APPENDIX B CSG WATER MANAGEMENT PLAN

Comet Ridge Ltd

Mahalo North
Coal Seam Gas Water Management Plan

31 July 2023 - Final

Document Control

Version	Date	Author	Description
Draft 1	27 April 2023	Ryan Morris	Draft for client review
Final	31 July 2023	Ryan Morris	Finalised following client review

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Definition and Acronyms

ATP	Authority to Prospect
BOM	Bureau of Meteorology
brine	High salinity (waste) product from the RO process
CSG	Coal Seam Gas
CWMP	Coal Seam Gas Water Management Plan (this document)
DES	Queensland Department of Environment and Science, formerly the Department of Environment and Heritage Protection (DEHP)
DSC	Designed storage capacity
EA	Environmental Authority
EoW	End of Waste
EC	Electrical conductivity
EoWCAW	End of Waste Code Associated Water (including coal seam gas water)
EoWIAW	End of Waste Code Irrigation of Associated Water (including coal seam gas water)
EV	Environmental Value
GAB	Great Artesian Basin
GCF	Gas Compression Facility
GL	gigalitres (1 billon litres)
GWBD	Queensland groundwater bore database
mAHD	Meters above Australian Height Datum – height above sea level
ML	megalitres (1 million litres)
ML/day	megalitres per day
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
NATA	National Association of Testing Authorities
PAG	The Petroleum gas (Production and Safety) Act 2004
permeate	Low salinity product from the RO process used for beneficial purposes
PWST	Produced water storage tank
PL	Petroleum lease
RMMP	Resource Monitoring and Management Plan
the project	The planned coal seam gas field and associated infrastructure
PWST	Produced water storage tank
RO	Reverse Osmosis
SAR	Sodium Adsorption Ratio
TDS	Total Dissolved Solids – a measurement of the salinity of water
WQO	Water Quality Objective
WTP	Water treatment plant

1. Introduction

Comet Ridge Mahalo North Pty Ltd (Comet Ridge) is proposing to develop a greenfield Coal Seam Gas (CSG) project contained within ATP2048 (the project). The project area is situated in Central Queensland approximately 45 kilometres (km) north of Rolleston and lies within the Central Highlands Regional Council area (Figure 1). The project will require the development of the 34 CSG production wells and 34 lateral wells, water and gas gathering lines, a gas compression facility (GCF) and ancillary infrastructure.

The project is expected to commence production in 2024. The production wells will target the Bowen Basin's Bandanna Formation and the produced gas will be fed into the domestic supply gas market. Project activities include:

- Drilling, construction, and operation (including workover) of up to 34 CSG well pairs.
- Installation, operation and maintenance of water and gas gathering flowlines.
- Construction, operation and maintenance of a gas compression facility (GCF), and necessary associated infrastructure that may include water storage tanks and water gathering stations.
- Installation operation and maintenance of necessary temporary and/or permanent associated infrastructure, including but not limited to, access roads, power and communication systems, laydown and storage areas, accommodation and administration facilities.
- Decommissioning and rehabilitation of infrastructure and disturbed areas.

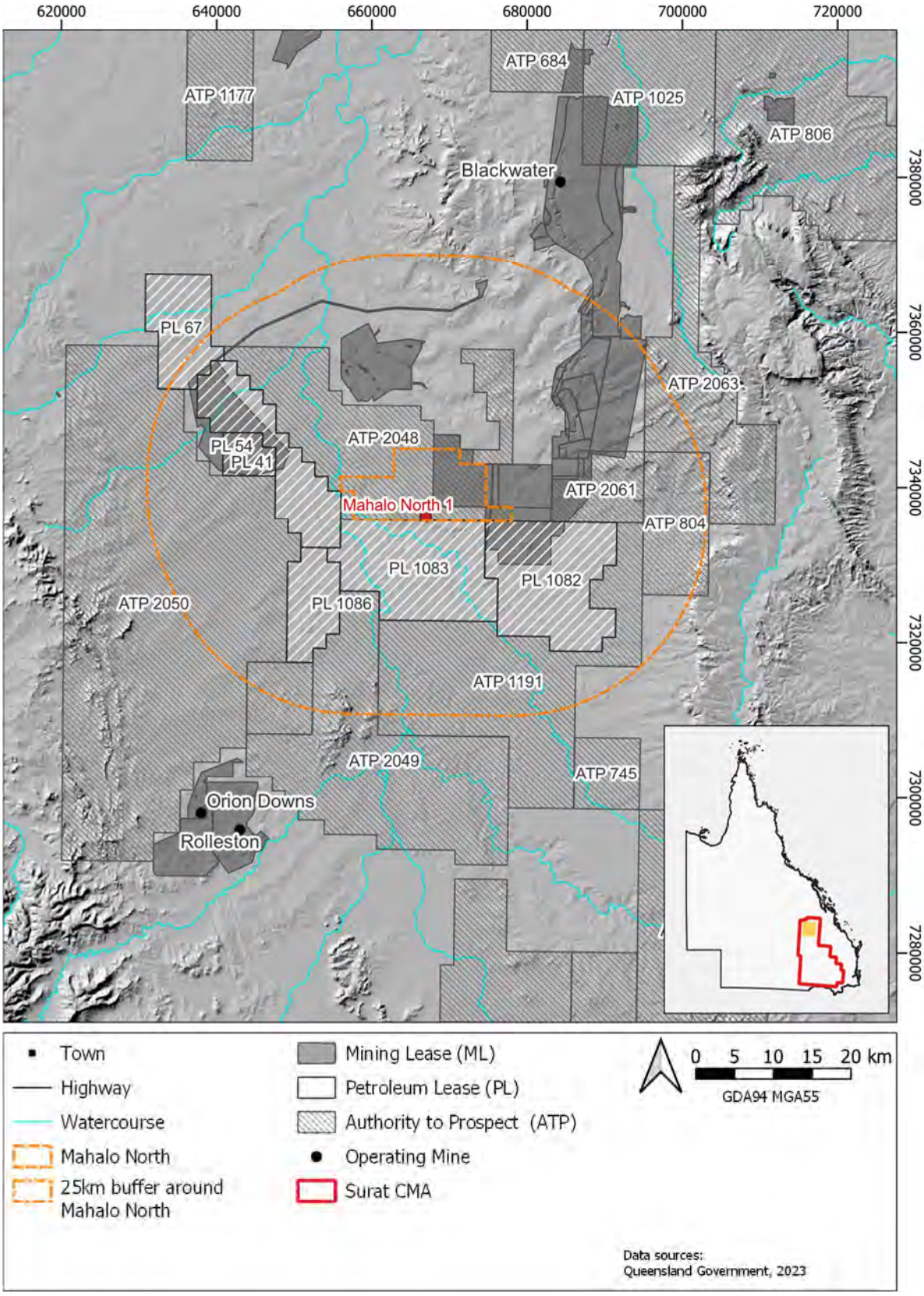
This document constitutes the CSG Water Management Plan (CWMP) for the Project. The objectives of this CWMP are to:

- Ensure the requirements of Section 126 of the *Environmental Protection Act 1994* (EP Act) are addressed as required for a site-specific Environmental Authority (EA) application; and
- Describe how the Project's CSG water will be managed in conformance with the Queensland Coal Seam Gas Water Management Policy 2012 (DEHP[1]) while addressing environmental and Project requirements.

This CWMP will consider managing CSG water for the lifetime of the project and will be deemed a live document. It will be regularly updated to account for continual improvement in the understanding of the produced water volumes and quality, changes to technologies and community and environmental requirements.

[1] The former Department of Environment and Heritage Protection (DEHP), currently the Department of Environment and Science (DES). Where references are made to documents, these have been attributed to the department name on the most recent version.

Figure 1 Site location



1.1. Water production forecast

To produce CSG, the pressure in the reservoir must be reduced to allow the gas to desorb from the coal. This pressure reduction is achieved by pumping groundwater from the well. When the reservoir pressure reaches the critical desorption pressure – dependent on the gas saturation of the target coal – gas will begin to flow. Upon desorption of the gas, the water production rate reduces as the presence of gas within the coal cleats inhibits the flow of water.

The Project will exercise its underground water rights under the *Petroleum and Gas (Production and Safety) Act 2004* through the production of associated water to enable the production of CSG. The current Project water production forecast is provided in Figure 2. It identifies a peak water production rate of 394 cubic meters per day (m^3/day) in April 2026. The water forecast shows a sawtooth pattern, with peaks representing new tranches of wells coming online, followed by a declining water rate until the next year when the next tranche of wells is commissioned. The magnitude of the peaks is dependent on the number of wells and the assumed characteristics of the coal seams that the wells intercept. The average forecast daily water production up to the end of 2035 (1 year after the last tranche of wells is commissioned) is 217 m^3/day, with production rates continuously declining thereafter.

The forecast cumulative volume of water that will be produced over the life of the Project is 1,100 megalitres (ML – 1.1 gigalitres) based on the current forecast.

1.2. Produced water quality

Water quality samples were collected from the Mahalo North 1 well during pilot production to ascertain the produced water quality. The samples were collected in accordance with the Queensland Government's *Monitoring and Sampling Manual 2009 – Environmental Protection (Water) Policy 2009*. Laboratory analysis was performed by a NATA accredited facility for the analyses requested. The water quality data is presented in Table 1.

The salinity of the produced water was 5,020 mg/L total dissolved solids (TDS). This is consistent with the salinity of RN62660, which is located within the project area (see Figure 1) and is believed to also extract groundwater from the Bandanna Formation. It is significantly fresher than the water produced in the Mira pilot (7,900-10,800 mg/L TDS), within PL1083 and approximately 9 km south of the project boundary (Golder, 2018). No other Bandanna Formation water quality data has been identified from publicly available sources in the immediate vicinity of the project.

1.3. Treated water quality

During the operation of the Mahalo North 1 pilot, the operation of a reverse osmosis (RO) plant to treat the produced water was trialled. Samples of the desalinated RO permeate were collected in accordance with the Queensland Government's *Monitoring and Sampling Manual 2009 – Environmental Protection (Water) Policy 2009*. Laboratory analysis was performed by a NATA accredited facility for the analyses requested. The water quality data is presented in Table 1.

These analyses show that RO is effective at reducing the salinity of the produced water. The reported TDS of the RO permeate was 69 mg/L, with proportional reduction in the concentrations of most parameters, particularly sodium and chloride.

Figure 2 Project water production forecast (April 2023)

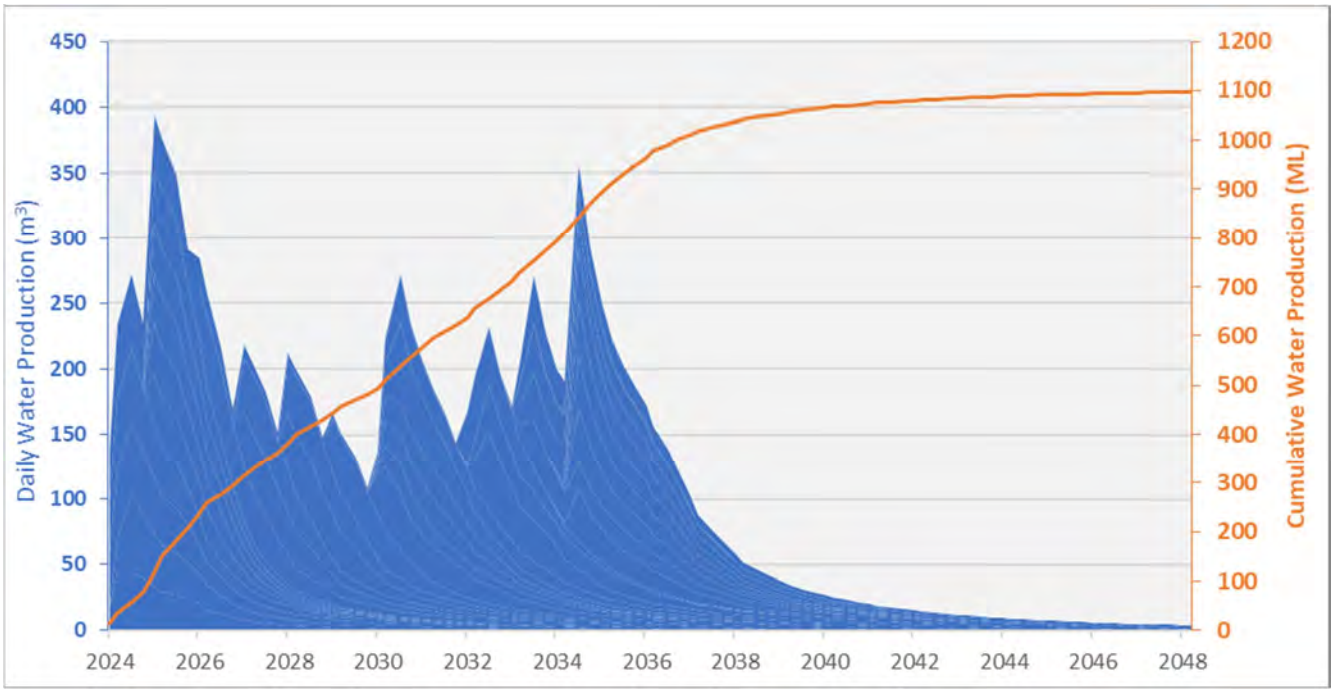


Table 1 Produced and treated water quality

Chemical Group	Parameter	Unit	Limit of Reporting	Mahalo North 1 CSG Produced Water	RO Permeate
Physiochemical Parameters	pH Value	pH Unit	0.01	8.21	6.87
	Sodium Adsorption Ratio	-	0.01	43.3	4.3
	Electrical Conductivity @ 25°C	µS/cm	1	7720	106
	Total Dissolved Solids	mg/L	1	5020	69
Major Ions	Hydroxide Alkalinity as CaCO3	mg/L	1	<1	<1
	Carbonate Alkalinity as CaCO3	mg/L	1	<1	<1
	Bicarbonate Alkalinity as CaCO3	mg/L	1	238	4
	Total Alkalinity as CaCO3	mg/L	1	238	4
	Sulfate as SO4 - Turbidimetric	mg/L	1	<1	<1
	Chloride	mg/L	1	2900	32
	Calcium	mg/L	1	88	<1
	Magnesium	mg/L	1	15	<1
	Sodium	mg/L	1	1670	18
	Potassium	mg/L	1	98	3
	Silicon as SiO2	mg/L	0.1	16.8	<0.1
	Fluoride	mg/L	0.1	0.1	<0.1
	Bromide	mg/L	0.01	7.45	0.107
Nutrients	Ammonia as N	mg/L	0.01	1.29	0.43
	Nitrite as N	mg/L	0.01	<0.01	<0.01
	Nitrate as N	mg/L	0.01	<0.01	<0.01
	Nitrite + Nitrate as N	mg/L	0.01	<0.01	<0.01
	Total Kjeldahl Nitrogen as N	mg/L	0.1	1.5	0.6
	Total Nitrogen as N	mg/L	0.1	1.5	0.6
	Total Phosphorus as P	mg/L	0.01	0.09	<0.01
Dissolved Metals/ Metalloids	Aluminium	mg/L	0.01	<0.01	<0.01
	Arsenic	mg/L	0.001	<0.001	<0.001
	Barium	mg/L	0.001	3.46	0.005
	Beryllium	mg/L	0.001	<0.001	<0.001
	Boron	mg/L	0.05	0.92	0.33
	Cadmium	mg/L	0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	<0.001	<0.001
	Cobalt	mg/L	0.001	<0.001	<0.001
	Copper	mg/L	0.001	<0.001	<0.001
	Iron	mg/L	0.05	<0.05	<0.05
	Lead	mg/L	0.001	<0.001	<0.001
	Manganese	mg/L	0.001	0.038	<0.001
	Mercury	mg/L	0.0001	<0.0005	<0.0001
	Molybdenum	mg/L	0.001	0.001	<0.001
	Nickel	mg/L	0.001	<0.001	0.001
	Selenium	mg/L	0.01	<0.01	<0.01
	Strontium	mg/L	0.001	9.25	0.014

Chemical Group	Parameter	Unit	Limit of Reporting	Mahalo North 1 CSG Produced Water	RO Permeate
	Vanadium	mg/L	0.01	<0.01	<0.01
	Zinc	mg/L	0.005	<0.005	0.006
Total Metals/ Metalloids	Aluminium	mg/L	0.01	0.63	0.01
	Arsenic	mg/L	0.001	<0.001	<0.001
	Barium	mg/L	0.001	3.49	0.005
	Beryllium	mg/L	0.001	<0.001	<0.001
	Boron	mg/L	0.05	0.98	0.37
	Cadmium	mg/L	0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	<0.005	<0.001
	Cobalt	mg/L	0.001	<0.001	<0.001
	Copper	mg/L	0.001	0.002	<0.001
	Iron	mg/L	0.05	3.94	<0.05
	Lead	mg/L	0.001	<0.001	<0.001
	Manganese	mg/L	0.001	0.063	<0.001
	Mercury	mg/L	0.0001	<0.0005	<0.0001
	Molybdenum	mg/L	0.001	<0.005	<0.001
	Nickel	mg/L	0.001	<0.005	0.002
	Selenium	mg/L	0.01	<0.01	<0.01
	Strontium	mg/L	0.001	10.4	0.016
	Vanadium	mg/L	0.01	<0.01	<0.01
	Zinc	mg/L	0.005	0.009	0.007
Petroleum Hydrocarbons	C6 - C9 Fraction	µg/L	20	<20	<20
	Sum of polycyclic aromatic hydrocarbons	µg/L	0.5	<0.5	<0.5
	Sum of BTEX	µg/L	1	<1	<1
Radionucleides	Gross alpha	Bq/L	0.05	-	<0.04
	Radium 226	Bq/L	0.03	-	<0.03
	Uranium	mg/L	0.002	-	<0.002
	Uranium 238	Bq/L	0.025	-	<0.05
	Radium 228	Bq/L	0.05	-	<0.25
	Gross beta activity - 40K	Bq/L	0.1	-	<0.1

2. Regulatory Context

2.1. Environmental Protection Act 1994

The management of potential environmental impacts, including the management of produced water, is managed through the EP Act. The EP Act (Section 126) defines the requirements for site-specific EA applications. Table 2 identifies the sections of this document where each requirement is addressed.

Table 2 Conformance with the requirements of Section 126 of the EP Act

Section of EP Act	Requirement	Relevant section of this document
126(1)(a)	The quantity of CSG water the applicant reasonably expects will be generated in connection with carrying out each relevant CSG activity	Section 1.1
126(1)(b)	The flow rate at which the applicant reasonably expects the water will be generated	Section 1.1
126(1)(c)	The quality of the water, including changes in the water quality the application reasonably expects will happed while each relevant CSG activity is carried out	Section 1.2
126(1)(d)	The proposed management of the water including, for example, the use, treatment, storage or disposal of the water	Section 4 and Section 5
126(1)(e)	The measurable criteria (the management criteria) against which the applicant will monitor and assess the effectiveness of the management of the water, including, for example, criteria for each of the following: • The quantity and quality of the water used, treated, stored or disposed of • Protection of the environmental values affected by each relevant CSG activity • The disposal of waste, including, for example, salt, generated from the management of the water	Section 6.1 (Table 7)
126(1)(f)	The action proposed to be taken if any of the management criteria are not complied with, to ensure the criteria will be able to be satisfied in the future	Section 6.1
126(2)	The proposed management of the water cannot provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless: (a) The application includes the evaluation of: i. Best practice environment management for managing the CSG water; and ii. Alternative ways for managing the water; and (b)The evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water.	Not relevant as CSG evaporation dams are not proposed for the Project.

2.1.1. Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The EP Act defines an Environmental Value (EV) as:

- A quality of physical characteristic of the environment that is conducive to ecological health or public amenity or safety, or
- Another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation.

The purpose of the *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPP (Water and Wetland Biodiversity)) is to determine the EVs and associated water quality objectives (WQOs) for Queensland waters. The EPP (Water and Wetland Biodiversity) states that EVs can be determined through an assessment of the value, condition, suitability and uses of the relevant waters.

EVs associated the Project area are discussed further in Section 3.6.

2.2. CSG Water Management Policy 2012

The Queensland CSG Water Management Policy (DEHP, 2012) is intended to guide CSG operators in managing CSG water in accordance with the Queensland government's position on its management and use.

The stated objective of the policy is to encourage the beneficial use of CSG water in a way that protects the environment and maximises it productive use as a valuable resource.

A management hierarchy is defined to facilitate compliance with the objective of the policy and its management under the EP Act. The hierarchy is as follows:

- **Priority 1** – CSG water is used for a purpose that is beneficial to one or more of the following: the environment, existing or new water users, and existing or new water-dependent industries. This could be achieved through:
    - Injection into depleted aquifers for recharge purposes
    - Substitution for an existing water entitlement
    - Supplementary water for existing irrigation schemes
    - New irrigation use, with a focus on sustainable irrigation projects
    - Livestock watering
    - Urban and industrial water supplies
    - Coal washing and dust suppression
    - Release to the environment in a manner that improves local environmental values

- **Priority 2** – after feasible beneficial use options have been considered, treating and disposing CSG water in a way that firstly avoids, and then minimises and mitigates, impacts on environmental values. Disposal to watercourses will only be approved for residual water where there is no feasible beneficial use, and disposal options will not adversely affect environmental values.

Disposal of CSG water to evaporation dams will only be approved under exceptional circumstances. The proposed management of the water cannot provide for using a CSG evaporation dam in connection with carrying out a relevant CSG activity unless the application includes an evaluation of the following:

- Best practice environmental management for managing the CSG water; and
- Alternative ways for managing the water; and

- The evaluation shows there is no feasible alternative to a CSG evaporation dam for managing the water.

The policy identifies the following priorities for managing brine and/or salt generated from the desalination of the CSG water if required to maintain the EVs during the CSG water management:

- **Priority 1** – Brine or salt residues are treated to create useable products wherever feasible; and
- **Priority 2** – After assessing the feasibility of treating the brine or solid salt residues to create useable and saleable products, disposing of the brine and salt residues in accordance with strict standards that protect the environment. These may include:
  - Injecting brine underground; and
  - Disposing to a regulated waste facility.

2.3. End of Waste Code Associated Water (including coal seam gas water)

Although the CSG Water Management Policy recognises produced water as “valuable resource”, prior to its treatment (if necessary) to a quality suitable for its intended use, it is considered a waste. If the water, or treated water, can be used for a beneficial use then the producer can register the water as a resource and where there is an End of Waste (EoW) code in place, the water can be supplied to third parties either on or off tenure. In this case, there is no application or assessment requirements, providing the use complies with the EoW code.

The *End of Waste Code Associated Water (including coal seam gas water)* (EoWCAW) (DES, 2019a) identifies responsibilities for both the *resource producer* and *resource user*. Specifically for the resource producer, it identifies that the resource must not be directly or indirectly released to any waters (stream, river, weir or any other natural watercourse), but must be supplied directly to the resource user. The resource must meet the stated water quality criteria and conditions for use identified in Table 3. The resource producer must register as such and must comply with the monitoring and management requirements identified in the EoW code. There are also requirements identified for the resource user that must be adhered to.

2.4. End of Waste Code Irrigation of Associated Water (including coal seam gas water)

The *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* (EoWIAW) (DES, 2019b) applies only to the direct supply of associated water produced during the extraction of petroleum and gas for irrigation purposes. The EoWIAW provides two compliance pathways for registered water producers that depend on water quality at the point of supply, via:

- Standard water quality parameters (electrical conductivity, sodium adsorption ratio, pH and heavy metal/metalloids) which may vary depending on the type of soil to be irrigated; or
- Preparation and compliance with a resource monitoring and management plan (RMMP) by an appropriately qualified person. The EoWIAW identifies the minimum requirements for an RMMP.

As with the EoWCAW, there are ongoing monitoring and management requirements that must be adhered to.

If CSG Water is provided to a third party for irrigation, it will be provided under the EoWIAW.

Table 3 Water quality criteria and conditions for the use of associated under the End of Waste Code (DES, 2019a)

Use	Water quality criteria	Conditions for the use of the resource
Aquaculture	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) Volume 1: Chapter 4.4 Table 4.4.2 and 4.4.3.	• Aquaculture is limited to a culture of species groups mentioned in Table 4.4.1 of Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) Volume 1: Chapter 4.4 which are cultivated or held in an enclosure on land. • The resource must not be directly or indirectly released to land
Coal washing	No water quality requirements	The resource must not be directly or indirectly released to land
Dust suppression	No water quality requirements	Use of the resource for dust suppression purposes must not exceed what is required to effectively suppress dust and be directly applied to the area being dust suppressed.
Construction	No water quality requirements	• The use of the resource must not result in runoff from the construction site; and • The use of the resource must not harm vegetation surrounding the construction site.
Landscaping and revegetation	• total dissolved solids (TDS) < 1000mg/L; • pH range of 6.0 – 9.5; and • Must not contain any substances in concentrations that may be toxic to plant growth.	• The amount of resource applied should not exceed what is required to effectively undertake landscaping or revegetation activities; • The application of the resource must not harm vegetation surrounding the area being landscaped or revegetated; and • not to be used for irrigation
Research and development	No water quality requirements	The resource must not be directly or indirectly released to land
Industrial and manufacturing operations	pH range of 6.0-9.5.	• The resource must not be directly or indirectly released to land; and • The resource must not be used in food preparation or production manufacturing industries such as fruit washing.
Domestic, stock and stock intensive an incidental land management	For stock and stock intensive drinking water the water quality of the resource must comply with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) Volume 1: Chapter 4.3 Table 4.3.1, 4.3.2, & 4.3.3.	• With regards to domestic use and incidental land management, the resource must not have characteristics/ properties which have the potential to cause harm to individuals should they come into contact or are exposed. • Stock and stock intensive drinking water is limited to watering livestock mentioned in Table 4.3.1 of Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) Volume 1: Chapter 4.3.

3. Environmental Context

3.1. Climate

Climate data has been sourced from the Bureau of Meteorology (BoM, 2021) and Long Paddock SILO (Queensland Government, 2021) for Station 35063 Somersby (Latitude -24.2111; Longitude 148.7403, shown on Figure 6). Monthly averages of maximum and minimum temperatures are presented as Figure 3, rainfall statistics are presented as Figure 4 and evaporation statistics are presented as Figure 5.The statistics were calculated on data from the 1930 to 2022.

The region is characterised by hot summers and mild winters and although overnight temperatures can be cold, on average they tend to remain above zero. Mean maximum temperatures range between ~34°C in the summer months and ~22°C in the winter months. Mean minimum temperatures range between ~21°C in the summer months and ~6°C in the winter months.

The annual average rainfall at Somerby is 610 mm, with the majority falling between November and March, but rain does fall throughout the year. The average monthly rainfall is higher than the median indicating that periodic large rainfall events bias the average high. Monthly evaporation rates exceed rainfall in all months of the year. The median and average monthly evaporation rates are similar. The annual average evaporation rate 2,072 mm/year.

Figure 3 Daily average minimum and maximum temperatures

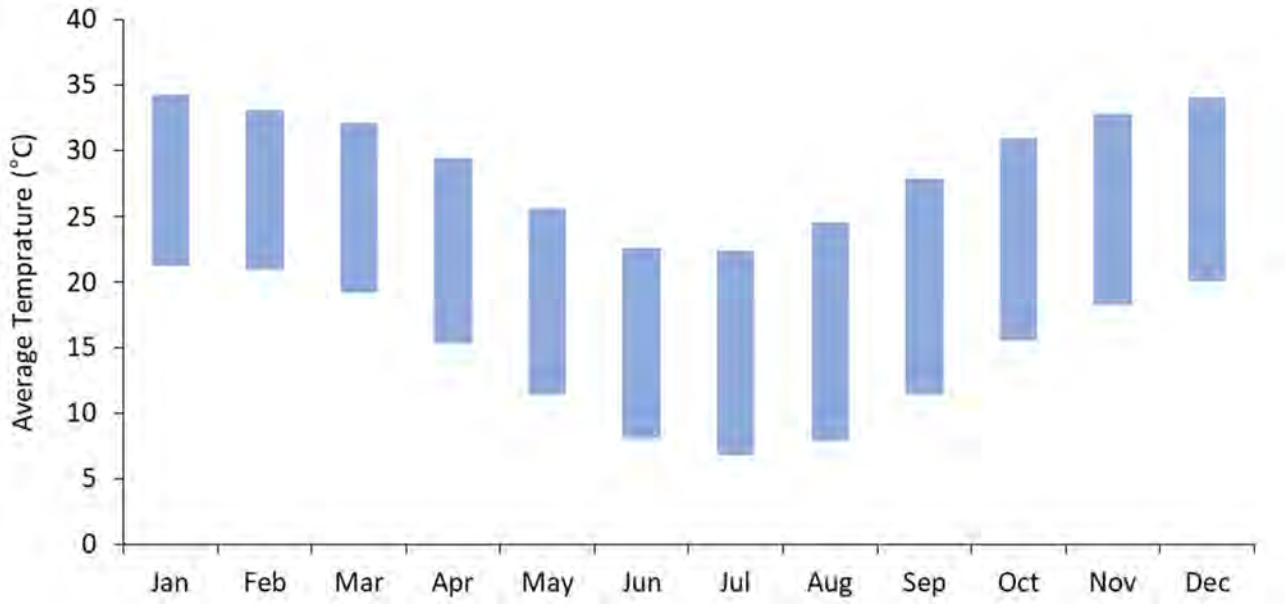


Figure 4 Monthly rainfall statistics

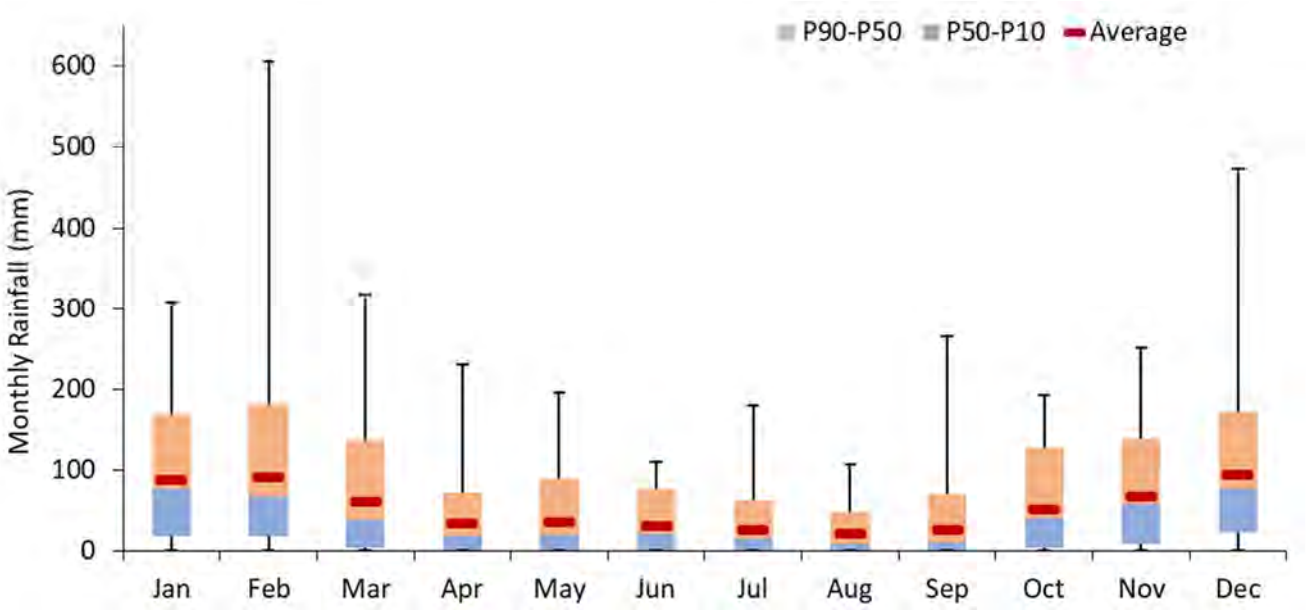
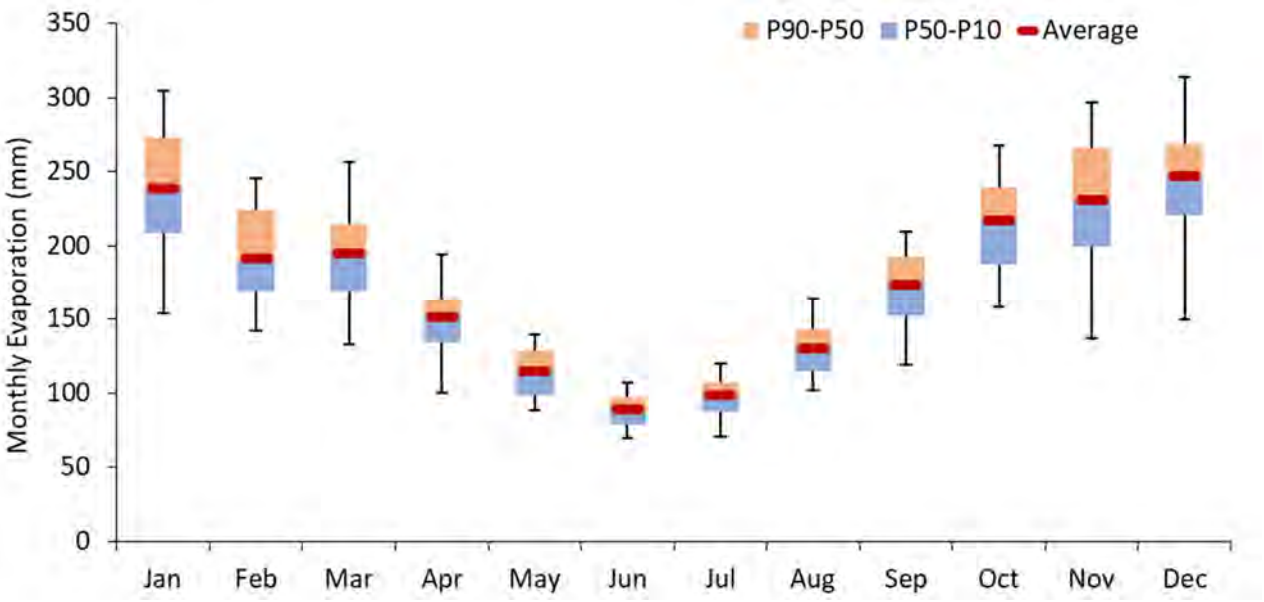


Figure 5 Monthly evaporation statistics



3.2. Topography and Drainage

The project area is wholly within the Comet River catchment of the Fitzroy Basin. The topography across the project area generally falls from east to west, towards the Comet River, which is the main drainage feature. Humboldt Creek, a tributary to the Comet River transects the southwestern corner of the project.

Ephemeral unnamed watercourses drain the central parts of Mahalo North, flowing into Sirius Creek near its confluence with the Comet River, approximately 18 km north of the project boundary.

Within the project area the elevation ranges from ~190 mAHD to ~250 mAHD.

The Expedition Ranges to the east of the Project area rises to ~800 mAHD along the escarpment.

Figure 7 presents the mean daily discharge for three surface water gauging stations within the vicinity of the project area. The data was sourced from the Queensland Government Water Monitoring Information Portal (State of Queensland, 2023). Stations 130506A and 130510A on the Comet River are active gauging stations (upstream and downstream of the project area, respectively), whereas 130505A on Humboldt Creek is no longer active. The locations of the gauging stations are shown on Figure **6**. These streamflow data indicate:

- Flow in the Comet River and Humboldt Creek is ephemeral, with extended periods of no flow,
- The majority of flow occurs during December to March, corresponding to the wet season, and
- In wetter periods, streamflow may be sustained through the dry season, indicating the potential for significant volumes of bank storage.

3.3. Soils

With reference to Atlas of Australian Soils (Queensland Government, 2023a), the soils across project area can be divided into three main areas:

- Central swathe, running southeast to northwest – Grey self-mulching cracking clays
- **North** – Red massive earths
- **Southwestern corner** – Red massive earths

There is no acid sulphate soil mapped within the project area.

3.4. Geology and Hydrogeology

The regional geology of the project area comprises sediments from the Early Permian to Middle Triassic age Bowen Basin. The Bowen Basin is an elongated, north to south trending basin extending over 160,000 km^2 from central Queensland, south beneath the Surat Basin, and into New South Wales, where it connects with the Gunnedah and Sydney basins. The project is located on the southern end of the Comet Ridge outcrop and is flanked by the Taroom Trough to the east and the Denison Trough to the west. CSG production at the project will target the Bandanna Formation of the Bowen Basin. The Bandanna Formation is also known as the Baralaba or Rangal Coal Measures.

Quaternary and Tertiary (Cainozoic) deposits overlay the Bowen Basin units. The Tertiary deposits comprise basalts with interbedded tuff and volcanolithic fragments. The Quaternary deposits predominantly comprise alluvial sediments associated with the major drainage features.

The regional water table is assumed to be hosted within the Tertiary Strata and lies at ~180mAHD (RDM Hydro, 2023). The water table depth is estimated to be around 55 m in the vicinity of the planned location of the project's gas compression facility (refer to Figure **9**).

3.5. Land Use

The majority of the project area is classified as being used for grazing. In areas adjacent to the Comet River, land use is classified as cropping and irrigated cropping. There are small areas of strategic cropping land in the most southeast and southwest corners of the project area.

There is overlapping tenure between the project area and mining leases associated with the Blackwater mine to the north, however there has been no active open cut mining within the area of overlap.

Figure 6 Topography and drainage of Mahalo North and surrounds

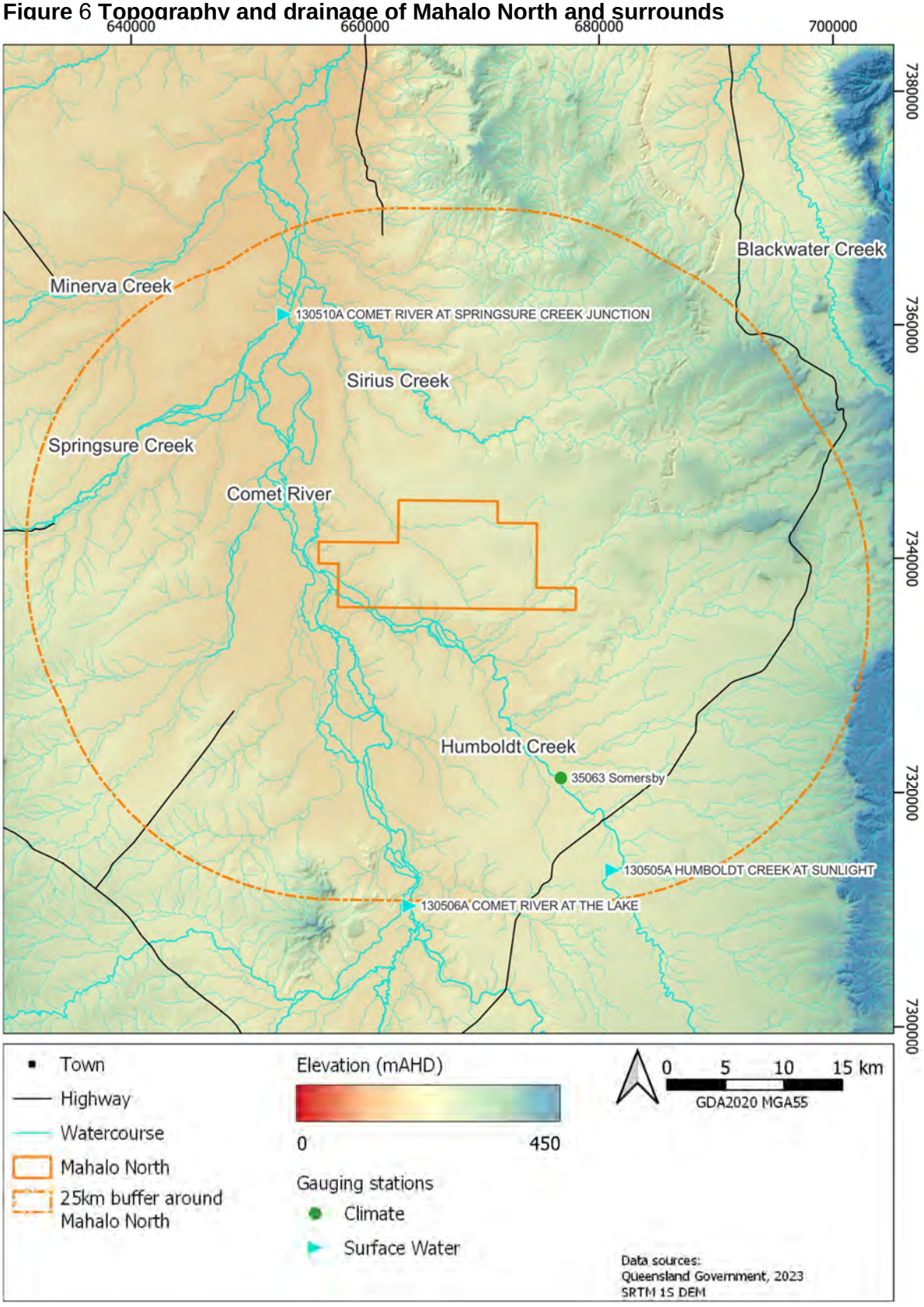


Figure 7 Mean daily discharge at gauging stations

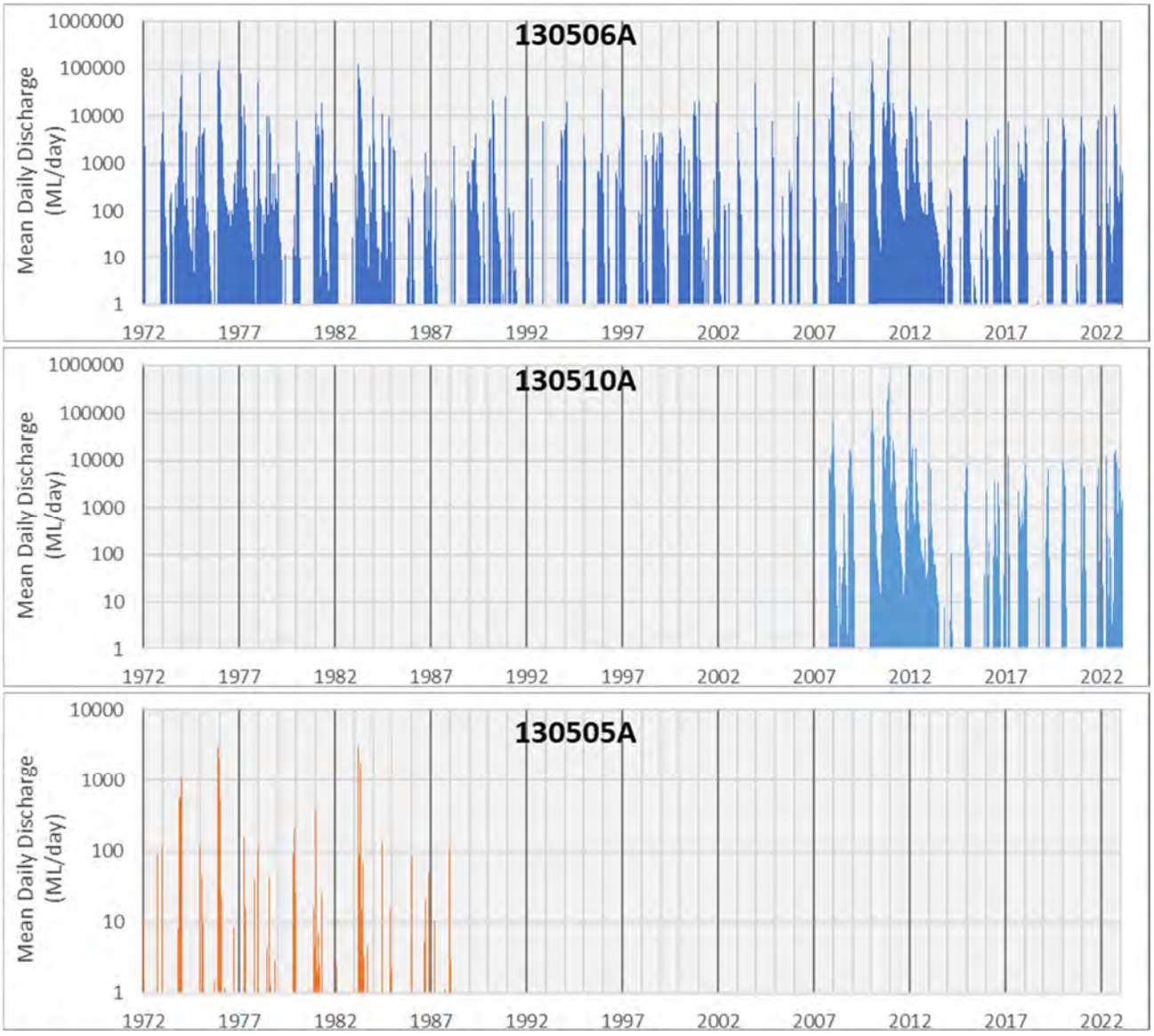


Table 4 Stratigraphy and hydrostratigraphy

Age		Formation		Hydrostratigraphic Description (after OGIA, 2021)	Location in Project Area
Quaternary		Alluvium		Partial aquifer	Associated with the Comet River and Humboldt Creek. Distribution within the project area limited to the southeastern and southwestern corners
		Colluvium		Aquitard*	Extensively present to the west of the Comet River, associated with the lower slopes of Tertiary Basalt outcrop.
Tertiary		Tertiary Sediments		Aquitard*	Surficial deposits across the majority of the project area and to the north and east.
		Tertiary Basalt		Partial aquifer*	Small areas of outcrop throughout the project area, predominantly in the west.
Triassic	Middle	Moolayember Formation		Tight aquitard	Does not outcrop or subcrop within 25 km of the project area
		Showground Sandstone	Clematis Group	Regional aquifer	Outcrops as the Expedition Ranges to the east of the project area, with a small inlier of outcrop to the south of the project area adjacent to the Inderi Fault.
	Early	Rewan Group		Tight aquitard	Outcrops to the northeast of the project area and subcrops beneath the Tertiary strata within the proposed PL, forming the primary aquitard.
Permian	Late	Bandanna Formation/Rangal Coal Measures		Interbedded aquitard	Target formation. Subcrops beneath the Tertiary Strata within the project area and outcrops to the northeast within the Blackwater mine tenements.
		Back Creek Group	Black Alley Shale	Tight Aquitard*	Outcrop and subcrop within the Comet Anticline to the north of the project area. Also subcrops with a small amount of outcrop to the southwest of the project area
			Peawaddy Formation		
			Burngrove Formation		
			Fair Hill Formation		
			MacMillan Formation		
			Crocker Formation		
			Maria Formation		
			Catherine Sandstone Ingelara Formation Freitag Formation		
			Upper Aldebaran Sandstone		
	Early		Lower Aldebaran Sandstone	Interbedded aquitard*	Does not outcrop or subcrop within the project area
			Cattle Creek Formation	Tight Aquitard*	
			Reids Dome Beds	Tight Aquitard*	

* No hydrostratigraphic designation by OGIA (2021)

3.6. Environmental Values and Water Quality Objectives

The purpose of the *EPP (Water and Wetland Biodiversity)* is to determine the EVs and associated WQOs for Queensland waters and to provide a framework for making consistent, equitable and informed decisions regarding the quality of the State's water. The EPP (Water and Wetland Biodiversity) identifies that environmental values can be determined through an assessment of the value, condition, suitability and uses of the relevant waters.

The project is located within the Comet River Sub-Basin of the Fitzroy Basin. The *Environmental Protection (Water) Policy 2009* provides defined EVs and WQOs for the Comet River Sub-Basin under Schedule 1 of the *EPP (Water and Wetland Biodiversity)* and are detailed in DEHP[2] (2011). EVs for the Comet River Sub-Basin are presented in Table 5 and includes both the values for surface water and groundwater.

The management intent for the Comet River Sub-Basin in the vicinity of the project area is that of a moderately disturbed ecosystem.

Table 5 Environmental Values for the Comet River Sub-Basin waters within the vicinity of the project

Water	Environmental Values											
	Aquatic Ecosystem	Irrigation	Farm Supply / Use	Stock Water	Aquaculture	Human consumer	Primary recreation	Secondary recreation	Visual recreation	Drinking water	Industrial use	Cultural and spiritual
Comet River Sub-Basin (WQ1307)												
Comet western tributaries – developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Comet eastern tributaries – developed areas	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Comet main channel – developed areas (including Comet weir waters)	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Fresh waters in undeveloped areas	✓		✓	✓		✓	✓	✓	✓	✓		✓
Groundwater	✓	✓	✓	✓			✓			✓	✓	✓

✓ denotes the EV is selected for protection. Blank indicates that the EV is not identified for protection.

[2] Note that the Queensland Department of Environment and Heritage Protection (DEHP) is now the Department of Environment and Science (DES)

4. CSG Water Management Strategy

The project has identified a water management strategy to meet the following objectives:

- Use of the produced water that maximises beneficial use consistent with all government policy and regulations;
- Meet the water needs of the project, in terms of high reliability of water usage and supply of water for project activities;
- Provide inherent design flexibility in terms of rate and quality, to ensure that gas development is not constrained by water management; and
- Where feasible, provide a water resource to the land holders

The selected water management strategy for the project is:

- Use of produced water for project construction, drilling and dust suppression activities under the EoWCAW. Water quality requirements for water used for these purposes will comply with the requirements identified in Table 3;
- Use of produced water for rehabilitation activities (landscaping and revegetation) if it meets water quality objectives under the EoWCAW (in accordance with Table 3); and
- Desalination, brine storage and treated water supply to landholders under the EoWIAW code. This was selected for the following reasons:
    - **Environment** – Provision of water to landholders is consistent with the identified environmental values for the project area. The treated water can be registered as a resource under an EoW, which provides standard conditions that can be readily met by the project with limited risk associated with regulatory approvals. Brine extracted/separated as part of the water treatment process will be stored and managed in suitably engineered structures. Future approvals will be required for the future disposal of salt from the brine.
    - **Community -** The provision treated water to landholders is a positive community outcome and assists with maintaining the project's social license to operate in the region.
    - **Flexibility** – desalination (RO) plants and storage capacities can be designed to be scalable to the project's needs.
    - **Cost** - cost competitive with other options, other than direct usage of untreated water, which is preferred when available.
    - **Risk -** Water management is a key risk for CSG development and this option of desalination, brine storage and landholder use offers a pathway with low approval risk, low technology risk, known schedule and cost metrics.

5. CSG Water Management Infrastructure

The project's water management infrastructure will comprise the following main components (Figure 8):

- CSG production wells;
- The water gathering network;
- Water transfer pipelines (where necessary);
- Produced water storage tanks(s);
- Water treatment plant;
- Treated water storage tank(s);
- Beneficial use offtakes; and
- Brine tanks.

The aggregation tanks, water treatment plant and storage tanks will be located at the processing facilities on the Meroo property and is shown on Figure **9**. The water management infrastructure is described further below. There are no environmentally sensitive areas mapped within 1,700 m of the processing facilities.

The CSG extraction process requires CSG water production. During the CSG extraction process, to depressurise target coal seams and allow gas to flow, ground water is abstracted (pumped) from the CSG production wells. Flow from the well is made up of water and gas, the production flow is then separated into individual parts by either:

- Annular separation: where water is pumped up the tubing and produced gas flows to the surface in the annulus of the well; or
- If annular separation is not effective, a surface separator can be installed that will separate the gas from the produced water.

Each well will have a wellhead gas and water metering package to achieve real-time continuous gas and water metering.

Gas and water will be delivered to the processing facilities via underground High-Density Polyethylene (HDPE) pipelines which operate under low-pressure. Gathering systems will be designed and installed in accordance with the *Code of Practice Upstream Polyethylene Gathering Networks – CSG Industry Version 5.0* (APAGA, 2019).

All produced water will be collected from the water gathering systems into a Produced Water Storage Tank (PWST) with a storage capacity sufficient to provide an adequate operating buffer for the desalination plant. CSG water storage structures classified as 'low hazard', such as tanks, will be designed in accordance with accepted engineering standards and will be constructed to an Australian Standard that ensures its integrity. For example. materials used in the construction of the structures will be suitable to contain the water for the Project duration. All tanks will be constructed on hardstand and will be double lined with a leak detection system.

From the PWST, CSG water will be either used directly for project activities or treated in the water treatment plant (WTP). The currently planned treatment process includes pre-filtration, membrane filtration, reverse osmosis and associated chemical storage and dosing systems. The WTP will have a capacity of approximately 1 ML/day of raw water feed. Treated water that does not meet engineer-defined treatment targets and/or WQOs will be returned to the PWST for re-processing.

The permeate (low salinity product) from the WTP will be transferred to the treated water tank(s), from which it will be directly utilised or transferred for beneficial use via dedicated offtakes.

The brine resulting from the water treatment process will be housed in two double-lined tanks with an approximate capacity of 55 ML each. Whilst the project has made allowance to install two tanks, the second tank should not be required unless there is significant period of above average rainfall, and would not be needed for several years following the commencement of production. The timing for the installation of the additional tank will be determined with the water balance model once actual brine production rates are confirmed (refer to Section 5.3). Solar and mechanical means may be utilised to enhance evaporation of the brine to concentrate it into a slurry or solid salt and reduce the interim storage volumes. Refer to Section 6.1 for further detail regarding the long-term brine management strategy.

Figure 8 Conceptual diagram of CSG water managament infrastructure

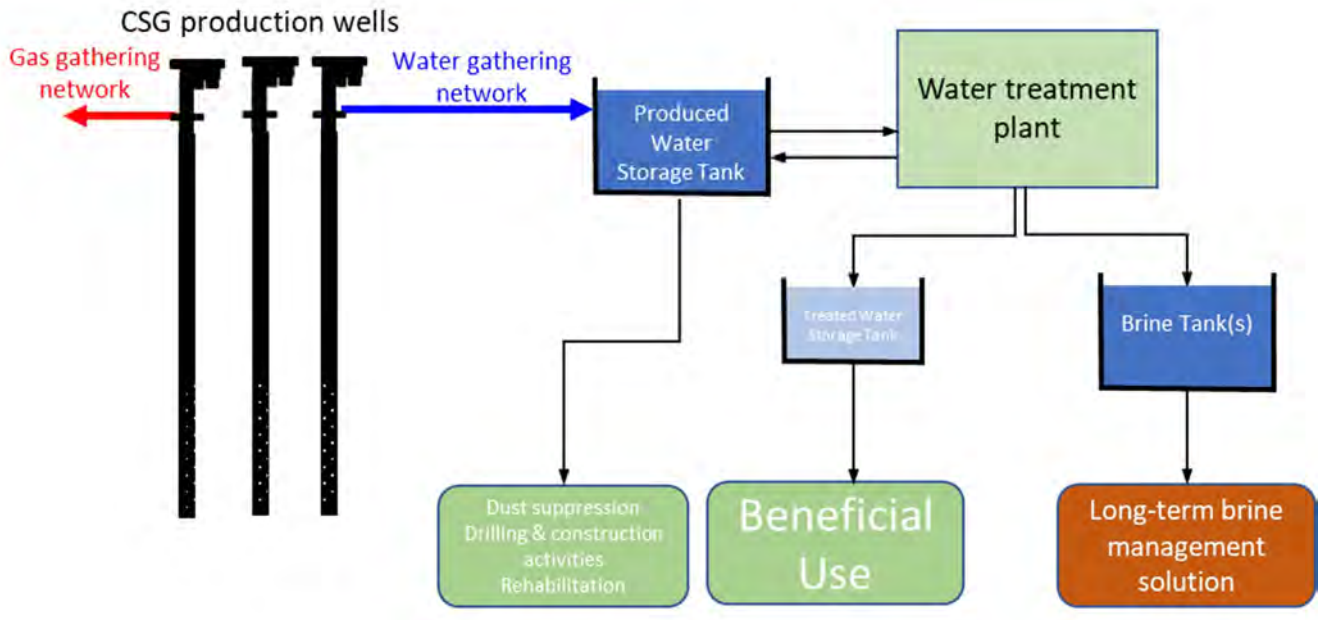
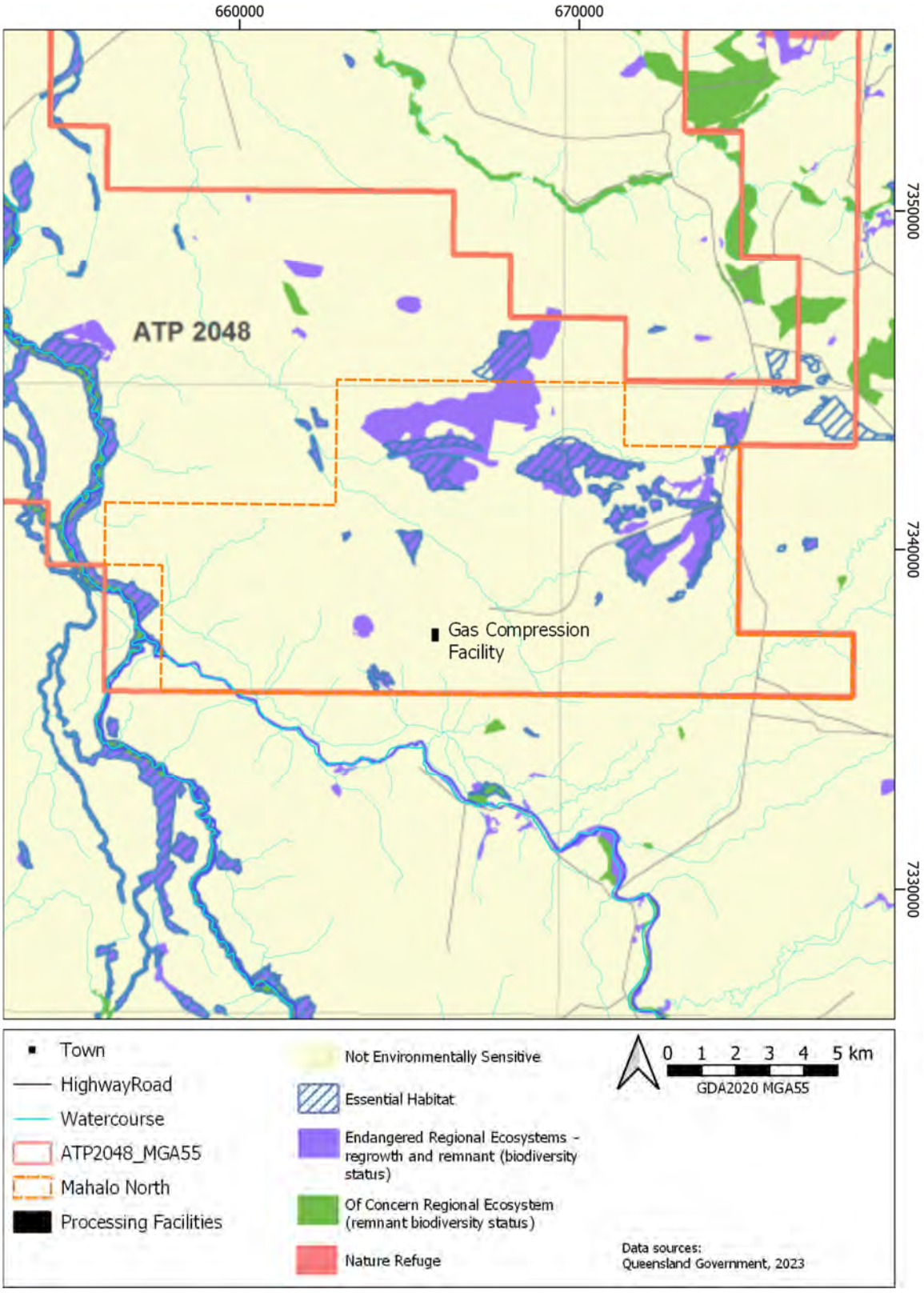


Figure 9 Location of major infrastructure and environmentally sensitive areas (after DES, 2023)



5.1. Beneficial Use Options

The water management strategy for the project has been developed to maximise the beneficial use of water. This includes utilising produced water for the following activities:

- Project activities, such as drilling and completion, dust suppression, rehabilitation etc; and
- Provision of treated water to landholders for agricultural use or for industrial use at surrounding mines.

5.1.1. Project Activities

When circumstances allow, untreated produced water will be used by the project on site for ongoing development and construction activities. For example, dust suppression, drilling, well completions and workovers, facilities construction, hydro-testing gathering networks and landscaping/rehabilitation works. Estimated volumes of water to be used for project activities are:

- 0.1 ML/day for the first ten years which is the period when wells and other Project infrastructure will be constructed;
- 0.05 ML/day, when there is sufficient volume available, from year eleven.

Potential adverse impacts from the management of produced water are addressed through compliance with state regulation, and any untreated produced water will be utilised for Project activities in accordance with the EoWCAW.

Adherence with the requirements of the EoWCAW will be met through the implementation of the Project's Environmental Management Plan (to be developed).

5.1.2. Provision of water to third parties

Treated water will be provided to third parties for agricultural (e.g. stock watering), irrigation or industrial use.

For non-irrigation use, the water will be supplied in accordance with the requirements of the relevant EoW and the water quality will comply with the WQOs identified in Table 3.

Irrigation will be managed in accordance with the EoWIAW. The irrigation water quality will target the standard water quality parameters (as per Section 7 (6.1) of DES, 2019b):

- Electrical conductivity of <950 µS/cm as a rolling 95th percentile over a 12-month period;
- Sodium adsorption ratio of:
    - 6 or less for heavy soils as a rolling 95th percentile over a 12-month period
    - 12 or less for light soils as a rolling 95th percentile over a 12-month period
- pH within the 6.8-8.5 range as a rolling 95th percentile over a 12-month period; and
- Heavy metals and metalloids that do not exceed the short-term trigger values as shown in Table 6.

The RO treated water (Table 1) complies with the short-term trigger values as shown in Table 6. The boron concentration in the treated water is suitable for sensitive crops.

If the standard parameters cannot be met, a RMMP will be prepared by an appropriately qualified person (as per Appendix B of DES, 2019b) and will be independently certified. The RMMP will be provided to DES prior to the commencement of irrigation, and the RMMP will be implemented to manage the irrigation scheme.

Table 6 Short-term (<20 years use) trigger values for irrigation water (DES, 2019b)

Element	Trigger value (mg/L)
Aluminium	20
Arsenic	2.0
Boron	As per Table 9.2.18 of ANZECC (2000)
Cadmium	0.05
Chromium	1
Cobalt	0.1
Copper	5
Fluoride	2
Iron	10
Lithium	2.5
Lead	5
Manganese	10
Mercury	0.002
Molybdenum	0.05
Nickel	2
Zinc	5

5.2. Brine and Salt Management

RO will may used to treat CSG produced water, resulting in treated water (permeate) and RO reject (brine). If this occurs, the brine will be managed in accordance with the CSG Water Management Policy (DEHP, 2012).

The brine will be transferred from the water treatment plant to the brine storage tanks. The tanks will be located in accordance with the Queensland requirements for buffers around watercourses, matters of national environmental significance (MNES), matters of state environmental significance (MSES) and environmentally sensitive areas (ESAs – refer to Figure **9**).

The stored brine will undergo solar and potentially mechanical evaporation, which will result in a highly concentrated slurry or solid salt, that will ultimately be transferred to a Regulated Waste Facility for disposal. As the Project progresses an ongoing assessment of the brine management will be undertaken to assess the best outcome for the final disposal of the brine/salt

Opportunities for beneficial use and/or disposal of salt in accordance with the CSG Water Management Policy (DEHP, 2012) will be considered throughout the lifetime of the Project. It is estimated that approximately 3,000 tons of salt will be produced over the lifetime of the project (based on a produced water salinity of 5,020 mg/L TDS - Table 1).

The project will undertake the rehabilitation of any tanks or infrastructure to ensure that there are no legacy issues following the end of the project. Rehabilitation will be undertaken in accordance with EA conditions.

5.3. Water Balance

A custom water balance model has been developed to support the long-term water management strategy for the project. The objectives of the water balance model were to:

- Assist with the sizing of water management infrastructure;
- Assist with determining the timing for the installation of additional infrastructure;
- Assess the implications of changing activities and processes on the management of CSG water; and
- Assess the implications of meteorological variability and reservoir uncertainties with respect to project water management.

The current version of the predictive model uses estimated inflows and outflows, including:

- Water production forecast (Figure 2);
- Rainfall and evaporation – which is based on BoM historical rainfall data, pan evaporation data, tank surface area, and a factor to reduce the evaporation as brine concentrates in the tank(s) based on Raoult's Law;
- Construction use and dust suppression – which is based on predicted offtake volumes described in Section 5.1.1; and

- Beneficial use – for which it is assumed all treated water will be used as it is produced.

The water balance model operates on a daily time-step to consider the changing volume in the tanks over time. The resilience of the water management system is assessed by using P50 (most likely) and P90 (conservative) rainfall scenarios. Some output from the model is presented in Figure 10 and Figure 11.

Figure 10 illustrates that under P90 rainfall conditions, the 7.6 ML produced water storage tank can be readily managed using the 1 ML/day RO plant to 50% capacity or less. Figure 11 shows that under P90 rainfall conditions a second 55 ML brine tank will only be required in 2033, and will be significantly oversized for the forecast brine volumes. Under a P50 rainfall scenario, only one brine tank will be required and at 55 ML will be significantly oversized.

Figure 10 Produced water tank volume – P90 rainfall scenario

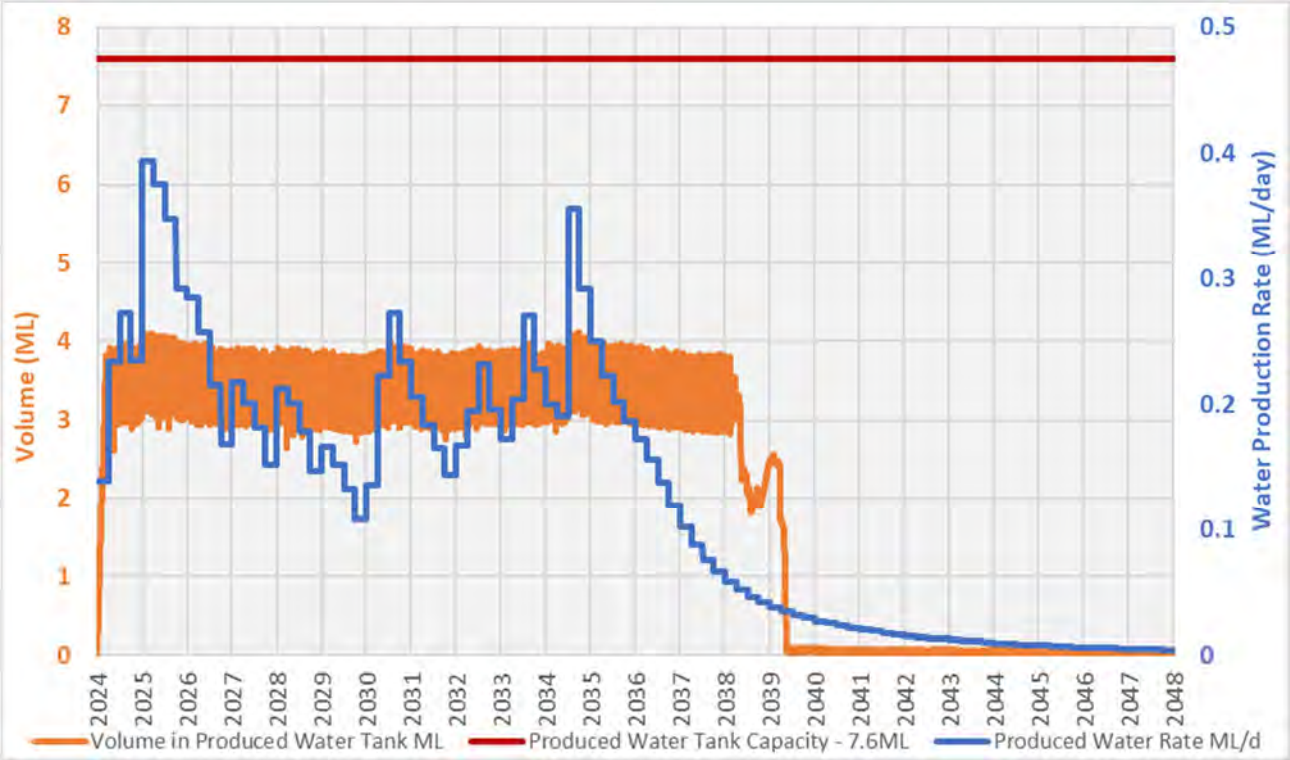
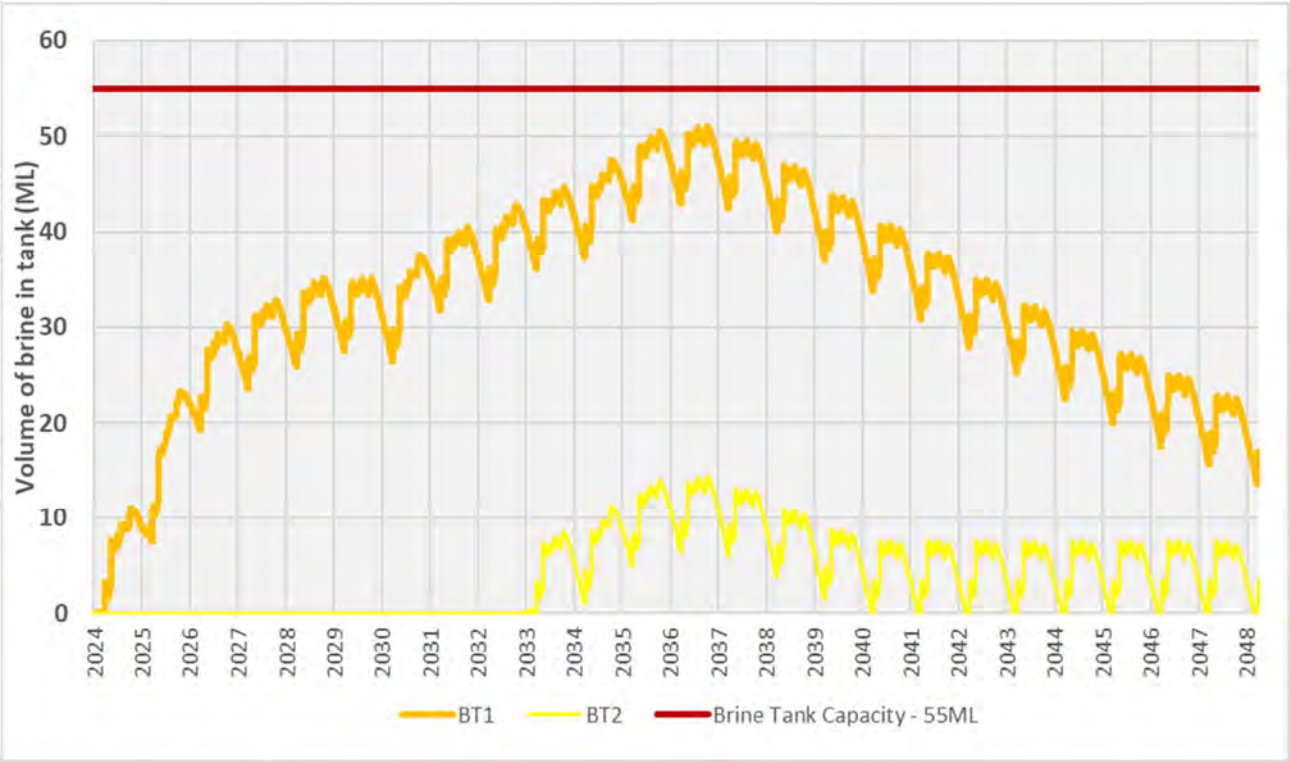


Figure 11 Brine tank volumes – P90 rainfall scenario



6. Management, Compliance and Monitoring

6.1. Management and Compliance

All produced water and brine management strategies will be implemented in accordance with the applicable EA conditions and in a manner that ensures protection and maintenance of all relevant EVs.

A site-specific application for CSG activity is required by the EP Act and must include measurable criteria (termed 'management criteria') which can be used to assess the effectiveness of the management of produced water and saline waste associated with the activity. The measurable criteria for the project are provided in Table 7.

The project's performance against the measurable criteria will be assessed and non-compliances reported with every Annual Return. If any of the measurable criteria are not met, the following actions will be implemented:

- Notification to DES of the incident (where necessary);
- Root cause analysis of the measurable criterion not being met, and implementation of corrective actions to address the root cause;
- Review and modification where necessary of management plans and procedures; and
- Reporting of the non-compliance in the Annual Return.

Table 7 Water management measurable criteria for the project

Objectives	Environmental Values Protected	Task	Performance indicator
There will be no unauthorised release of water to the environment from the gathering network	Land Groundwater quality Surface water quality	Safety in design processes adhered to. Non-regulated structures designed in accordance with relevant Australian Standards. Routine monitoring in accordance with the project Environmental Management Plan (to be developed). Regular maintenance in accordance with Asset Integrity Management Plan (to be developed). Compliance with EA conditions.	No reportable unplanned releases of CSG water. Annual reporting.
There will be no unauthorised releases to the environment from storage infrastructure.	Land Groundwater quality Surface water quality	Water storage infrastructure designed in accordance with regulatory requirements. All regulated structures are to be designed, constructed, and operated in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016a). Non-regulated structures designed in accordance with relevant Australian Standards. Routine monitoring of tank levels relative to designed storage capacity (DSC). Routine monitoring in accordance with the project Environmental Management Plan (to be developed), specifically related to seepage monitoring activities. Scheduled visual inspections of tank integrity and annual integrity assessment. Maintenance of an operational water balance model to ensure sufficient water management infrastructure will be available. Compliance with EA conditions.	No exceedances of the DSC. Routine monitoring completed Annual Inspection Reports completed and remedial actions implemented within agreed timeframe. No reportable unplanned releases of CSG water.
Beneficial use of CSG water is maximised	Land Groundwater quality Surface water quality	Continuous measurement of all aspects of the volumes water production, treatment and usage. Routine monitoring of the untreated and the treated CSG produced water quality. Routine maintenance of facilities and infrastructure in accordance with Asset Integrity Management Plan (to be developed). Maintenance of an operational water balance model to ensure sufficient water management infrastructure will be available. Compliance with EA conditions.	Sufficient capacity in water management infrastructure to managed produced water rates/volumes. Water quality for beneficial uses meets required water quality objectives. Water balance model updated annually.
Management of brine and salt in accordance with regulatory requirements	Land Groundwater quality Surface water quality	Brine and salt storage infrastructure designed in accordance with regulatory requirements. All regulated structures are to be designed, constructed and operated in accordance with the requirements of the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (DES 2016a). Routine monitoring of tank levels relative to DSC. Routine monitoring in accordance with the project Environmental Management Plan (to be developed), specifically related to seepage monitoring activities. Scheduled visual inspections of tank integrity and annual integrity assessment. Develop and maintain an operational water balance model to ensure sufficient water management infrastructure will be available.	No exceedances of the DSC. Routine monitoring completed. Annual Inspection Reports completed. No reportable unplanned releases of brine or salt.

Objectives	Environmental Values Protected	Task	Performance indicator
		Continued assessment of opportunities for beneficial use and/or disposal of salt in accordance with the CSG Water Management Policy (DEHP, 2012). Compliance with EA conditions	

DSC = designed storage capacity

6.2. Monitoring

All water quality monitoring will be undertaken by a suitably qualified person in accordance with the Queensland Government's Monitoring and Sampling Manual 2018 – *Environmental Protection (Water) Policy 2009.*

6.2.1. Produced CSG Water Quality Monitoring

The quality of untreated produced CSG water will be monitored on an annual basis. Laboratory analysis will be performed by a NATA accredited facility for the analyses to be undertaken.

The water quality data will be used to:

- Ensure that the water is suitable for use in accordance with the WQOs of the intended end uses (project activities and provision to third parties); and
- Ensure that water treatment facility is operating in accordance with its design.

6.2.2. Produced CSG Water for Project Activities

Where produced water is used for project activities and is provided to third parties but not for irrigation, monitoring will be undertaken to ensure the suitability of the water quality for the intended use in compliance with the WQOs identified in Table 3. This will include:

- Monthly frequency for metals and metalloids, then six monthly after three consecutive laboratory results which are less than 50% of the water quality parameters listed in Table 3;
- Fortnightly monitoring EC, pH and TDS[3].

Where untreated produced CSG water is used for project activities, including dust suppression, construction activities and rehabilitation works, records will be maintained of inspections for:

- On-site ponding;
- Runoff from the site where the resource is applied;
- Vegetation die-off;
- Visible salting; or
- Serious or material environmental harm.

6.2.3. Treated CSG Water Quality Monitoring for Irrigation

In accordance with EoWIAW, treated CSG water provided for irrigation will be sampled and monitoring on the following frequency:

[3] EC, TDS and pH will be measured in the field using a an appropriately calibrated handheld meter under and will be carried out by an appropriately qualified person in accordance with written procedures.

- Monthly frequency for metals and metalloids, then six monthly after three consecutive laboratory results which are less than 50% of the water quality parameters listed in Table 6;
- Fortnightly monitoring for sodium adsorption ratio (SAR), pH and EC[3].

Laboratory analysis will be performed by a NATA accredited facility for the analyses required. Samples will be collected in accordance with the Queensland Government's Monitoring and Sampling Manual 2009 – Environmental Protection (Water) Policy 2009.

6.2.4. CSG Water Storage Tank Monitoring

Inspections and monitoring of the water storage tanks will be undertaken by the Project to assess integrity of the structures and monitor any potential impacts to EVs. The following monitoring will be scheduled:

- Weekly monitoring:
  - Tank water levels;
  - Visual inspections of tank integrity;
  - Visual inspections for signs of leakage from foot of tank;
  - Visual inspection for algal growth, hydrocarbon contamination or animals; and
  - Comparison of current water level with DSC[4].
- Annual monitoring:
  - Integrity assessment by a suitably qualified and experienced person; and
  - An assessment of the future availability of storage capacity through water balance modelling.

6.3. Seepage Monitoring Program

The project will establish a monitoring program surrounding the water storages, to monitor for potential leaks and seepage. The program will be designed and implemented in accordance with the EA conditions.

[4] DSC = designed storage capacity

6.4. Reporting

6.4.1. Annual Return

An annual review of the monitoring will be undertaken with any non-compliances reported as part of the EA Annual Return. This will include an assessment of the effectiveness of the Project's CSG water management against the criteria identified in Table 7.

6.4.2. Annual Monitoring Report

Upon request, an Annual Monitoring Report will be provided to DES that summarises the results of the previous 12-month period of monitoring under this plan.

6.5. Reviews

Any changes to the project that may influence the management of CSG water and or management of treated CSG water and brine will initiate a review of this CSG WMP.

7. References

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