

DoW. 2009b. *Operational policy no. 1.02 – Policy on water conservation/efficiency plans: Achieving water use efficiency gains through water licensing. September 2009*. Department of Water, Perth.

DoW. 2009c. *Operational policy no. 5.12- Hydrogeological reporting associated with a groundwater well licence*. Department of Water, Perth.

DoW. 2011. *Operational Policy 5.08: Use of operating strategies in the water licencing process June 2011*. Department of Water, Perth.

DoW. 2012. *La Grange groundwater allocation plan: Evaluation statement 2011–2012*. Department of Water, Perth, WA. Available at: http://www.water.wa.gov.au/planning-for-the-future/allocation-plans/north-west-region-allocation-plan/la-grange-groundwater-allocation-plan

IGS. 2017. *Shamrock Station irrigation development. Stage 1 hydrogeological assessment*. Innovative Groundwater Solutions, Middleton, SA. Unpublished report prepared for Argyle Cattle Company Pty Ltd.

Phoenix. 2018. *Injudinah Swamp baseline vegetation assessment and installation of vegetation health monitoring transects for the Shamrock Station Irrigation Project*. Phoenix Environmental Sciences Pty Ltd, Balcatta, WA. Unpublished report prepared for Argyle Cattle Company.

Attachment 1 Shamrock Station Irrigation Project Stage 1 Monitoring and Management Response Plans.

ATTACHMENT 1A: Shamrock Station Irrigation Project Stage 1 Monitoring Plan. Highlighted text refers to sub-stages of development: Stage 1A, Stage 1B and Stage 1C (refer Table 3). Asterisks denote monitoring to commence once these Salt Water Interface Monitoring (SWIM) bores have been installed by WA Government.

Category	Parameters	Monitoring Site	Frequency	Time	Comment
Baseline groundwater quality	pH, conductivity (compensated to 25 ^{0}C), TDS, Alkalinity (as $CaCO_3$), Na, Ca, K, Mg, Carbonate, Bicarbonate, Chloride, Sulphate, Nitrate, Total Nitrogen Oxides (or Nitrite), Ammonia, Total Kjeldahl Nitrogen, Nitrogen, Phosphate, Total Phosphorus, Aluminium, Bromide, Boron, Cadmium, Chromium, Copper, Fluoride, Iron, Lead, Molybdenum, Nickel, Silicon, Strontium, Zinc	New production and monitoring bores	Once-off	After bore construction	Pumped sample not airlift sample Depth of sampling point must be reported
Climate	Rainfall	Bureau of Meteorology Bidyadanga	daily	9 am	Data downloaded for annual reporting purposes
Water Use	Flowmeter reading	Production bores Any new / replacement production bores	monthly	As close as practicable to the end of the month	
Barometric pressure	Pressure (pressure transducer logged data)	On-site monitoring bore 15LAG08S On-site monitoring bore MB17001S	hourly	Ongoing	Used to correct pressure readings collected by pressure transducers recording changes in groundwater level
Groundwater pressure	Pressure (pressure transducer logged data) – on-site monitoring bores	17MB001S, 17MB001I 15LAG08S, 15LAG08I	hourly	Ongoing	EC also logged at these sites (see below) 15LAG08SI pressure logger provided by DWER but to be replaced by ACC when it fails. Depth of sampling point to be located within the screened/slotted interval of the bore (Table 1).
	Pressure (pressure transducer logged data) – regional monitoring bores	15LAG6S, 15LAG6D 15LAG7S, 15LAG7I 17MB002S*, 17MB002D* 17MB003S, 17MB003I 17MB004*	hourly	Ongoing	Subject to land access permission 15LAG6D pressure logger provided and maintained by DWER EC also logged at some of these sites (see below) 15LAG07SI pressure logger provided by DWER but to be replaced by ACC when it fails. Depth of sampling point to be located within the screened/slotted interval of the bore (Table 1).
Groundwater levels	Depth to water – on-site monitoring bores	17MB001S, 17MB001I 15LAG08S, 15LAG08I	quarterly	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	
	Depth to water – regional monitoring bores	15LAG6S, 15LAG6D 15LAG7S, 15LAG7I 17MB002S*, 17MB002D* 17MB003S, 17MB003I 17MB004*	quarterly	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	Subject to land access permission
Groundwater quality	Field electrical conductivity and pH	All operating production bores	monthly	As close as practicable to the end of the month. Measurements taken using a hand-held pH & electrical conductivity meter	

Category	Parameters	Monitoring Site	Frequency	Time	Comment
	Electrical conductivity (logged data)	17MB001S, 17MB001I 15LAG08S, 15LAG08I	hourly		Depth of sampling point to be located within the screened/slotted interval of the bore (refer to Table 1).
		17MB003S, 17MB003I 15LAG7S, 15LAG7I			Subject to land access permission Depth of sampling point to be located within the screened/slotted interval of the bore (Table 1).
	Field electrical conductivity and pH	17MB001S, 17MB001I 15LAG8S, 15LAG8I	Quarterly for the first year	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	
		15LAG7S, 15LAG7I 17MB002S* 17MB003S, 17MB003I			Subject to land access permission
	Field electrical conductivity (profiling)	15LAG06D 17MB002D* 17MB004*	annual	ongoing	Subject to land access permission 17MB004 included at request of DoEE Down-hole profiling using EC sonde in the two new, fully-penetrating bores. Options for 15LAG06D include sonde in the slotted interval, deep EC logger, or induction logging.
	Total Nitrogen	17MB003S, 17MB003I 17MB002S* 15LAG7S, 15LAG7I	Quarterly for the first year	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	Subject to land access permission
	pH, conductivity (compensated to 25 ^{0}C), TDS, Alkalinity (as $CaCO_3$), Na, Ca, K, Mg, Carbonate, Bicarbonate, Chloride, Sulphate, Nitrate, Total Nitrogen Oxides (or Nitrite), Ammonia, Total Kjeldahl Nitrogen, Nitrogen, Phosphate, Total Phosphorus, Aluminium, Bromide, Boron, Cadmium, Chromium, Copper, Fluoride, Iron, Lead, Molybdenum, Nickel, Silicon, Strontium, Zinc	Production bores 17MB001S, 17MB001I 15LAG08S, 15LAG8I	annual	Sep/Oct	Which production bores to be annually sampled will be agreed upon once bores have been constructed - at a minimum all western-most pivots must be sampled
		17MB002S* 15LAG7S, 15LAG7I		Sep/Oct	Subject to land access permission
Surface water levels	Pressure (pressure transducer logged data)	Injudinah Swamp Claypan	hourly	Ongoing	Subject to land access permission
	Depth of water (manual using staff gauge)		quarterly	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	
Surface water quality	electrical conductivity and pH (logged data)	Injudinah Swamp Claypan	hourly	Ongoing	Subject to land access permission
	Field electrical conductivity and pH,		Quarterly for the first year	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	
	pH, conductivity (compensated to 25 ^{0}C), TDS, Alkalinity (as $CaCO_3$), Na, Ca, K, Mg, Carbonate, Bicarbonate, Chloride, Sulphate, Nitrate, Total Nitrogen Oxides (or Nitrite), Ammonia, Total Kjeldahl Nitrogen, Nitrogen, Phosphate, Total Phosphorus, Aluminium, Bromide, Boron, Cadmium, Chromium, Copper, Fluoride, Iron, Lead, Molybdenum, Nickel, Silicon, Strontium, Zinc		Quarterly for the first year	Dec/Jan, Mar/Apr, Jun/Jul, Sep/Oct	

Category	Parameters	Monitoring Site	Frequency	Time	Comment
Vegetation monitoring	Vegetation condition	Transects of potential groundwater dependent vegetation at • closest potential groundwater-dependent vegetation within PEC to project; • near Injudinah Swamp Claypan surface water monitoring site; and • control (non-impact site)	Baseline & Annual if water level trigger exceeded	Baseline to be established prior to Stage 1 abstraction commencing i.e., end of dry season. Bi-annual (end of dry season and during irrigation season, e.g., July) for early detection where groundwater level trigger exceeded	

ATTACHMENT 1B: Shamrock Station Irrigation Project Stage 1 Management Response Plan

"Level 1 trigger" is to provide early warning that impacts may exceed the predicted conditions, and thus investigation of causal factors is warranted. This in-turn may lead to mitigation measures being implemented.

"Level 2 trigger" is a threshold beyond which the impacts are unacceptable and immediate management intervention is required to mitigate against any adverse impacts occurring to existing users or the environment.

Issue	Management Objectives	Measurement	Trigger Description	Level 1 Trigger value	Level 2 Trigger value	Level 1 response	Level 2 response	Comment
Over abstraction	Do not exceed the licensed groundwater allocation	Monthly flowmeter readings and volume calculations	Change in horticultural operations	Greater than expected cumulative groundwater use in the year	AWE	Manage abstraction so that AWE is not exceeded. Advise DWER of possible breach of licence conditions. Keep record of correspondence	Cease abstraction until new water year	Exceedance of the AWE is noncompliance to licence conditions
Drawdown impacts on other users	Do not affect neighbor's ability to abstract groundwater	Groundwater levels at monitoring bores: 17MB001S&I 17MB002S&D 17MB004 15LAG06S&D	water levels lower than predicted	Adopted trigger level to be set following a minimum of one year continuous baseline monitoring to assess natural variation	Adopted trigger level to be set following a minimum of one year continuous baseline monitoring to assess natural variation	Reassessment of drawdown predictions. Advise DWER of any revised predictions. If required by DWER, develop a revised abstraction plan for approval by DWER	Invoke management actions stipulated in revised abstraction plan	Need to establish predicted drawdown at 5 years and 10 years at monitoring sites once their final locations have been established.
Drawdown impacts on GDEs	Drawdowns to be within acceptable limits so as not to impact ecological function of identified GDEs	Groundwater levels at new monitoring bore 17MB003S	water levels lower than acceptable	Adopted trigger level to be set following baseline monitoring to assess natural variation. Trigger level to be set 0.25 m below the long-term dry season average minimum groundwater level at each bore. The long-term dry season average minimum is calculated from annual minimum groundwater levels recorded at the end of each dry season	Adopted trigger level to be established once EWRs for the wetland have been established by DWER	Reassessment of drawdowns prediction. Review data against climate factors to determine cause of trigger exceedance Commence annual vegetation monitoring and report to DWER on vegetation condition	Conduct additional vegetation condition and stress assessment (predawn pressure test) at transects near 15LAG11 and replacement for 15LAG09 If vegetation is stressed either: • consider the need to apply to DWER for a vegetation clearing permit, • reduce, move or cease abstraction until water levels recover If vegetation is not stressed • Rerun model to develop revised drawdown at GDEs, and • Reassess risk of impacts at GDEs and revise triggers if appropriate	Need to establish baseline at 17MB003S and 15LAG09I before triggers can be set

Issue	Management Objectives	Measurement	Trigger Description	Level 1 Trigger value	Level 2 Trigger value	Level 1 response	Level 2 response	Comment
		Surface water levels at monitoring sites located at PEC Spring		No trigger level to be adopted before reliable baseline is acquired. External variables including climatic conditions and water consumption by stock preclude adoption of surface water levels as trigger for management action	No trigger level to be adopted before reliable baseline is acquired. External variables including climatic conditions and water consumption by stock preclude adoption of surface water levels as trigger for management action			Need to establish baseline at Spring before triggers can be set. A trigger can only be set if long-term baseline data from surface water monitoring can be directly related to shallow water table monitoring, in order to properly characterise the nature of surface water-groundwater connectivity.
Groundwater salinity	Maintain groundwater quality	Electrical conductivity in groundwater from: • operating production bores • monitoring bores 17MB001S&I 17MB003S&I 15LAG7S&I	Field electrical conductivity exceeds acceptable value	Values exceed baseline by 15% or 200 μS/cm (whichever is greater). NB. Baseline value will likely be based on 80th percentile of measured historical data.	Values exceed baseline by 25% or 350 μS/cm (whichever is greater). NB. Baseline value will likely be based on 80th percentile of measured historical data.	Repeat quarterly measurement.	Repeat quarterly measurement. If the repeat measurement is greater than Level 2 Trigger value, then report exceedance to DWER within 10 working days	Need to establish baseline at 17MB001S&I, 17MB003S&I, and 15LAG7S&I before triggers can be set. In particular, the baseline for 17MB003S needs to account for seasonal and inter-annual wetting and drying cycles and their impact on EC and/or chemistry
						Review of EC data to assess seasonal fluctuations and increasing trend. Initiate internal investigation regarding causes for increases in salinity. Report findings in Annual monitoring report. If required by DWER, develop water quality management plan for approval by DWER	Invoke management actions stipulated in water quality management plan	Water quality management plan will outline actions to which the licensee commits. The WQM may include a change in: • types of fertilisers used, • fertiliser application rates, • methods of fertiliser application • irrigation practices • monitoring regime (locations, frequency and parameters)
	Ensure saline wedge movement does not impact GDEs, and other users' water supply	Electrical conductivity and water level in groundwater from monitoring bores: 17MB002D, 17MB004 and 15LAG06D	Movement of saltwater interface to remain within predicted range	Values exceed baseline by 15%. NB. Baseline EC profile will likely be based on 80th percentile of measured historical data.	Values exceed baseline by 25%. NB. Baseline EC profile will likely be based on 80th percentile of measured historical data.	Review of EC data to assess seasonal fluctuations and increasing trend. Initiate internal investigation regarding causes for increases in salinity. Report findings in Annual monitoring report.	Invoke management actions stipulated in revised abstraction plan	Need to establish baseline for all bores and compare with model predicted drawdown before triggers can be set

Issue	Management Objectives	Measurement	Trigger Description	Level 1 Trigger value	Level 2 Trigger value	Level 1 response	Level 2 response	Comment
						If required by DWER, develop a revised abstraction plan for approval by DWER		
Changes to water quality due to abstraction and/or fertiliser application	Maintain groundwater quality	Annual comprehensive water quality analysis of pumped groundwater sampled from: • production bores • monitoring bores 17MB001S&I 15LAG7S&I	TN TP pH EC – see groundwater salinity issue	Adopted trigger levels for nutrients and pH to be set following a minimum one year of continuous baseline monitoring to assess natural variation. If water level triggers are exceeded at 17MB003S then quarterly EC and pH will be collected.	Adopted trigger levels for nutrients and pH to be set following a minimum one year of continuous baseline monitoring to assess natural variation.	Repeat sampling if analysis results deemed spurious. Review of data to assess seasonal fluctuations and trends. Initiate internal investigation regarding causes for exceedances. Report findings in Annual monitoring report If required by DWER, develop water quality management plan for approval by DWER	Invoke management actions stipulated in water quality management plan	Depth of sampling point in bores must be consistent and stipulated in Operating Strategy Need to establish baseline nutrients and pH before triggers can be set
		Field pH measured quarterly	pH EC – see groundwater salinity issue	No trigger level to be set until baseline established, however routine measurements at following sites should be evaluated and explored if pH drops below 6.0 • 17MB001S&I 17MB002S&D 17MB003S&I 15LAG06S 15LAG7S&I	Successive quarterly pH measurements not to be lower than 6.0 pH at 15LAG07S&I, 17MB001S&I, 17MB002S, MB003S&I and production bores	Repeat sampling. Review of data to assess seasonal fluctuations and trends. Initiate internal investigation regarding causes for exceedances. If required by DWER, develop water quality management plan for approval by DWER	Invoke management actions stipulated in water quality management plan	Depth of sampling point must be consistent and stipulated in Operating Strategy

Attachment 2 Injudinah Swamp baseline vegetation monitoring report