Gove Procedure Manual
HSE Department

Document Type: Procedure

Document Title: Water Management Plan

Document Number: GPM-EHS-100

KEY POINTS

- This procedure highlights water (surface water, groundwater and marine) related issues in Gove Operations; identify risk profile pertaining to each domain and management objectives.
- It specifies legal and other regulatory requirements, guidelines and criteria used for performance assessment.
- It identifies relevant procedures used as supporting document for water management.

This procedure to be read in conjunction with the Gove EBA if applicable.

000	July 2021	Environmental Superintendent	Environment Senior Advisor	HSE Business Partner
Rev No	Date	Document Owner	Reviewer 1	Authorised by

Controlled Document

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Glossary of Terms

Abbreviation	Meaning
AGD84	Australian Geodetic Datum 1984
AHD	Australian Height Datum
AIMS	Australian Institute of Marine Science
AST	Above-ground Storage Tank
BPL	Bayer Process Liquor
CDU	Charles Darwin University
CoPC	Contaminants of Potential Concern
DAF	Dissolved Air Flotation
DAPL	Dense Aqueous Phase Liquid
DEPWS	Department of Environment, Parks and Water Security (previously DENR)
DPH	Dissolved Phase Hydrocarbons
DQIP	Discharge Quality Improvement Plan
DITT	Department of Primary Industry, Tourism and Trade (previously DPIR)
ECP	Eastern Containment Pond
GDA94	Geocentric Datum of Australia, 1994
GDE	Groundwater dependent Ecosystem
GPM	Gove Procedures Manual
GWMP	Groundwater Monitoring Plan
ha	Hectares
HDPE	High Density Poly Ethylene
HME	Heavy Mining Equipment
HSE	Health Safety and Environment
HSEQ	Health Safety Environment Quality
HFO	Heavy Fuel Oil
LV	Light Vehicle
LFTF	Light Fuel Tank Farm
MBHD	Melville Bay Height Datum
mb TOC	Metres Below Top of Casing
mdt	Million dry tonnes

Abbreviation	Meaning
mg/L	Milligrams per Litre
MHMP	Marine Health Monitoring Plan
MMP	Mining Management Plan
NATA	National Association of Testing Authorities
NT EPA	Northern Territory Environment Protection Authority
NEPM	National Environmental Protection Measure
NPI	National Pollutant Inventory
NT	Northern Territory
OoM	Order of Magnitude
PAH	Polycyclic Aromatic Hydrocarbons
PFAS	Per- and Polyfluoroalkyl Substances
RDA	Residue Disposal Area
RTBS	Rio Tinto Business Solutions
SCP	Southern Containment Pond
SPS	Steam Power Station
SWL	Standing Water Level
SWMP	Surface Water Monitoring Plan
SNL	Supernatant Liquor
SSTL	Site Specific Trigger Levels
TPH	Total Petroleum Hydrocarbons
ULP	Unleaded Petrol
WCP	Western Containment Pond
WDL	Waste Discharge Licence
WSA	Wet Season Storage Allowance
WWNP	Wastewater Neutralisation Plant

1 INTRODUCTION AND BACKGROUND

Gove Operations is operated by RTA Gove Pty Limited; the operations include an active bauxite mine, and an alumina refinery and a residue disposal area (RDA) in closure. The operations are located on the Gove Peninsula in North-East Arnhem Land of the Northern Territory (NT), Australia. Since 1972 the site has mined bauxite to supply the alumina refinery and export markets. The operation includes four functional areas, mine production, refinery, RDA, and marine, based on the land use, operational status, and geographic location. These four functional areas and lease details are provided on **Figure 1**.

The bauxite mine is located approximately 20km to the east of Gove Harbour. The ore is transported via a conveyor to stockpiles at the refinery and port at Gove Harbour. These operations are undertaken 24 hours a day, seven days a week, at a rate of approximately 13 million dry tonnes (mdt) of bauxite per year.

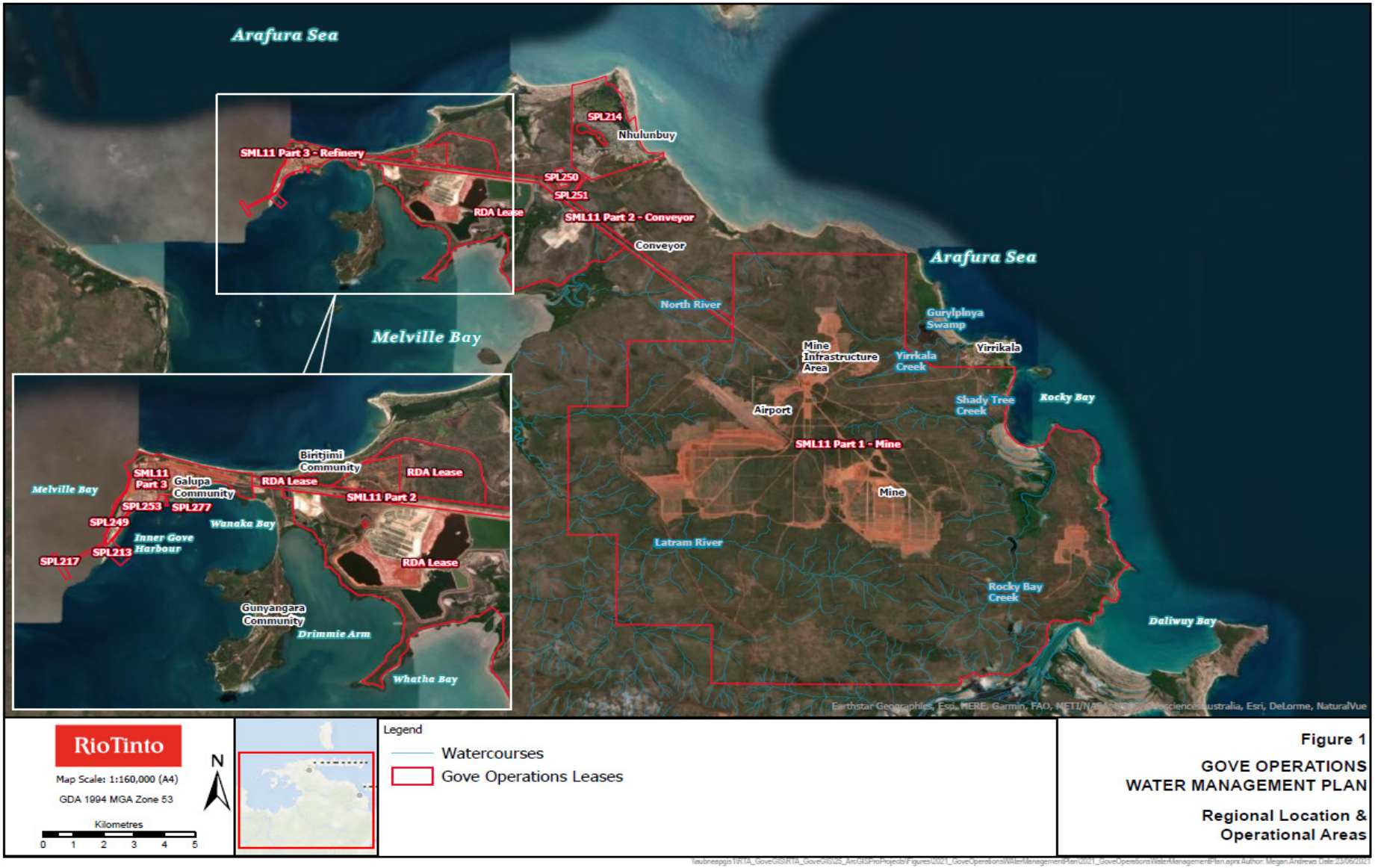
In November 2017, RTA Gove announced that it would not restart the alumina refinery which had been under care and maintenance since 2014. As a result, the refinery and RDA are advancing through the closure planning process, via the advancement of multiple closure studies.

Further details regarding the history of the operations and the scope, progress, and objectives of closure, are detailed within the Mining Management Plan (MMP).

1.1 Water Management Plan Objectives

This Water Management Plan (the Plan) defines the drivers, targets, and controls at Gove Operations to assist in compliance with legislation, guidance, and internal Rio Tinto standards relating to water management. The key objectives of the Plan are as follows:

- Achieving compliance with legislative requirements and the Rio Tinto Environmental Performance Standard E11 for water quality protection and water management.
- Developing and maintaining an understanding of the potential short-term and long-term impacts on the receiving environments.
- Providing operational procedures and guidance on responsible water management and remediation actions.
- Preventing or otherwise minimising adverse impacts on water quality and quantity.
- Implementing appropriate measures to protect the receiving environment and address stakeholder concerns.
- Summarising adaptive management concepts relating to water use and water quality protection.


Arafura Sea
SML11 Part 3 - Refinery
SPL214
Nhulunbuy
SPL250
SPL251
RDA Lease
SML11 Part 2 - Conveyor
Conveyor
Arafura Sea
Melville Bay
North River
Gurylpinya Swamp
Mine Infrastructure Area
Yirrikala Creek
Yirrikala
Shady Tree Creek
Rocky Bay
Airport
SML11 Part 1 - Mine
Mine
Latram River
Rocky Bay Creek
Daliwuy Bay
Biritjimi Community
RDA Lease
SML11 Part 3
Galupa Community
RDA Lease
SML11 Part 2
Melville Bay
SPL253
SPL277
SPL249
Wanaka Bay
Inner Gove Harbour
SPL213
SPL217
RDA Lease
Gunyangara Community
Drimmie Arm
Whatha Bay
Earthstar Geographics, Esri, HERE, Garmin, FAO, METI/NASA, ... Geosciences Australia, Esri, DeLorme, NaturalVue
RioTinto
Map Scale: 1:160,000 (A4)
GDA 1994 MGA Zone 53
Kilometres
0 1 2 3 4 5
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Legend
Watercourses
Gove Operations Leases
Figure 1
GOVE OPERATIONS
WATER MANAGEMENT PLAN
Regional Location &
Operational Areas

1.2 Water Management Plan Integration

Figure 2 sets out the relationships between the Plan and key compliance documents, Rio Tinto standards, and the subordinate operational monitoring plans. The operational monitoring plans detail monitoring programs designed to improve environmental performance, including the current (WDL) trigger values and limits. Annual updates and progress against the monitoring plans are provided to both the Department of Industry, Tourism and Trade (DITT) and the Department of Environment, Parks and Water Security (DEPWS).

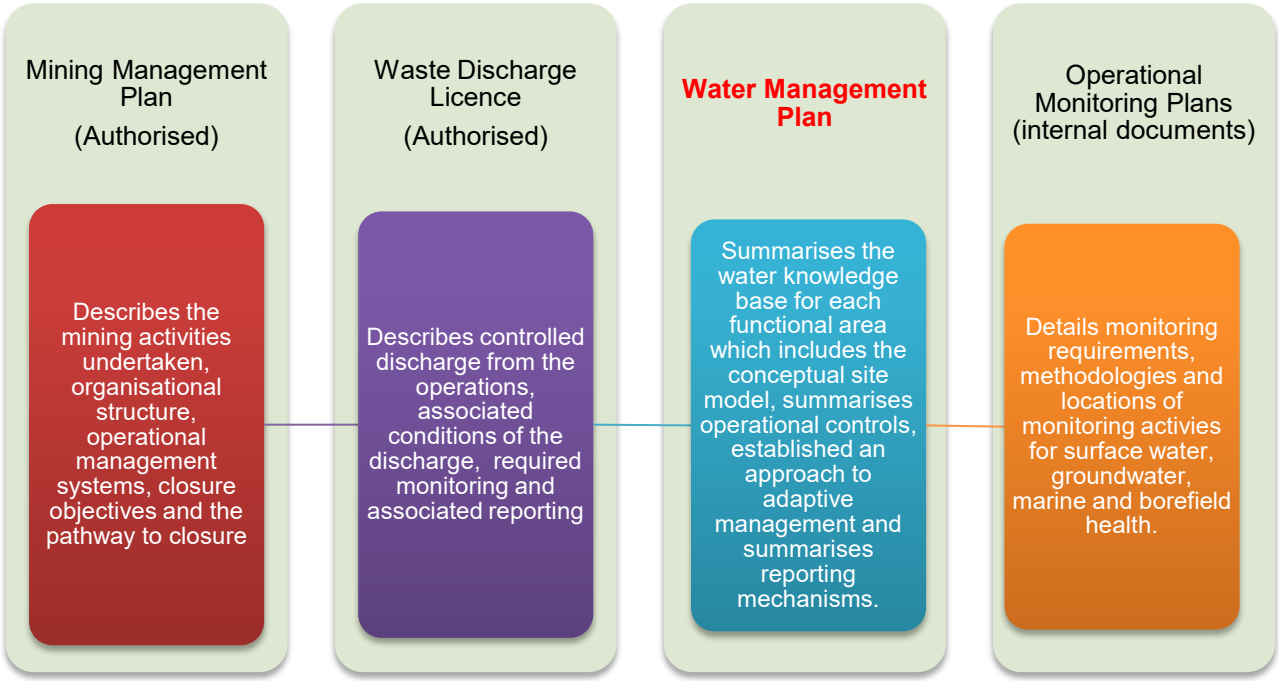


Figure 2: Water Management Plan Integration

1.3 Structure of the Plan

Key structural components of the plan are described below:

- **Section 2** – **Site setting**: describes environmental and regulatory settings in which the site operates. This includes climate, legislation, licences, permits, notices, and relevant guidance documents.
- **Section 3** – **Water strategy and targets**: summarises the water management strategy, water management objectives, and other information relating to statutory requirements.
- **Section 4** – **Water knowledge base**: summarises the physical setting, surface water, groundwater, and marine conditions, including water management infrastructure for each functional area. In addition, the sections include a conceptual site model (CSM) which details sources of contamination, migration pathways, and sensitive human health and environmental receptors.
- **Section 5** – **Operational controls**: summarises management systems implemented, provides a responsible, accountable, informed and consulted (RACI) matrix, summarises regulated structures, water balance modelling, refinery surface water structures and seepage interception systems at the RDA.

- **Section 6** – **Adaptive management**: outlines the systematic process for incrementally improving management practices by learning from the outcomes of past and current practices. In this section, an adaptive management plan for water management is detailed.
- **Section 7** – **Reporting**: details incident and annual reporting requirements for both internal and external stakeholders, specifically relating to water.

2 SITE SETTING

2.1 Climate

The Gove Peninsula has a monsoonal climate, influenced by coastal factors, and is characterised by hot, wet, humid summers and mild, drier winters. The Gove region experiences most of the annual rainfall over a distinct wet season from December to April, characterised by an active northwest monsoon. Thunderstorms are common, and heavy rainfall events can occur, often associated with tropical cyclones. Every two years a tropical cyclone and gale force winds are expected to pass near Gove. As well as generating high wind forces, cyclones can also cause storm surges in addition to considerable wave action. The generalised climate at the Gove operations includes:

- An average annual rainfall of approximately 1,430mm/year.
- An average annual evaporation of approximately 2,150mm/year.
- Strongly seasonal rainfall, with approximately 90 percent of rainfall occurring during the five-month period of December to April.
- Relatively low evaporation during the wet season months of January to April, due to the relatively high humidity over this period.
- Average minimum temperatures range between 20 and 26 degrees Celsius, with the lowest temperatures recorded during the period July to September.
- Average maximum temperatures range between 28 and 33 degrees Celsius, with the highest temperatures recorded during the period November to January.

Long-term daily climatic data for the Gove Operations is available from weather station number 014508, Bureau of Meteorology (BoM). Long-term average climatic data to 2021 are summarised in **Table 1**.

Table 1. Long-Term Climatic Characteristics (BoM station No. 014508)

Item	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
	Wet Season				Dry Season							Wet	
Rainfall (mm/month)													
Mean	277	271	277	220	86	31	18	5	6	10	42	42	1,432
Median	279	221	273	138	55	22	12	3	0	1	3	3	1,353
Maximum	740	571	515	1080	373	113	68	28	86	191	284	544	2,572
Evaporation (mm/month)													
Mean	180	147	155	162	167	156	161	190	201	223	219	208	2,156

Rainfall gauges are installed across the site to provide an improved understanding of rainfall distribution.

2.2 Declared Beneficial Uses

Gove Operations is surrounded by the Dhimurru Indigenous Protected Area (IPA) that encompasses 92,000 hectares (ha) of land and 459,000ha of sea country. A permit may be required from Dhimurru Aboriginal Corporation depending on the activity (that is, within recreational or marine areas), or as a courtesy Gove Operations may notify the organisation of high-profile activities.

Gove Operations must be considerate of the following beneficial use declarations:

- Declaration of Beneficial Uses, Gove Area Marine Water, Gazette numbers G9, 11 March 1998 and G20, 27 May 1998.
- Site of Conservation Significance, SOCS Number 24 Gove Peninsula and North-East Arnhem Coast.

Beneficial Use Declarations are a legislative process, under the *Water Act 1992*, to control the effects of water contamination and assist in the protection and management of water. This process enables communities to decide how a particular water body should be used by choosing one or more Beneficial Use categories. The current declared Beneficial Use for the Gove Area Marine Waters include aquatic ecosystem protection, recreational water quality, and aesthetics.

2.3 Regulatory Environment

2.3.1 Applicable Legislation

Applicable Northern Territory (NT) legislation to water management for Gove Operations is summarised in **Table 2**.

Table 2. Relevant Authorities, Licences, Permits and Notices

Legislation (NT)	Authority	Relevance to Gove operations
Mining Management Act (amended 2015)	Department of Industry, Tourism and Trade	This is principal environmental regulation for all mining activities in the NT. Authorises the management of water within approved mining leases.
Water Act 1992	Department of Environment, Parks and Water Security	Applies to all areas of Gove Operations and the any off-lease impacts, noting that the legislation provided some exemptions for holders of an Authorisation issued under the MM Act. Provides for the investigation, allocation, use, control, protection, management, and administration of water resources, including extraction of groundwater, and wastewater management.
Water Legislation Amendment Act 2018	Department of Environment, Parks and Water Security	This removed exemptions previously given to mining and petroleum activities by the NT *Water Act*. The intention of this amendment, commencing from 1 January 2019, was to bring the mining industry in line with other users. This was completed by repealing relevant parts of the Act so that provisions of the *Water Act* concerning interference with waterways, taking water from waterways, undertaking bore field maintenance, collecting groundwater from bores, and appropriate aquifer recharge now apply to mining activities.
Waste Management and Pollution Control Act 2016	NT Environment Protection Authority	Provides for the protection of the environment through encouragement of effective waste management and pollution prevention and control practices and for related purposes.
Fisheries Act 1988	Department of Industry, Tourism and Trade	Authorises the collecting of oysters for sampling as part of the marine monitoring program.

2.4 Licences, Permits and Notices

Relevant authorities, licences, permits, and notices pertaining to water management at Gove Operations are listed in **Table 3**.

Table 3. Relevant Authorities, Licences, Permits and Notices

Document	Authority	Relevance to Gove Operations
Mining Management Plan	Department of Industry, Tourism and Trade, *MM Act*	The MMP identifies the environmental risks from these activities and indicates the strategies for avoidance, mitigation, and rehabilitation, so that impacts on the environment are within acceptable and sustainable limits. The MMP also describes the Environmental Protection Management Strategy (EPMS) for water quality protection.
Northern Territory of Australia, 2019. Waste Discharge Licence.	Department of Environment, Parks and Water Security, *Section 74 of the Water Act*	For compliance with Section 16 Prohibition of pollution of the Water Act, Gove Operations should apply and be granted an authorisation to allow waste to be discharged into water resources.
Water Extraction Permit	Controller of Water Resources, *Water Act 1992*	Permits the licence holder to take water from a watercourse, well, and or, underground source.
Bore works permit	Section 57, *Water Act 1992*	An application for a bore work permit (to drill, construct, alter or decommission), is required for all bore holes drilled to depth exceeding 3m.
Special permit	Section 17, Fisheries Act	Permit to collect oysters.
Access or Works Permit	NLC *Aboriginal Land Act 1978*	Any access to complete works including field sampling off lease requires a permit from the Northern Land Council (NLC). To enter and remain on Aboriginal Land or Sea adjoining Aboriginal Land for work related purposes. This includes both land and offshore activities associated with oyster collection and monitoring, and marine health monitoring.
Aboriginal Areas Protection Authority (AAPA)	*NT Aboriginal Sacred Sites Act, 1989*	Sets specific conditions and protection measures for Sacred Sites

2.5 Standards and Guidelines

Relevant standards and guidelines pertaining to water management at Gove Operations are listed in **Table 4.**

Table 4. Relevant Standards and Guidelines

Document	Relevance to Gove Operations WMP
National Environmental Protection (assessment of site contamination) Measure – Schedule B1 Guideline on Investigation Levels for soil and groundwater 2013 (F20013C00288) (NEPM)	The purpose is to establish a nationally consistent approach to the assessment of site contamination to support sound environmental management practices. The desired environmental outcome for this measure is to provide adequate protection of human health and the environment, where site contamination has occurred.
ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines	This guideline is applicable to fresh and marine water; it is used to assess the potential impacts to water flora and fauna, including macro invertebrates.
ANZFA, 2004 – Australia New Zealand Food Authority Standards Code. FSANZ, 2016 – Food Standards Australia and New Zealand.	These guidelines are used to assess the potential toxicological impacts of Gove operations to marine ecosystem.
AS/NZS 5667.1:998 – Water Quality Sampling. Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples	This standard provides general guidance on water sampling and the preservation and handling of collected samples.
AS/NZS 5667.11:1998 – Water Quality Sampling. Part 11: Guidance on Sampling of Groundwater	This standard provides specific guidance on the sampling of groundwater.
Rio Tinto Environment Standard E11 - Water quality protection and water management	Environment standards for management of risk associated with water withdrawal, use, storage, treatment, and discharge.
Rio Tinto Safety Standard D5 – Management of tailings and water storage	Safety standard for management of risks associated with tailings and water storage facilities.
Minimum construction requirement for water bores in Australia	Outlines requirements for the construction and decommissioning of groundwater bores.

3 WATER STRATEGY AND TARGETS

3.1 Rio Tinto Water Strategy

Rio Tinto is committed to managing water resources in a responsible manner by accounting for social, cultural, environmental, and economic values. To achieve this, all managed operations are required to conform with operational standards, which includes a specific environmental standard for water quality protection and water management (E11).

This Plan defines the drivers, broad objectives, and targets to ensure conformance with the E11 standard. Conformance with all standards is assessed by qualified Rio Tinto auditors, on a periodic basis (typically every two years), through the Health, Safety, Environment and Community Audit program and identifies the program, procedures and activities that ensure the management of water at the Gove Operations is aligned with the Rio Tinto strategy and environmental performance standards.

3.2 Gove Operations Water Targets

Gove Operations water targets are driven by their key legislative requirements, and these include:

- Compliance with the Authorisation and MMP granted and approved under the *Mining Management Act 2001* (*MM Act*).
- Compliance with Water Extraction Licence granted by NT Controller of Waters under the *Water Act.*
- Compliance with WDL granted under the *Water Act 1992*.
- Preparation and implementation of Water Management Plan, a requirement of both the *Water Act* and the MM Act, to manage the risks and protect water quality and resources.
- Submission of Annual Environmental Mining Report to report performance against the MMP.
- Submission of Annual Water Monitoring Report to track compliance with MMP.
- Submission of Annual Water Monitoring Report to track compliance with WDL.
- Submission of WDL Annual Audit and Compliance Report.
- Obtain a special permit to take quantities and types of fish and aquatic life from waters within a specified area and subject to special conditions, for the purposes of environmental monitoring (oyster sampling). Permits issued under the *Fisheries Act, 1988*.
- Obtain a bore work permit (to drill, construct, alter or decommission), pursuant to section 57 of the *Water Act*, for bore holes drilled to depth exceeding 3m.

3.3 Mining Management Plan

Under the Mining Management Act, Gove Operations is required to have an approved MMP for the mine-related activities to accompany any application for a new or variation to a *MM Act* Authorisation. As the 2019 MMP was submitted prior to the 30 June 2019, this maintains the *Water Act* exemptions for mining activities. However, should the MMP requires a major change, or a new Authorisation be issued these exemptions under the transitional provisions will be removed.

The MMP authorises the mine-related activities and the strategies to be implemented, to manage impacts to the environment to acceptable and sustainable limits over both the short and long-term. Gove Operations is required to implement these strategies, and this Plan is the key document to ensure compliance with the MMP, in relation to the protection of water quality and water management.

The 2019 MMP introduced Environmental Protection Management Strategies (EPMS) for water quality protection; there are separate strategies for surface water (EPMS01), groundwater (EPMS02), and marine (EPMS03).

When drafting the 2019 MMP, WDL 171 included licencing for stormwater releases from the RDA and Stockpile Creek at the refinery. In the renewal of WDL in 2020, these sites were removed, however, given they formed part of the approved 2019 MMP, these stormwater release points are authorised under the MMP. To ensure that releases of stormwater runoff are within acceptable and sustainable limits, this Plan will embed the compliance and monitoring for the quality of releases and potential impacts on the receiving environment.

The 2019 MMP describes the closure objectives and pathway to the remediation and rehabilitation of all areas disturbed by mining to a safe, stable, non-polluting, and agreed final landform. Closure criteria have been established and agreed to measure attainment of these objectives; these criteria use specific closure indicators. The closure indicators measure the performance of the final landform after the completion of the closure actions. The indicators relevant to water are groundwater, marine water, and oyster quality.

4 WATER KNOWLEDGE BASE

Gove Operations has collected a comprehensive and consistent suite of water monitoring data, under the marine health, groundwater, and surface water monitoring programs and as a component of other specific studies designed to improve environmental performance or fill defined knowledge gaps. The data associated with these monitoring programs and additional studies are provided to interested governmental departments.

4.1 Mine

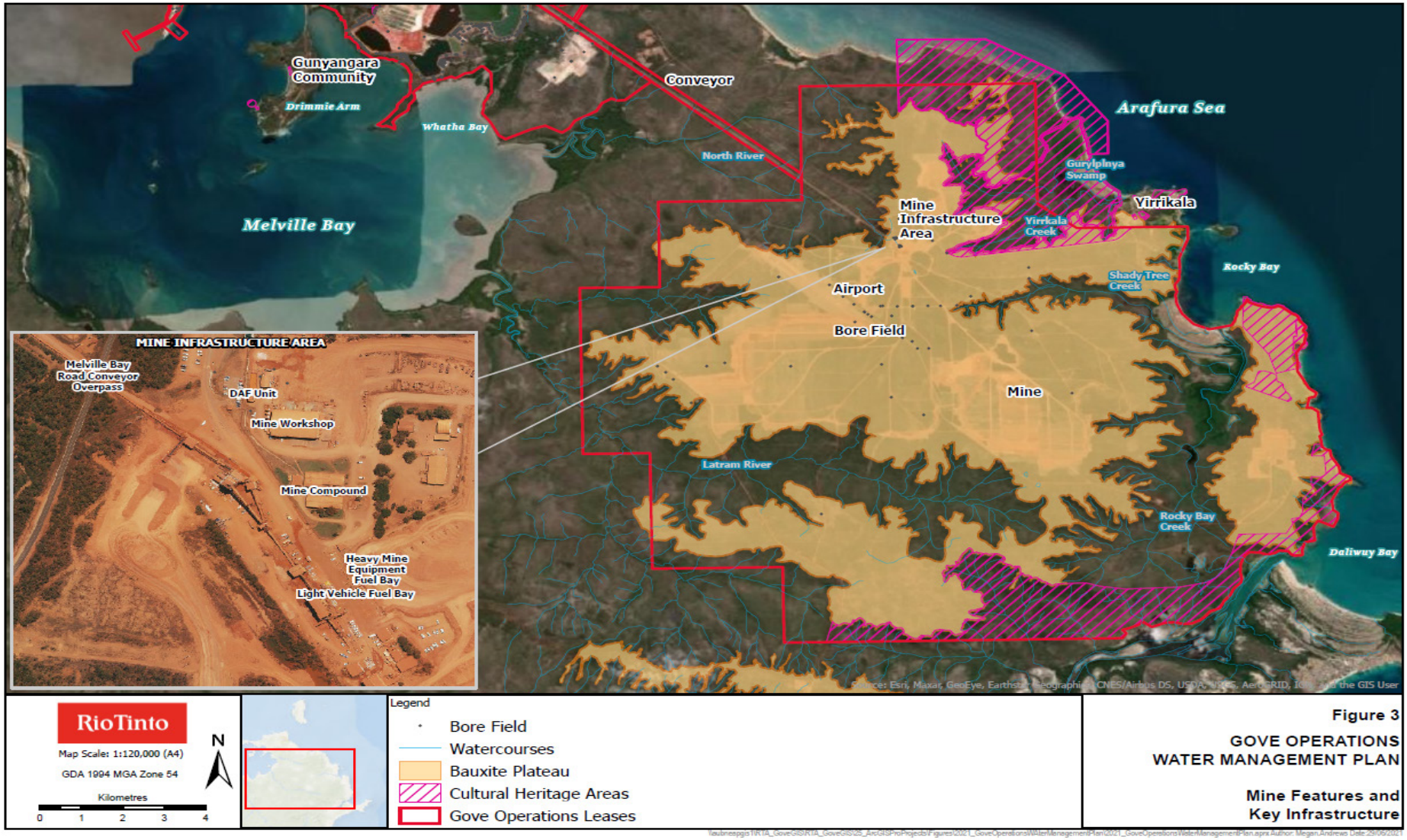
The mine area includes the mine lease area of 20,018ha on the eastern side of the Gove Peninsula and the conveyor lease of 282ha that connects the mine to the refinery via a series of conveyors. The bauxite is mined from an extensive plateau at 60 to 80m above sea level. There are three distinct plateaus which are mined, and these comprise of the Main, Eldo and Rocky Bay plateaus which are located at the central and eastern part of the Gove Peninsula. The conveyor is approximately 20km in length which traverses gently undulating terrain. **Figure 3** displays the key mine features and key infrastructure.

4.1.1 Mine Surface Water

The topography across the mine lease area is represented by the extensive Gove Plateau ranging from 60 to 80m above sea level, on the central and eastern part of Gove Peninsula. The plateau is fringed by escarpments, up to 20m in height, which are less pronounced on the Melville Bay side to the west. The plateau is capped with laterite, which contains the bauxite deposits mined by Gove Operations.

There are seven main catchments across the Gove Plateau. The catchments are briefly described below:

- Yirrkala Creek – flows to the northeast into Gunyipinya Swamp before discharging to the coastline north of Yirrkala into the Gulf of Carpentaria.
- Shady Tree Creek – flows east from the mine area into Rocky Bay and into Gulf of Carpentaria.
- Rocky Bay Creek – flows northeast into Rocky Bay and into Gulf of Carpentaria. This creek system divides Rocky Bay Plateau and the Main plateau.
- Latram River – headwaters in the south and west of the mine and drains in a northwest direction into the head of Melville Bay. Latram River provides important community recreation areas, aquatic ecosystem habitats and riparian areas. Most of the active mining areas in the west of the mining lease drain to the Latram River.
- North River – located northwest of the mine and drains into the North River then into the head of Melville Bay.
- Rainbow Creek – located to the north of the mine and drains to the north into the Arafura Sea.
- Daliwuy Bay – located to the south of the mine and drains the southern part of the lease into Daliwuy Bay and into Gulf of Carpentaria.


Gunyangara Community
Drimmie Arm
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Latram River
Rocky Bay Creek
Daliwuy Bay
MINE INFRASTRUCTURE AREA
Melville Bay Road Conveyor Overpass
DAF Unit
Mine Workshop
Mine Compound
Heavy Mine Equipment Fuel Bay
Light Vehicle Fuel Bay
RioTinto
Map Scale: 1:120,000 (A4)
GDA 1994 MGA Zone 54
Kilometres
0 1 2 3 4
N
Legend
Bore Field
Watercourses
Bauxite Plateau
Cultural Heritage Areas
Gove Operations Leases
Figure 3
GOVE OPERATIONS
WATER MANAGEMENT PLAN
Mine Features and
Key Infrastructure

4.1.2 Mine Groundwater

The groundwater beneath the plateau is hosted within the fluviatile sands and gravels of the Mullaman Beds, which overlay a granite basement, and is generally present at 25 to 35m below surface. Groundwater discharges to the lower reaches on the Latram River and Yirrkala Creek, and may discharge in the wet season to the lower reaches of Shady Gum Creek and Rocky Bay Creek.

The Mullaman Beds sequence forms the primary groundwater aquifer beneath the plateau and is used to supply potable water for the operation and surrounding communities. The following four units have been identified within the Mullaman Beds, based on geophysical logging of boreholes:

- Unit A – bauxite/laterite/sub-clay.
- Unit B – feldspathic to clayey sandstone.
- Unit C – clean quartzose sandstone, with shales and claystones at depth.
- Unit D – interbedded sequence of sandstones, claystones and carbonaceous bands. Some cemented zones occur, and pyritic nodules are common.

4.1.3 Mine Water Management Infrastructure

Key infrastructure related to water quality protection and water management across the mine area includes:

- Potable water bore field.
- Dissolved Air Flotation (DAF) unit.
- Erosion and Sedimentation Basins

The bore field is located at the mine; it includes production bores across three areas:

- Airstrip – located along the eastern margin of the airstrip.
- Shady Gum Creek – running east from near the centre of the airstrip towards Shady Gum Creek.
- Latram River – located west of current mining areas, near the Latram River.

There is a network of observation bores which are used to monitor water levels within the Mullaman Beds aquifer. The bore field has operated since 1970 and was last expanded in 2005, with the installation of the two Latram River production bores. Abstraction of groundwater from the Mullaman Beds aquifer is in accordance with the Water Extraction Licence issued by the Northern Territory Controller of Waters, which approves water extraction of 11,100 ML per annum. The Nhulunbuy Corporation Limited manages the water treatment and supply for the town.

The abstracted groundwater has low salinity and is considered a high-quality potable water source. Treatment therefore includes only aeration and chlorination prior to distribution. The abstracted water is pumped to three primary storage tanks and several short-term storage tanks, which provide sufficient combined capacity to maintain water supply through peak demand periods.

The three primary water storage facilities include:

- Mine Water Tank – managed by Gove Operations for supply to the mine area and airport.
- Mt. Saunders Tank – managed by Nhulunbuy Corporation Limited for supply to the town area.
- Mt. Gorton Tanks – managed by Gove Operations for supply of domestic water (and formerly process water) to the refinery.

The oily water and stormwater runoff from mine infrastructure areas is directed to a collection pond at the DAF unit. The DAF consists of an oil skimmer system and flotation system to remove suspended solids.

4.1.4 Mine Conceptual Site Model

Table 5 summarises the CSM for the mine functional area. It identifies the potential sources of contamination, relevant containment of those sources, potential pathways of the contaminants, controls implemented by the mine area, and potential sensitive receptors.

Table 5. Mine Conceptual Site Model

Areas	Source	Containment	Pathway	Control	Receptor	Exposure Pathway Complete?
	Description	**Mitigation**	**Description**	**Mitigation**	**Description**	
Mine infrastructure	Spills from HME/LV refuelling bays.	Controlled use within bund areas. Spill procedures.	Migration into groundwater.	Nil	Town/communities GDE	Highly unlikely
	Overflow from the DAF unit.	Workshop area bunded and runoff captured in Collection Pond, wastewater pumped into DAF unit for treatment and release.	Overflow of Collection Pond during high rainfall events. Migration into groundwater.	Managing water levels in Collection Pond prior to wet season and expected high rainfall events. Engineered designed facility	Local vegetation Groundwater/GDE	Possible Highly unlikely
	Run-off from the Mine Workshop area, including HME wash pad and laydown area.	Run-off diverted into a large sediment sump prior to discharge in the drain	Overflow into the drain around the outside car park	Nil	Local vegetation	Unlikely
Mining	Run-off from mined out areas.	Sediment and control measures during mining operations	Mining activities within sunken landform. No pathway to receiving environment.	Rehabilitation of mined areas	Local vegetation	Highly unlikely

HME – Heavy Mining Equipment

LV – Light Vehicle

GDE – Groundwater Dependent Ecosystem

4.2 Refinery

The refinery is located on the north-western portion of the Gove Peninsula, surrounded by the Gove Area Marine Waters of Melville Bay, Gove Harbour, and the Arafura Sea. The refinery footprint is approximately 150ha and includes the alumina refinery (in closure), bauxite stockpiles, bauxite crushers, screener, and conveyors, export conveyor and ship loader, ports (cargo and export), hazardous material storage tanks, power generators, sewerage treatment system, wastewater neutralisation plant (WWNP), and sea water circuit including intake, channel, and outlet.

The bauxite conveyor runs around the northern and western bounds of the alumina refinery and terminates at the export wharf. **Figure 4** provides the key features and key infrastructure at the refinery.

Bauxite was historically refined through the Bayer process which used caustic, high temperatures and pressure to extract the aluminium from the bauxite. The signature of caustic materials is typically indicated by elevated pH, alkalinity (measured as Acid Neutralising Capacity), and metal(loid) concentrations. These metals(loid)s include aluminium (Al), arsenic (As), chromium (Cr), copper (Cu), gallium (Ga), molybdenum (Mo), vanadium (V), and zinc (Zn). The storage of fuel at the Harbour Tank Farm and Light Fuel Tanks Farm are sources of potential contamination from uncontrolled releases. It should be noted that the majority of heavy fuel oil has been removed from the harbour tank farm, but the LFTF continues to store diesel. Contaminants of potential concern (CoPC) associated with these facilities include total petroleum hydrocarbons (TPH) and polycyclic aromatic hydrocarbons (PAH). The oily water pond in the central refinery is also a source of these contaminants. The oily water pond underflow intermittently flows into the seawater circuit, only when the water level is above the invert of the underflow pipe.

4.2.1 Refinery Surface Water

The refinery is relatively flat with most of the surface level at or below 6m Melville Height Datum (MHD). A granite outcrop (Mt. Gorton), with an elevation of 24m MHD is located in the north western portion of the refinery, near Wargarpunda Point. Other minor elevations to a maximum of 10m MDH are present along site west coast, and to a maximum of 8m MDH along Wallaby Beach to the north.

Drainage of surface water at the site is inferred to follow the topography, that is, generally directed towards the south of the site, Melville Bay, possibly towards the west, and Arafura Sea, in a limited area on the northwest corner. Stockpile Creek, located to the east of the alumina refinery, flows into Wanaka Bay, it receives run off from the stockpiles, part of eastern refinery, the radio tower, and experiences high peak flows during the wet season. Prior to refinery development, Stockpile Creek was a small ephemeral creek; its catchment and channel have been highly modified to increase holding capacity in the sedimentation basins and is now a series of sediment settlement ponds and channel.

The surface water catchments at the refinery are summarised in **Table 6** and displayed in **Figure 5.**

Figure 4
GOVE OPERATIONS WATER MANAGEMENT PLAN
Refinery Features & Key Infrastructure

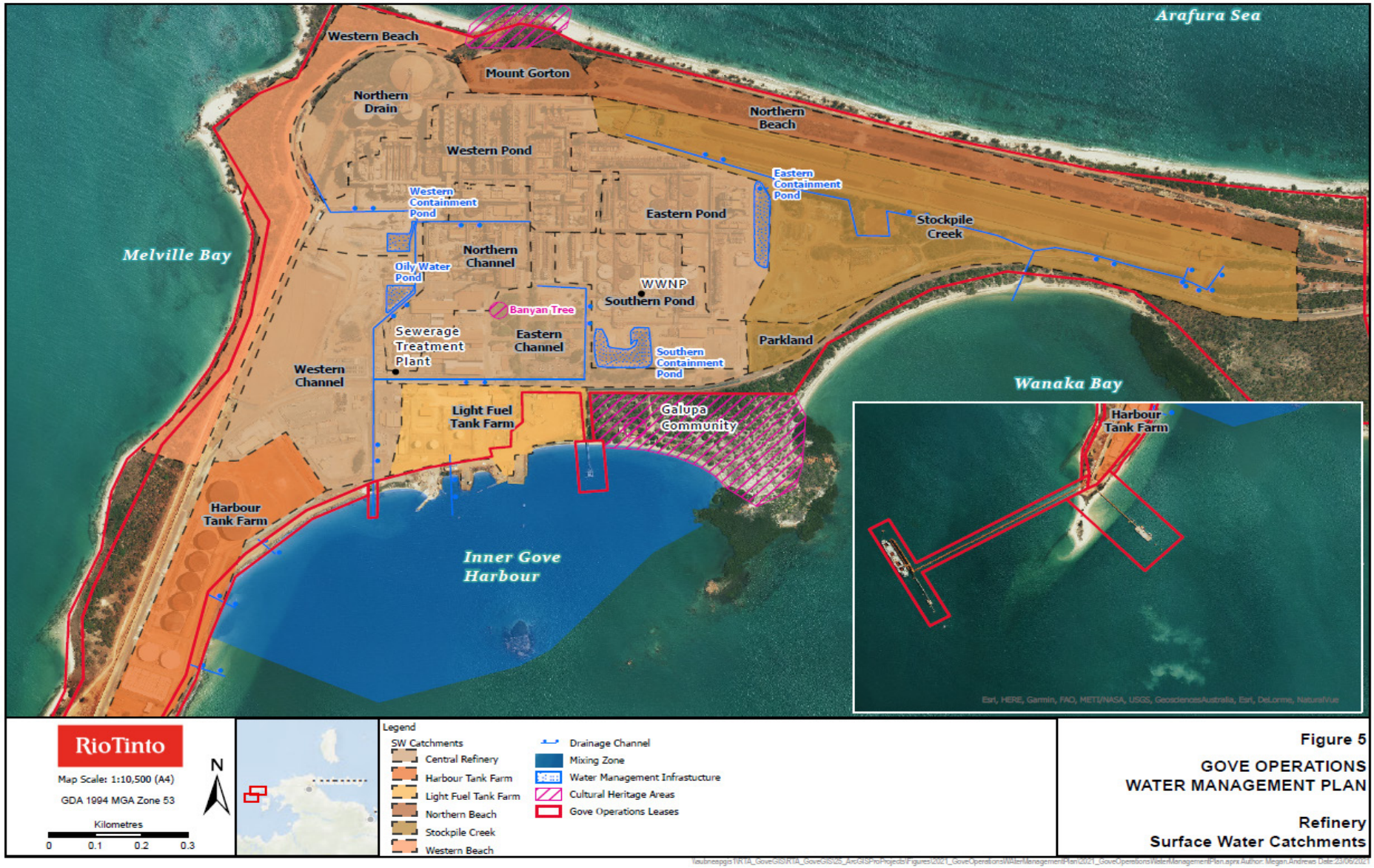


Figure 5

GOVE OPERATIONS WATER MANAGEMENT PLAN

Refinery Surface Water Catchments

Table 6. Refinery Surface Water Catchment Areas

Catchments	Area (ha)	Description	Receiving waters
Central Refinery Catchment			
Refinery Process Area Containment sub catchments			
Western Containment Pond (WCP)	14.9	The WCP catchment receives runoff from the former 'white-side' operations area of the closed alumina refinery this infrastructure includes the: • Precipitation Plant. • Hydrate Filtration and Classification Plant. • Calcination Plant. • Lime Plant.	Inner Gove Harbour / Melville Bay Discharging into the marine environment under the WDL conditions for the seawater outlet.
Southern Containment Pond (SCP)	9.6	The SCP catchment receives runoff from the former 'red-side' operational area of the alumina refinery and contains non-operational infrastructure including: • Mud Washing Plant. • Red Mud Disposal Plant (formerly piped to RDA facilities). • Caustic Plant. • Process Cooling Plant.	
Western Channel	15.9	The Western Channel catchment includes the confluence of the Western and Eastern Seawater Channels, and the main Outfall Channel from the seawater circuit to Melville Bay. The Western Channel catchment includes the following features: • Laydown areas (temporary/maintenance works laydown areas and scrap yard). • Stockpiling areas (formerly used as a bauxite export stockpile area). • Containerised temporary power generator farm (replacing the Refinery Power Station that was shut down in curtailment). • Disused fuel-oil storage tanks. • Vehicle/equipment wash down bay. • HDPE lined Oily-Water Pond.	
Northern Channel	7.9	The Northern Channel catchment includes the following non-operational infrastructure: • Steam Power Station and Diesel Power Station. • Fresh/Cooling Water System. • Hydrate Filtration and Classification Plant. • Water Treatment Plant. • Central Control Building.	
Eastern Containment Pond (ECP)	9.9	The ECP catchment receives runoff from the former 'red-side' operational area of the alumina refinery and contains non-operational infrastructure including: • Mud Washing Plant. • Digestion Vessels. • Liquor Purification Plant.	Inner Gove Harbour / Melville Bay Surface water runoff from unpaved areas, and any overflow events are discharged into the marine environment under the WDL conditions for the sea water outlet. Wanaka Bay / Inverell Bay / Melville Bay ECP can overflow during storm event and contribute to discharge from Stockpile Creek.
Refinery Operational Support Facilities sub catchments			
Northern Drain	6.9	Northern Drain catchment includes mostly non-operational refinery infrastructure and conveyor infrastructure: • Alumina Silo and Reclaiming Plant. • Former alumina export conveyor. • Current bauxite export conveyor. • Laydown area.	Inner Gove Harbour / Melville Bay Discharging into the marine environment under the WDL conditions for the seawater outlet.

Catchments	Area (ha)	Description	Receiving waters
Eastern Channel	9.5	The Eastern Channel catchment includes administration/office/warehouse/maintenance buildings, paved parking areas, paved roads, and landscaped areas. The Eastern Channel catchment also includes process water inputs to the eastern reach of the main Seawater Channel, including: • Evaporation Plant, which lies in the north of the catchment (non-operational). • Discharge pipe for the neutralised Supernatant Liqour (SNL) from the WWNP (WWNP located within Southern Pond catchment to the north). • Sewerage treatment plant and discharge pipe into Eastern Channel.	
Stockpile Creek catchment			
Sub catchments			
Stockpile Creek	31.9	The Stockpile Creek catchment has been substantially modified since curtailment of Refinery operations in 2014, with the establishment of the primary Bauxite Stockpiling areas, Materials Handling infrastructure and Laydown Areas. To improve the quality of discharges from Stockpile Creek into Wanaka Bay, construction of new sediment retention and settlement ponds commenced in 2019, this works include rehabilitation and erosion and sediment controls across the catchment and were completed in 2020. Surface water runoff are released via Stockpile Creek.	Wanaka Bay / Inverell Bay / Melville Bay Discharging into the marine environment via Stockpile Creek.
Parkland	1.9	Native vegetation located to the east of the Southern Pond area and north of Melville Bay Road. Surface water runoff flows towards Wanaka Bay via Stockpile Creek.	
Light Fuel Tank Farm catchment			
	7.0	The Light Fuel Tank Farm (LFTF) area includes three paved areas for parking, bulk liquid storage, warehousing of dangerous goods, and contains: • Bulk storage of Light Fuels (diesel) with bunded Above Ground Storage Tanks (AST). • Transit Yard – Laydown area for importation of materials and equipment. • Open sided drum storage shed. • Oily water separation unit. • Offices and Storage Sheds. • Light vehicle fuel station.	Inner Gove Harbour / Melville Bay flowing into marine environment under WDL conditions for LFTF bund separator release.
Harbour Tank Fam catchment			
Sub catchments			
	13.3	The Harbour Tank Farm is largely unpaved, with lined bund areas for the tanks, paved roads, and parking areas, and contains: • Heavy Fuel Oil (HFO) storage (only residual stored post curtailment). • Caustic Liquor Storage. • Export conveyor. • Workshop facilities. • Laydown areas. • Minor storage, maintenance, and office buildings (associated with the tank farm and port operations).	Inner Gove Harbour / Melville Bay flowing into marine environment under WDL conditions for bund separator release.
Northern Beach catchment			
Sub catchments			
Mount Gorton	2.7	Potable water from bore field is stored in water tanks in this area. Approximately 50% native vegetation cover. Paved areas drain to south to Stockpile Creek catchment. Stormwater runoff flows north and east from this catchment to Northern Beach / coastal areas.	Arafura Sea
Northern Beach	10.9	The catchment provides a buffer-zone between material (bauxite) stockpiling/handling areas and the Northern Beaches / Arafura Sea. Stormwater runoff from this catchment sheds to the north to the coastal environment, away from the Stockpile Creek surface water catchment.	
Western Beach catchment			
Western Beach	11.8	Native vegetation, approximately 90% vegetation cover, located to the west of the export conveyor and alumina refinery. Surface water runoff flows towards beach and Arafura Sea.	Arafura Sea

4.2.2 Refinery Groundwater

The refinery is underlain by granite-gneiss from the Melville Bay metamorphic, expressed as limited outcrops in the area to the north of the refinery (Mt. Gorton). At depth, the granite-gneiss is extensively weathered and overlain by a residual clayey (kaolinitic) saprolite horizon. This layer is gradational and varies in thickness but can be up to 2m in extent. The saprolite is overlain by unconsolidated marine sediments, predominantly consisting of clean, fine to coarse grained quartz and calcareous sand of variable thickness, reported to a maximum depth of approximately 18m.

The soil profile beneath the refinery is variable and is dependent on location. Soil profiles include:

- Compacted clayey gravelly sand (imported fill).
- Disturbed natural soils.
- Marine sands.

Groundwater beneath the refinery is measured at depths varying from approximately 3 to 5m below ground level (bgl) during the dry season (May to December). Variations of up to 1m in groundwater depths over time are observed. Groundwater is inferred to be generally flowing towards the coast, radially from a mound under Mt. Gorton. The underlying granite is considered an aquitard, that restricts the flow of groundwater.

Over the life of operation, loss of integrity from the bunded areas has caused localised contamination of groundwater and soil, resulting in a contaminated groundwater plume beneath the refinery. The decontamination and decommissioning of the central refinery footprint over the next seven years, in accordance with the 2019 MMP, will reduce and largely remove these potential sources of contamination.

4.2.3 Refinery Water Management Infrastructure

Refinery water management infrastructure consists of surface water, water treatment and groundwater infrastructure, as summarised below:

Surface Water: The surface water management infrastructure includes the seawater circuit, along with a series of pumps, bunds, and containment ponds to capture potentially contaminated surface water and spills. Surface water within the containment ponds is managed as potentially contaminated and transferred to the RDA (currently Pond 6) for storage and pumped back to WWNP for treatment before discharging into the receiving environment. There are three water containment ponds constructed to capture refinery process water and bund area overflow as tertiary containment. The Eastern, Western and Southern Containment Ponds are described within **Table 7**.

Table 7. Refinery Contaminated Runoff Storage Infrastructure

Storage Facility	Structural Details	Pump	Full Surface Area (m^2)	Full Supply Volume (m^3)
Western Containment Pond – Western Pond Catchment Area	Pond is concrete lined with a baffle wall to increase the length of flow path from inlet to outlet. The pond has a ramp to the bottom to allow removal of sediment.	Pump operation triggered by pond capacity limits. It pumps to sand disposal tank, which then is pumped to the RDA.	2,203	5,538
Southern Containment Pond – Southern Pond Catchment Area	Earth pond is clay lined to prevent leakage to the underlying water table.	Auto pump with level sensor that pumps to sand disposal tank, which then is pumped to the RDA	6,475	9,000
Eastern Containment Pond – Eastern Pond Catchment Area	Earth pond is clay lined to prevent leakage to the underlying water table	Auto pump with level sensor that pumps to the SCP, which then is pumped to the RDA -	5,030	8,718

The oily water pond operates as a settlement pond with the underflow releasing into the seawater circuit. During heavy rainfall events the pond has an overflow weir which releases into the seawater circuit.

Water Treatment: The WWNP is located within the central refinery, which when operating releases treated wastewater via the seawater circuit. The seawater circuit comprises the main seawater intake, two seawater pumps drawing water from Melville Bay, and concrete lined channels with a design flow in the order of 10,000m^3/hr. The sea water outfall discharges into the inner Gove Harbour and Inverell Bay.

Water from the sewerage treatment plant (STP) is intermittently released either into the seawater circuit or via irrigation to land application areas. STP water presents as non-saline with elevated nitrogen and phosphorus.

Groundwater Infrastructure: Across the refinery footprint the focus is on limiting the migration of contaminants towards the sensitive receptors. Since the 1990s until recently, Gove Operations has been recovering contaminated groundwater by Airwell positive displacement pumps.

These recovery bores have been severely impacted by scaling rendering them inoperable for several years. These factors as well as the restriction of safe access to the bores during the scheduled demolition of the refinery from 2021, requires a new approach to the management and potential remediation of the contaminated groundwater beneath the refinery. It is proposed to focus on source reduction as a component of refinery decontamination, whilst reassessing groundwater remediation activities during the closure study process for implementation post-demolition.

An air sparge system operates along the southern boundary of the light fuel tank farm (LFTF) compound, part of the remediation activities in response to the loss of containment of an above-ground storage tank (AST) in 2010. Monitoring of the remediation works indicate that operation of the air sparge system is no longer required. A trial to better understand the movement of contaminants, without the air sparge containment system is planned for 2021/22, with an intent to decommission the system if the trial is successful.

4.2.4 Refinery Conceptual Site Model

Table 8 summarises the CSM for the refinery functional area. It identifies the potential sources of contamination, relevant containment of those sources, potential pathways of the contaminants, controls implemented by the refinery area, and potential sensitive receptors.

Table 8. Refinery Conceptual Site Model

Areas	Source	Containment	Pathway	Control	Receptor	Exposure Pathway Complete?
Central Refinery	Storage of Bayer Spent Process Liquor (BSPL) for use in WWNP. Residual caustic material in tanks, pipes, and contaminated soil. Overflow of SCP and WCP during heavy rainfall events. Contaminated soil / sediment and surface water runoff. Oily water pond underflow and overflow	Managed pumping to control water levels in sumps, bunds, and containment ponds. Ongoing source reduction in closure. Erosion and sediment control measures.	Surface and sediment runoff from central refinery sub catchments into seawater channel.	Dilution with seawater at approx. 10,000m^3/h	Gove Harbour	Almost Certain
			Migration to groundwater	Nil	Gove Harbour	Possible
Stockpile Creek	Surface water runoff from bauxite stockpiles. Overflow of ECP during heavy rainfall events.	Managed pumping to control water levels in sumps, bunds, and containment ponds. Ongoing source reduction in closure. Erosion and sediment control measures.	Surface and sediment runoff from Stockpile catchment into Stockpile Creek.	Erosion and sediment control measures. Maintenance and control of sediment basins.	Wanaka Bay to Inverell Bay and Melville Bay.	Possible
Light Fuel Tank Farm	Storage and handling of fuel.	Tanks within bund area. Control-release valves on bunds. Oily water separator unit.	Surface water captured in bunds overflows during high rainfall events.	Release from bunds controlled by valves. Runoff contained and directed to the oily separator unit.	Inner Gove Harbour beach	Highly unlikely
Harbour Tank Farm	Residual hydrocarbons in tanks. Storage of BSPL for use in WWNP.	Tanks within bund area. Control-release valves on bunds. Oily water separator unit. Source reduction in closure.	Bunds overflow during high rainfall events.	Release from bunds controlled by valves.	Inner Gove Harbour beach	Highly Unlikely

4.3 Residue Disposal Area

The RDA functional area contains red mud and liquor ponds within the southern portion of the RDA. This portion of the facility is active, as it continues to receive underflows from the wastewater treatment plant located in the refinery and contaminated refinery water runoff and the runoff from the uncapped red mud ponds. The wastewater treatment plant reduces liquor pond storage volumes by treating contaminated water and releasing it via the sea water channel. Contaminated water inventories are recharged by rain falling on contaminated catchments (refinery, red mud ponds, liquor ponds) compounding efforts to reduce volumes of stored liquor. The progressive capping of the red mud ponds with HDPE liners commenced in 2008 due to increasing wastewater inventory presenting unacceptable risk that future inventories would exceed available storage volume. Capping of red mud ponds increases their stability and provides better control of the water balance and environmental risks.

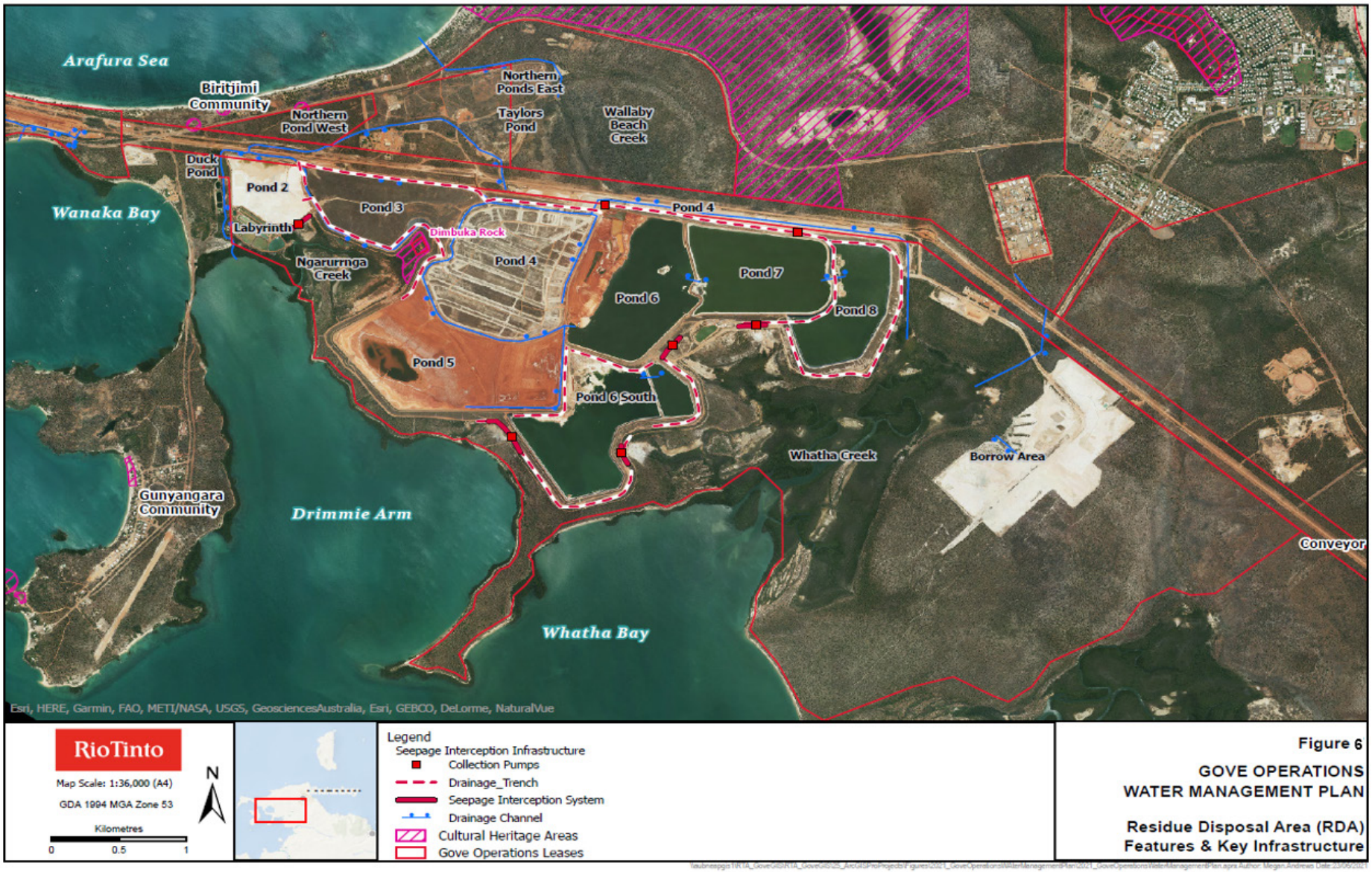
The northern portion of the RDA includes the northern ponds, these were the original red mud storage used until 1978. Historical rehabilitation of the northern ponds included encapsulating the red mud with earth capping and vegetation establishment in the late 1990's.

The eastern portion of the RDA includes an existing borrow area, that was utilised to provide capping materials for Pond 4. The area further to the east, has been identified as the future borrow area and is the potential source of critical clean topsoils and subsoils for the capping of red mud ponds and the creation of final landforms across the refinery and RDA.

The RDA functional area southern portion surrounds the Dimbuka Rock Sacred Site, and access is to be maintained and the final landform embankments surrounding the Sacred Site need to be sympathetic to the significance of the site as a landmark.

Prior to construction of the RDA, the area consisted of a complex tidal drainage system that fed into a large embayment adjacent to Drimmie Head. The landscape was generally flat and most of it characterised by dry open sandy forest and paperbark swamps during the wet season. Tidal flushing of the embayment occurred in a west-east direction, and Drimmie Head was connected to the mainland by a narrow sand spit that was covered during periods of high tide. A causeway was constructed across the spit in the 1940’s changing the direction of tidal flow. These tidal drainage systems included Ngarurrnga (Macassar) Creek and Whatha (Crawfords or No Name) Creek.

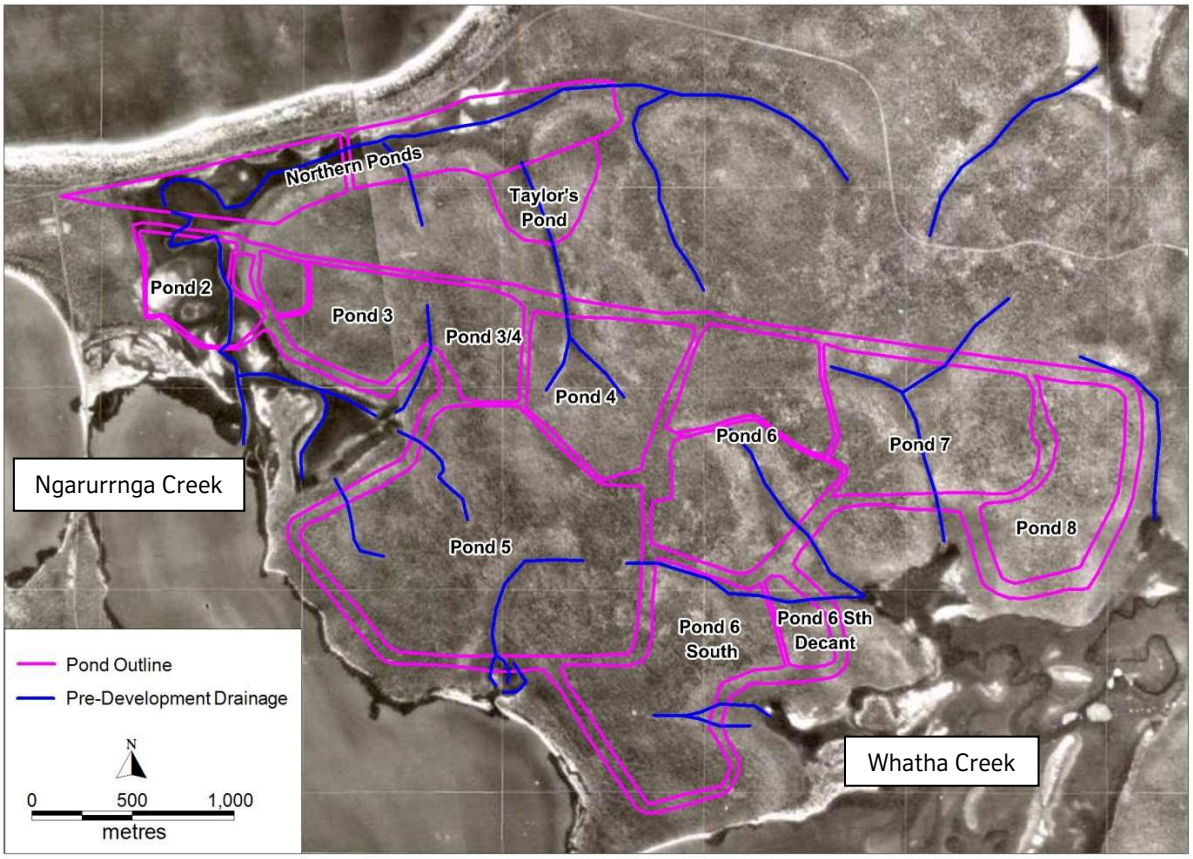
Figure 6 displays the RDA key features and water management infrastructure.


Arafura Sea
Biritjimi Community
Northern Pond West
Northern Ponds East
Taylors Pond
Wallaby Beach Creek
Duck Pond
Pond 2
Pond 3
Pond 4
Wanaka Bay
Labyrinth
Dimbuka Rock
Ngarurrnga Creek
Pond 4
Pond 7
Pond 6
Pond 8
Pond 5
Pond 6 South
Whatha Creek
Borrow Area
Gunyangara Community
Drimmie Arm
Conveyor
Whatha Bay
Esri, HERE, Garmin, FAO, METI/NASA, USGS, GeosciencesAustralia, Esri, GEBCO, DeLorme, NaturalVue
RioTinto
Map Scale: 1:36,000 (A4)
GDA 1994 MGA Zone 53
Kilometres
0
0.5
1
N
Legend
Seepage Interception Infrastructure
Collection Pumps
Drainage_Trench
Seepage Interception System
Drainage Channel
Cultural Heritage Areas
Gove Operations Leases
Figure 6
GOVE OPERATIONS
WATER MANAGEMENT PLAN
Residue Disposal Area (RDA)
Features & Key Infrastructure

4.3.1 RDA Surface Water

Figure 7 shows the pre-development catchments overlain by a historical aerial photo (1958). The figure has been developed from topographical data sourced from the Shuttle Radar Topographic Mission which is administered by Geoscience Australia. It shows keys changes to surface water flow and catchment such as:

- Macassar Creek (Ngarurrnga Creek) is covered by Pond 2 and now releases to the environment via the Duck Pond Creek release point.
- Surface water for the part of Northern Ponds flows to the north into Wallaby Beach Creek.
- Duck Pond Creek modified to act as a drain to return surface water flows from Northern Ponds, and the runoff from the capped Pond 3.
- Runoff from the capped Pond 4 returns to the environment via Whatha (Crawfords or No Name) Creek.



Source: 1958 aerial photograph, digitised by John Bradley, 2016.

Figure 7: RDA Interpreted Pre-Development Hydrology

Construction of the RDA not only changed the surface water flow, but the local topography was also significantly modified with elevations ranging from 3 to 25m (AHD). The surface water flows were altered by the construction of the ponds, that captured rainfall reducing the inflows to creeks, and the diverting runoff from capped ponds to artificial drains such as Duck Pond Creek and Northern Outlet Drain, and different receiving environments.

The current surface water catchments are described in **Table 9.**

Table 9. RDA Surface Water Catchments

Catchments	Area (ha)	Description	Receiving environment
Duck Pond Creek Catchment			
Sub catchments			
Northern Ponds West	242	Northern Ponds West is capped with an earth cap installed in 1980. The caustic waste stored here was seawater neutralised and contained a high sand content. This is the main reason the area now has good vegetation coverage. There is a known seepage area on the southern side of the pond into a low-lying area, which is the location of the pre-development Ngarurrnga Soak. Surface water primarily flows via a drain to the Duck Pond Creek release point.	Drimmie Arm / Melville Bay
Northern Ponds Taylors		Taylors Pond is located in the southeast corner of the Northern Ponds, it stored solid scale and industrial waste. In the 1990s the area was capped with laterite and topsoils and revegetated. There is currently sparse vegetation coverage, with localised erosion of the cap and the east and south batters. Surface water primarily flows via a drain to the Duck Pond Creek release point. A small section on the catchment runs into a drain flowing to the Wallaby Beach Creek release point.	
Pond 3		This pond was used to store red mud waste it was capped in 2010, to control the RDA water balance, with a HDPE liner secured and protected with an earth cap. The drains across the capped surface direct flows to the Pond 3 drain along its northern boundary, releasing the stormwater runoff via the Duck Pond Creek release point.	
Pond 2		This pond was constructed to initially store red mud waste; it was also used to store hydrotalcite (the underflow from the WWNP). In 2019 the pond reached its capacity for solid waste it can receive as wastewater inflows from the refinery. Captured rainfall and wastewater is then transferred to the WWNP for treatment.	Inner Gove Harbour / Melville Bay
Wallaby Beach Creek			
Sub catchments			
Northern Pond East	225	Northern Ponds East is capped with an earth cap installed in 1979. The caustic waste stored here was not seawater neutralised. The vegetation coverage is dominated by grasses with scattered areas of shrubs and trees, with some localised erosion of the cap and batters. Poor establishment of vegetation is a result of poor drainage, and no seawater neutralisation of the caustic waste. The surface water flows predominantly to Wallaby Beach Creek release point.	Wallaby Beach / Arafura Sea
Wallaby Beach Creek		Native vegetation.	
Upper Whatha Creek Catchment			
Sub catchments			
Pond 4	214	This pond was used to store red mud and it was capped in 2016, to control the RDA water balance, with a HDPE liner secured and protected with an earth cap. A series of drains across the cap direct the water flow to the Northern Outlet Drain (NOD) that releases into Whatha Creek.	Whatha Creek / Whatha Bay / Melville Bay
NOD		The NOD receives runoff from the roads either side of the drain, Pond 6, 7, 8 northern embankments, and native vegetation to the north.	
Lower Whatha Creek Catchment			
Sub catchments			
East	621	This catchment receives run off from the industrial estate, and native vegetation. The borrow area is a sunken landform and drains via groundwater infiltration.	Whatha Creek / Whatha Bay / Melville Bay
West		This catchment receives run off from embankments of Pond 6, Pond 6S, Pond 7, Pond 8, and gravel roads.	
Pond 6, 6S, 7 and 8		These ponds receive contaminated wastewater from the refinery area and runoff from RDA and refinery. The wastewater is pumped to WWNP for treatment prior to release into the environment.	Inner Gove Harbour / Melville Bay
Pond 5 Catchment			
Pond 5 embankment and future capped area.	65	This catchment receives runoff from the base of Pond 5, and gravel roads. On completion of the Pond 5 capping project surface water from the capped pond is proposed to be released via three drains into Drimmie Arm.	Drimmie Arm / Melville Bay
Pond 5 (uncapped)		Red mud storage pond, capping commenced in 2021. Captured rainfall pumped to wastewater storage ponds and piped to WWNP for treatment and discharge.	Inner Gove Harbour / Melville Bay
Ngarurrnga (Macassar) Creek Catchment			
Sub catchments			
Ngarurrnga	66	This catchment receives runoff from the base of Pond 2, Pond 3, Pond 4, Pond 5, and gravel roads. The catchment includes Dimbuka Rock, which is a Sacred Site. All water flows into Ngarurrnga creek.	Ngarurrnga creek / Drimmie Arm / Melville Bay
Labyrinth		Water treatment system no longer in use, captured rainfall either pumped to wastewater storage ponds and piped to WWNP for treatment and discharge, or released to Duck Pond creek depending on water quality.	Inner Gove Harbour / Melville Bay

4.3.2 RDA Groundwater

The RDA was originally topographically low-lying and was likely dominated by tidally influenced estuary features and multiple granite outcrops. The areas surrounding the RDA include coastal environments to the north and estuarine and harbour environments to the south. The hydrostratigraphy described for the RDA, comprises three relatively distinct sequences, which includes:

- Unit 1: Zones of increased permeability within alluvial sequences.
- Unit 2: Upper weathered intervals (top 1-3m) of the granitic unit.
- Unit 3: Fresh granite which when fractured may represent an aquifer but is otherwise considered an aquitard (barrier to groundwater flow)

In the majority of areas, the three units grade into each other, with hydrostratigraphic variability (for example, hydraulic conductivity) as a result of varying degrees granite weathering.

The key hydrogeological features of the RDA include:

- A key physical driver for groundwater and seepage expression from the RDA is the elevated phreatic surfaces within the residue ponds and the head of liquor in the SNL ponds. This downward driving pressure has resulted in elevated groundwater levels being recorded across the RDA contributing to the migration of seepage and seepage impacted groundwater away from the RDA and towards the receiving environment. In places, this has been observed as artesian groundwater conditions adjacent to pond embankments.
- Unit 1 includes paleochannel and dune sand deposits that readily transmit groundwater and seepage flows. Marine and estuarine muds within Unit 1 can locally restrict groundwater flow due to their lower permeability compared to sandy alluvial deposits.
- Mixing of contaminated groundwater and seepage with native groundwater in the terrestrial and marine domains has altered the groundwater quality as a result of two key mixing processes. One series of reactions describes the mixing of native low-salinity terrestrial groundwater with saline or hypersaline marine, or estuarine groundwater. The other series describes the mixing of seepage with these native groundwaters. The presence of these reactions coupled with the expected reduced seepage rates, due to reduced hydraulic head, suggests that post closure of the RDA, residual seepage can safely and sustainably mix with receiving waters.

4.3.3 RDA Water Management Infrastructure

Key water management infrastructure at the RDA includes:

- Ponds.
- Surface water drains.
- Monitoring infrastructure such as piezometers, groundwater monitoring wells and survey points.
- Toe drains and associated collection sumps (geotechnical controls).
- Seepage interception and recovery systems.
- A network of pumps and pipes connecting the refinery and RDA to facilitate wastewater transfer.

Details of the RDA ponds are included below in **Table 10**.

Table 10. Characteristics of RDA Ponds

Area	Ponds	Storage Capacity (GL)	Catchment Area (ha)	Average Evaporative Surface Area (ha)	Function	Status
Southern RDA	Pond 2	0.49	28	21	WWNP Underflow Solids Management	Inactive
	Pond 3	Nil	60	Nil	Red mud storage	Inactive – Capped HDPE
	Pond 4	Nil	112	Nil	Red mud storage	Inactive – Capped HDPE
	Pond 5	1.17	115	62	Red mud and SNL storage	Inactive
	Pond 6	4.75	91	77	Red mud, SNL storage and WWNP Underflow Solids Management	Inactive, will become active with hydrotalcite deposition
	Pond 6 South	5.93	76	64	SNL storage	Active wastewater storage
	Pond 6 South Decant	0.87	11	10	SNL storage	Active wastewater storage
	Pond 7	8.95	70	65	SNL storage	Active wastewater storage
	Pond 8	6.11	52	47	SNL storage	Active wastewater storage
Northern	Northern Ponds	Nil	180	Nil	Red mud storage	Inactive/rehabilitated – Capped earth

To minimise seepage impacts on surrounding environment a series of seepage interception systems and associated pumps have been installed, including:

- Pond 2 east embankment (interception/cut-off trench and associated pumps).
- Pond 6S eastern embankment (interception/cut-off trench associated pumps).
- Pond 6S western embankment (seepage sump and associated pumps).
- Pond 6 eastern embankment (interception/cut-off trench and associated pumps).
- Pond 7 southern embankment (interception/cut-off trench and associated pumps).

To further improve seepage recovery, an additional three seepage zones are being investigated, including:

- Pond 5 northwest embankment.
- Pond 7 borrow pit.
- Pond 8 east embankment.

Controlling and where possible reducing the RDA water balance is the fundamental control to manage the current environmental risk, compliance with the annual Wet Season Allowance and implementation of the closure plan. Evaporation and wastewater treatment via the WWNP reduce the volume of wastewater in the ponds while capping of red mud ponds and decontamination and demolition of the refinery will reduce the wastewater that reports to the RDA.

4.3.4 RDA Conceptual Site Model

Table 11 summarises the CSM for the RDA functional area. It identifies the potential sources of contamination, relevant containment of those sources, potential pathways of the contaminants, controls implemented by the RDA area, and potential sensitive receptors.

Table 11. RDA CSM

Areas	Source	Containment	Pathway	Control	Receptor	Exposure pathway complete?
Pond 2 (28ha)	Storage of hydrotalcite / red mud / wastewater in Pond 2.	Storage of waste maintained at or below pond capacity.	Seepage under pond embankment causing vegetation decline and surface water and groundwater contamination.	Seepage interception system installed at Pond 2 eastern embankment.	Marine environment. Vegetation. Groundwater.	Possible
Pond 3 (60ha)	Capped red mud.	Encapsulated with HDPE liner. Immobile unless failure of liner occurs.	Seepage under pond embankment causing vegetation decline and surface water contamination.	Capped Pond minimal infiltration.	Marine environment. Vegetation.	Highly Unlikely
	Earth cap on top HDPE liner	Erosion and sediment controls and vegetation establishment.	Surface water infrastructure directs runoff to Duck Pond Creek discharge point.	Maintenance of infrastructure.	Marine environment. Vegetation.	Possible
Pond 4 (112ha)	Capped red mud.	Encapsulated with HDPE liner. Immobile unless failure of liner occurs.	Seepage under pond embankment causing vegetation decline and surface water contamination.	Capped Pond minimal infiltration.	Marine environment. Vegetation.	Highly Unlikely
	Earth cap on top HDPE liner	Erosion and sediment controls and vegetation establishment.	Surface water infrastructure directs runoff to NOD	Maintenance of infrastructure (establishment of vegetation in NOD).	Marine environment. Vegetation.	Possible
Pond 5 (115ha)	Red mud and SNL.	Storage of waste maintained at or below pond capacity.	Seepage under pond embankment causing vegetation decline and surface water and groundwater contamination.	Planned capping of pond and installation of seepage interception system along NW embankment.	Marine environment. Vegetation. Groundwater.	Likely
	Earth cap on top HDPE liner when constructed.	Erosion and sediment controls and vegetation establishment.	Surface water infrastructure directs runoff to Drimmie Arm.	Maintenance of infrastructure (use of holding dam to capture and test quality of runoff prior to release.	Marine environment. Vegetation.	Possible

Areas	Source	Containment	Pathway	Control	Receptor	Exposure pathway complete?
Pond 6 (91ha)	Wastewater, red mud and hydrotalcite storage pond.	Wastewater pumped to WWNP. Storage of waste maintained at or below pond capacity.	Seepage under pond embankment causing vegetation decline and surface water contamination.	Seepage Interception System – Pond 6 - E	Marine environment. Vegetation.	Highly unlikely
Pond 6 South (64ha) Pond 6 South decant (11ha)	Wastewater storage pond.	Wastewater pumped to WWNP.	Seepage under pond embankment causing vegetation decline and surface water and groundwater contamination.	Seepage Interception System - Pond 6S –E and Pond 6S – W.	Marine environment. Vegetation. Groundwater.	Unlikely
Pond 7 (70ha)	Wastewater storage pond.	Wastewater pumped to WWNP.	Seepage under pond embankment causing vegetation decline and surface water and groundwater contamination	Seepage Interception System - Pond 7 S.	Marine environment. Vegetation. Groundwater.	Possible
Pond 8 (52ha)	Wastewater storage pond.	Wastewater pumped to WWNP.	Seepage under pond embankment causing vegetation decline and surface water and groundwater contamination.	Seepage recovery at Pond 8 E.	Marine environment. Vegetation. Groundwater.	Possible.
Northern Ponds (180ha)	Red mud	Encapsulated with earth cap. Erosion and sediment controls and vegetation establishment.	Seepage under pond embankment and through capping failures causing vegetation decline and surface water and groundwater contamination.	Seawater addition in drain prior to Duck Pond for neutralisation and dilution. Early implementation of Northern Ponds Closure Plan.	Marine environment. Vegetation. Groundwater.	Possible

4.4 Marine

The inner Gove Harbour marine environment is the primary receiving environment for mining activities at Gove Operations. Through collaboration with the Australian Institute for Marine Sciences (AIMS) and Charles Darwin University (CDU), an industry leading practice marine health monitoring program has been and continues to be implemented. This program includes seawater, oyster and sediment sampling and has been completed consistently since 2010.

As a result of historical mining activities, hydrotalcite and sediment runoff has been intermittently discharged via the refinery seawater channel over the life of the refinery. Gove Operations has investigated the sediment to determine an appropriate course for closure. Monitoring of the area indicates that the sediment is not impacting the environmental values.

Assessment of the sediment characteristics suggest that disturbance of the sediment should be avoided, due to its fine particle size and anoxic nature. It is expected that any physical intervention on a broad scale to remove the sediment may cause localised deoxygenation of the water and cause a significant environmental impact.

Modelling studies and field campaigns completed by AIMS investigated the potential for affected sediment to be redistributed through natural oceanographic processes, which would facilitate natural attenuation over time without any physical intervention. These natural processes included tidal currents and wind-generated ocean waves.

5 OPERATIONAL CONTROLS

5.1 Operational Actions and Responsibilities

Gove operations operates under Rio Tinto's health, safety, environment, and quality (HSEQ) management system which is certified to the international standard ISO 14001. The system is a management tool implemented by Rio Tinto and not a statutory requirement.

The objective of the HSEQ management system is to maintain an understanding of the potential impacts of the operation on the environment, manage these impacts according to relevant legislation, corporate and external standards, codes, and other requirements. It also requires Gove Operations to monitor the impacts of the operation and implement strategies to ensure continual improvement of the system is ongoing. In context to site water management, the HSEQ management system includes:

- Operational control of processes to manage water.
- The segregation of operational activities at the Gove Operations into functional areas.
- RACI assignment of water management system (**Table 12** – Mine, **Table 13** – Refinery and **Table 14** – RDA and Marine).

The RACI assigns roles to key personal for tasks associated with operational controls for the site's water management risks. The intent is to define which Gove Operations leader and department will assume responsibility for each area or aspect of onsite water management.

Area and Tasks	HSE Business Partner	Environment Superintendent	Operations Manager	Mine Workshop Superintendent	Mine Production Superintendent	Services Manager	Utilities Superintendent	RDA Superintendent
Mine								
Environmental monitoring & reporting	A	R	I	C	C	I	C	
Environmental inspection. Licence renewals.	A	R	I	C	C	I	C	
Mine Production Areas								
Operate in accordance with plan - identification of remedial works including erosion and sedimentation control.		I	A	C	R			
Workshop Areas								
Operate in accordance with plan - identification of remedial works including erosion and sedimentation control.		I	A	R	C			
DAF Infrastructure								
Operation of DAF and infrastructure.		C		I		A	R	C
Bore Field Infrastructure								
Operation in accordance with plan - Maintenance of civil and mechanical infrastructure.		C	I		I	A	R	
Monitoring of groundwater levels and abstraction volumes.		I				A	R	

Table 12 Water Management System Operational RACI - Mine

Table 13 Water Management System Operational RACI – Refinery

Area and Tasks	HSE Business Partner	Environment Superintendent	Closure Manager	Services Manager	Utilities Superintendent	RDA Superintendent	WWNP Superintendent
Refinery							
Environmental monitoring & reporting	A	R	I	I	C		C
Environmental inspection & Licence renewals.	A	R	I	I	C		C
Seawater Circuit and Containment Facilities							
Operation in accordance with plan - maintenance of civil and mechanical infrastructure.	I	C	I	A	R		C
Operation and maintenance of monitoring equipment.		C	I	A	R		C
Waste Water Neutralisation Plant							
Operation and maintenance of WWNP.	I	C	A	I	C	C	R
Tank Farms Bund and Releases							
Operation in accordance with operational plan. Water storage inventory. Identification of remedial works.	I	C		A	R		

Table 14 Water Management System Operational RACI – RDA/Marine

Area and Tasks	Business HSE Partner	Environment Superintendent	Closure Manager	Services Manager	Utilities Superintendent	RDA Superintendent	WWNP Superintendent
RDA							
Environmental monitoring & reporting	A	R	I	I	C	C	
Environmental inspection. Licence renewals.	A	R	I	I	I	C	
RDA Tailings and SNL Storage Ponds							
Operation in accordance with operational plan. Water storage inventory. Identification of remedial works.	I	C	A	I	C	R	C
Operation and maintenance of monitoring equipment.		C	A		C	R	
Seepage Recovery Infrastructure							
Operation in accordance with operational plan. Water storage inventory. Identification of remedial works.	I	C	A	I	C	R	
Operation and maintenance of monitoring equipment.	I	C	A		C	R	
Marine							
Environmental monitoring & reporting	A	R	I	I	I	I	I
Environmental inspection. Licence renewals.	A	R			I	I	I

RACI definition

Accountable	• The person ultimately answerable for the correct and thorough completion of the deliverable or task. They ensure the prerequisites of the task are met and delegates the work to those responsible. • The accountable person signs-off (approves) work that those responsible complete. There must be only one accountable person for each task or deliverable.
Responsible	• Those who do the work to complete the task. • There is at least one role with a participation type of responsible, although others can be delegated to assist in the work required.
Consulted	• Those whose opinions are sought (typically subject matter experts) and with whom there is two-way communication.
Informed	• Those who are kept up-to-date on progress, often only on completion of the task or deliverable; and with whom there is one-way communication.

5.2 Regulated Structures - Tailings Storage Facility

Engineering inspections of regulated structures including RDA ponds, dams, diversions, and levees occurs in accordance *Rio Tinto Standard D5, Management of tailings and water storage facilities*, as well as site and regulatory requirements. Regulated structures are operated in accordance with operational plans established for each specific structure. The inspection reports assess the condition of the structures and the effectiveness of the operational plan and where appropriate, provides recommendations for remedial works.

5.3 RDA Water Balance

Gove Operations uses a model to complete their annual water balance calculations to monitor compliance with the wet season storage allowance (WSA). The WSA sets the acceptable storage volume to be available at 1 December each year, in order to mitigate the risk of overtopping during the wet season. The water balance model determines the relationship between volumetric change needed for the historical dataset (over approximately 130 years), and then these numbers are statistically extrapolated to determine the design 1 in 200 wet season allowances. Wet season allowance considers the wet season rather than a single event. Typically, wet seasons are measured from November to March. All the historical rainfall for this period is analysed to estimate the magnitude of a 1 in 200-year average return interval wet season design standard.

5.4 Refinery Surface Water Structures

The surface water infrastructure assets including containment ponds, bunds, sumps, and pumps that are operated and maintained in accordance with the Operating Instruction Manual. This is to support the effective mitigation of the risks from uncontrolled releases or failure of the structures.

5.5 Seepage Interception Systems

Seepage interception systems are operational at the RDA. Seepage is collected in the sumps of the interception systems and volumes of seepage are recorded by operators, in addition to operational status of duty and standby pumps. Regular monitoring of the effectiveness of the seepage interceptions systems is undertaken and considers hydraulic capture and seepage quality to facilitate continuous improvement in seepage interception.

6 ADAPTIVE MANAGEMENT APPROACH

The NT EPA Guidance on Adaptive Management (2018) states that:

> *'adaptive management involves exploring alternative ways to meet management objectives, predicting the outcomes of alternatives based on the current state of knowledge, carefully selecting and implementing one or more of these alternatives in a timely way, monitoring to learn about the impacts of management actions, and then using the results to update knowledge and adjust management actions. Management procedures are changed in steps until monitoring shows that the desired outcome is obtained'.*

The principles of adaptive management, a systematic process for incrementally improving management practices by learning from the outcomes of past and current practices, can be applied to water management.

Monitoring data is reviewed periodically for trends, quality, and adequacy. Following the principles of adaptive management, data outliers will be assessed against water management objectives. If the principles of adaptive management are applied, it may reduce risk of the operation to water resources.

7 REPORTING

7.1 Incident Investigations

All incidents are managed according to Gove Operations incident and action management procedure (GPM-EHS-020). This document sets requirements for managing all HSE and community incidents at Gove Operations. The aim is to:

- Define the reporting criteria and process for investigating and communicating incidents.
- Assist with uniformity and consistency of the investigation and root cause analysis process.
- Assist with corrective and preventive actions are managed appropriately, including evaluation of effectiveness.

Gove Operations uses Rio Tinto Business Solution (RTBS) to report incidents, identified hazards, near misses, inspections, audits, emergency exercises, complaints, or requests from external parties. Incidents reported in the RTBS environment, health, and safety management application are accessible to site personnel and reminders are sent to relevant personnel and their supervisors until corrective actions have been completed and reported. Under Division 4 Section 29 of the *MM Act*, Gove Operations must report environmental incidents that cause environmental harm to the Chief Executive Officer of Department of Industry, Tourism and Trade (DITT), as soon as practicable after incident is known.

7.2 Annual Reporting

To comply with the conditions of the MMP and WDL, the following reports are prepared:

- WDL Annual Water Monitoring Report submitted annually to DEPWS reporting the performance of managing surface water and marine health monitoring under WDL. The annual reporting period is from 1 April to 31 March.
- Annual Water Monitoring Report submitted annually to DITT reporting the performance of managing surface water (including wastewater discharge across the refinery and RDA), groundwater quality and marine health monitoring. The annual reporting period is from 1 April to 31 March.
- Annual Return is the annual audit compliance report submitted to DEPWS reporting on compliance against WDL.
- Environmental Mining Report submitted annually to DITT to report performance against the MMP for each calendar year.
- Bore field Health Assessment is completed every five years on the performance of the Bore field and reported to NT Water Controller.
- Rio Tinto Social and Environmental (S&E) Surveys are completed on an annual basis. The S&E Survey assesses the performance of the Business Unit in terms of social performances, resource use, air emissions, land clearance and rehabilitation, biodiversity management and waste production. Rio Tinto uses information from the S&E Surveys in the development of the annual sustainability report.