Project Order, Variations and Research Progress

Project Title: Groundwater baseline study of the Canning Basin

This document contains three sections. Click on the relevant section for more information.

1 Original Project Order

Project Order

Proforma 2020

1. Short Project Title

Groundwater baseline study of the Canning Basin

Long Project Title	Groundwater baseline study of the Canning Basin
GISERA Project Number	W.21
Proposed Start Date	15/07/2020
Proposed End Date	28/02/2021
Project Leader	Olga Barron

2. GISERA Region

- ☐ Queensland
- ☐ New South Wales
- ☐ Northern Territory
- ☐ South Australia
- ☒ **Western Australia**
- ☐ Victoria

3. GISERA Research Program

- ☒ **Water Research**
- ☐ GHG Research
- ☐ Social & Economic Research
- ☐ Biodiversity Research
- ☐ Agricultural Land Management Research
- ☐ Health Research

4. Project Summary

Objective

This project will explore and summarise the current state of knowledge related to groundwater systems in the Canning Basin to identify requirements for future groundwater systems investigations, characterisation and monitoring. While numerous groundwater studies have previously occurred in parts of the Canning Basin generating knowledge about the groundwater resource potential of different aquifers, their geographic locations are highly dispersed, and their findings remain segregated. It is timely to conduct an inventory of these studies and their findings to understand the current status of groundwater knowledge for the entire basin before any further development and anthropogenic influences occur.

Description

Background

The Canning Basin, in northwest Western Australia, is a large Phanerozoic intracratonic basin with an onshore area of over 400000 km^2 (Figure 1). The northern part of the basin is dominated by the Fitzroy Trough, a major fault-bounded graben containing more than 18 km of sediment deposited during several cycles of marine transgression and regression which occurred between the Early Ordovician and Cretaceous. Southern areas consist mainly of the Kidson and Willara Subbasins, in which the sedimentary sequence is thinner (up to 5 km).

The Canning Basin is not only the largest sedimentary basin in Australia, aside from the Eromanga Basin (sub-division of the Great Artesian Basin), it also contains by far the largest potential opportunity for developing groundwater resources for use by shale gas and other industries (Figure 1). However, given the extremely large scale of the basin, development of such groundwater resources is uneconomic due to vast distances from the groundwater resources to infrastructure and population centres where water is required. Furthermore, exploration and investigations across large parts of the basin have to date primarily focussed on the geology and its prospectivity for oil and gas as opposed to groundwater investigation and quantification.

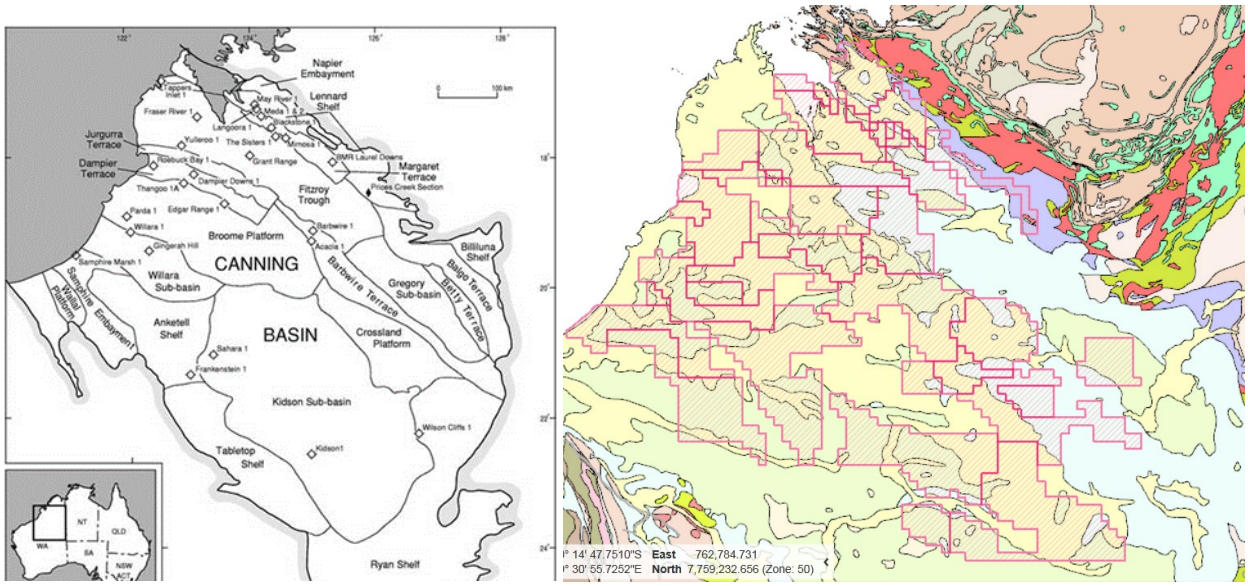

Figure 1 Canning basin elements (from Geoscience Australia) and a map of lease blocks in the Canning Basin WA DMP (2014). Petroleum titles from GSWA online map, overlain on bedrock geology.

The regional geology and structure of the basin has been extensively reviewed and summarised in numerous publications by the Western Australia government Department of Mines and Petroleum (Dent, 2016; Parra-Garcia et al., 2014; Playford et al., 2009; Mory 2010). In addition, further improving the current understanding of the basin's groundwater resources is important given the basin encompasses one of the driest parts of the Australian continent and is subject to climate extremes.

Investigation of groundwater resources in the West Canning Basin began in the late 1970s where an estimated 50 GL/yr yield of groundwater was discovered in the western region (Leech, 1979). In the early 1990s, Smith (1992) collated and reviewed hydrogeological information for the north-eastern part of the Canning Basin (Fitzroy Trough) where he estimated both storage and recharge for key aquifers. Storage estimates for the Broome Sandstone, Wallal Sandstone and Poole Sandstone were found to be significant, 60,000, 200,000 and 400,000 gigalitres respectively each. Estimates for annual recharge were also found to be significant for both the Broome Sandstone and Wallal Sandstone, 80 and 35 GL/yr respectively. Information for the Wallal Sandstone was also collated by Haig (2008) and found the aquifer to have a large storage and superior water quality (acceptable for domestic purposes) compared with the overlying aquifers of the region. Furthermore, groundwater storage in this aquifer was found to be larger than any other known aquifer within the Pilbara and West Kimberly Regions of WA. In the mid-2000s, Lindsay and Commander (2005) undertook a hydrogeological assessment of the Fitzroy Alluvium along the Fitzroy River. The assessment estimated that the alluvium had the potential to support groundwater development in the order of 200 GL/yr.

More recently, aquifers in the coastal part of the Broome Platform particularly the Broome Sandstone aquifer in LaGrange has received significant attention due to the steady increase of irrigated agriculture in the region. Currently 50 GL/yr of groundwater is allocated for use in irrigation from the Broome Sandstone aquifer that coincides with an area encompassing about 36,000 km^2. The water allocation plan for the LaGrange area has been underpinned by airborne geophysics, extensive field investigations, desktop analyses and modelling to conceptualise the groundwater flow systems and quantify the water balance and evaluate the available groundwater for use (Annetts et al., 2017; Harrington, 2015; Harrington and Harrington, 2016; Paul et al., 2013; Paul et al., 2019).

The most recent work on groundwater in the Canning Basin comes from a comprehensive field, desktop and modelling study by Taylor et al., 2018a, 2018b and Dawes et al., 2018 as part of the Northern Australia Water Resource Assessment project. The study identified the interconnected Grant Group and Poole Sandstone as the most prospective aquifers in the Fitzroy Trough and estimated it was possible to develop up to 120 GL/yr of groundwater in the long term (Taylor, 2018a). In addition, the Devonian Reef Complex, Erskine and Wallal Sandstones were also identified as having good potential for future groundwater development, but that detailed field investigations and modelling would be needed to better evaluate the opportunities and risks (Taylor, 2018b).

Project outline

This project will develop a framework defining the scope of and data requirement for "groundwater baseline characterisation", including hydrogeological setting, groundwater balance, flow and interaction between aquifers, groundwater quality, environmental function and current use.

The framework will guide data collection and knowledge gap analysis. It is likely that the following type of data will be considered:

- Geological and geophyscial data, including local and national products.
- Groundwater infrastructure and associated data (i.e. water levels, water quality, recharge and aquifer storage estimates, bore yield, chemistry and isotopes, lithology and stratigraphy, aquifer attribution) as well as pervious groundwater systems conceptual and numerical models.
- Surface water features (i.e. perennial and ephemeral watercourses, wetlands, lakes, springs and waterholes), some of which can be associated with groundwater dependent assets (as below).
- Groundwater dependent assets (i.e. surface water features, vegetation and the marine environment).
- Current water uses as well as ecological and cultural values with an emphasis on the social aspects and those which are culturally significant for Aboriginal and Torres Strait Islander people in the Canning

Basin, which are closely linked to the groundwater dependant ecosystems and water dependant asset (as above).

Within the framework, the project team will source, systematically review and evaluate data, currently available to directly or indirectly characterise groundwater systems in the Basin. It is anticipated that the data are available from various sources, at various scales and uncertain quality and will require quality control and further data integration.

Need & Scope

Groundwater resources across the Canning Basin are a critical requirement for local communities, culturally significant for Aboriginal and Torres Strait Islander people in the Canning Basin and industries, existing or planned (including the agriculture and energy sectors) to explore for and in the future develop oil and gas resources within their permit areas. The abstraction of these groundwater resources throughout the lifetime of the exploration and resources development phases for onshore gas will cause various spatial and temporal hydrological changes. Given that petroleum titles occur within the Canning-Kimberley proclaimed groundwater area, licenses to take water from aquifers at any given location will be required by energy operators. The sustainable development of water resources associated with unconventional oil and gas development was one of the largest concerns raised by various stakeholders to the recent Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation (ISP, 2018). Therefore, any groundwater resource development will be heavily scrutinised and will require robust hydrogeological assessments and information. The key metric assessed as part of the application process is the risk that cumulative abstraction of groundwater over time may impact existing and future users, cultural values of Aboriginal and Torres Strait Islander people in the Canning Basin, the water dependent environment and the water balance of the resource. Prior to evaluating these impacts, a sound understanding of the hydrogeological framework including structural features, the nature of key groundwater flow processes, initial water balances and the occurrence and location of Groundwater Dependent Ecosystems (GDEs), existing groundwater users (all forming the baseline conditions) and culturally significant groundwater dependent assets for Aboriginal and Torres Strait Islander people is required.

Methodology

The project will be undertaken in three stage:

Stage 1: Development of the framework for groundwater baseline characterisation

Stage 2: Data collection and integration

Stage 3: Reporting

Task 1 Framework for groundwater baseline characterisation

During the initial stage of the project, the framework for the groundwater baseline characterisation will be developed, based on the regulators' requirements and best practice established elsewhere (including previously undertaken assessments with CSIRO, such as Northern Australia Water Resources Assessment, including in WA, Bioregional Assessment and Geological and Bioregional Assessment programs in parts of eastern Australia). The framework will define the data requirement for the effective baseline characterisation and assist in data collection process as well as data gap analysis.

Task 2 Data collection and integration

The project will undertake a literature, data review and desktop assessment of existing geological and hydrogeological data and evaluate their value in terms of groundwater resource characterisation.

During the project the project team will explore the data availability, engaging with various data custodians, which include (among others):

- Geological Survey of Western Australia (GSWA), which set up a project focusing on the Canning Basin.
- Geoscience Australia (GA), which maintain national geological/geophysical and hydrogeological database. The Basin also covered by the GA recent exploration program for the Northern Australia.
- Department of Mines, Industry Regulation and Safety (DMIRS), the main regulator for the mining and energy development in the region, also maintaining WA specific information on the various aspects of the WA resource sector.
- Department of Water and Environmental Regulation (DWER), the main water and environmental regulator, who led investigation in groundwater resources in the west and north of the Basin.
- Department of Prime Industries and Regional Development (DPIRD), the main regulator for regional development, including agriculture, who led much work on the water resource assessment for the agriculture in the west and north of the Basin.
- Western Australian Environmental Protection Authority (EPA) who consider environmental impact assessment (EIA) for energy and water development projects in the Canning Basin.
- CSIRO through the Northern Australian Water Resource Assessment project (NAWRA).
- Other CSIRO research particularly from CSIRO Energy, supporting gas sector development, including in the Canning Basin.
- Gas, petroleum and minerals industries, which may have acquired some local data and the project team will explore if an access for such data may be granted.

The existing data will be compiled and where possible, analysed and integrated.

Tasks 3: Reporting

The project will produce a report as well as database, gathered during the project life. The report will summarise the main findings, critical gaps in current knowledge and provide initial recommendations for future work. This research will also determine what further baseline work is required to build a more comprehensive set of baseline measurements in this region where for example, confidential reports and data cannot be initially obtained during the life of this project.

Thus, this project may advise on:

1. Additional geological, geophyscial and groundwater investigations including installation of infrastructure required for
    a. groundwater systems characterisation;
    b. future groundwater level and quality monitoring;
    c. both including for the location of significant groundwater dependent assets (GDEs, cultural significance, current groundwater users).

2. Future groundwater field program for
    a. groundwater sampling for hydrogeochemistry and environmental tracers;
    b. quantitative characterisation of groundwater flow processes including recharge, throughflow, discharge, inter-aquifer connectivity and groundwater–surface water connectivity (crucial for groundwater system conceptualisation).

3. Modelling of the water balance and potential cumulative impact rick assessment in areas where data is sufficient to support these recommendations.

4. The future research directions, which will quantify any cultural importance of groundwater resources.

5. Project Inputs

Research

The project will explore availability of data, required for baseline condition characterisation, and where possible data integration. The project activities aiming to meet the project objectives, include

1. Baseline review and validation of all available data to summarise current level of geological and hydrogeological knowledge. This includes tabulating data but also producing multiple two dimensional geological and hydrogeological cross sections and spatial maps of key hydrogeological data (surface water features, soil types, ground surface elevation, groundwater quality and chemistry, groundwater level, bore yields, hydraulic properties where possible). Geophysics will also be incorporated to provide another line of spatial evidence for the layering and geometry of geological units. Data sources are likely to include:
    a. DMIRS publicly available data via various online platforms such as GeoVIEW, including data from Western Australian Mineral Exploration reports (WAMEX), Western Australian Petroleum and Geothermal Information Management System (WAPIMS) and the Geological Survey of Western Australia (GSWA) geology and structure data sets and reports specific to the Canning Basin.
    b. DWERs publicly available groundwater data including bore locations, stratigraphy, groundwater level, bore yield, chemistry and water quality) via the online Water Information Reporting (WIR) data portal and spatial data download tool.
    c. Geophysical survey data available through Geoscience Australia (GA) and company or consultancy reports such as regional magnetics, airborne electromagnetic (AEM) and seismic.
    d. Additional relevant data published in hydrogeological assessment reports produced by consulting firms.
    e. Availability of additional hydrogeological and geophysical data and reports from industry operators will be explored.
2. Producing estimates of gross recharge rates using the Australian Water Resources Assessment Landscape model (AWRA-L) to derive recharge fluxes for the important hydrogeological units hosting. This starting point for deriving initial components of the water balance will be important for understanding the scale of volumetric fluxes into and out of key aquifers. Data sources are likely to include:

a. Deep drainage estimates across the study area from the Bureau of Meteorology AWRA-L model.
b. Baseline gross recharge estimates across the study area from the one-dimensional WAVES soil-vegetation-atmosphere transfer model.
c. Spatial mapping of ground surface elevations, soil types and depth of regolith cover, e.g. the 1 second Shuttle Radar Topography Mission (SRTM) Digital Elevation Model available from Geoscience Australia (GA); the Soil and Landscape Grid of Australia (SLGA) available through the Terrestrial Ecosystem Research Network (TERN), etc

3. Spatial mapping defining 'potential' GDEs, which may be sourced from GA or BoM.
4. Other groundwater dependent assets culturally significant for Aboriginal and Torres Strait Islander people in the Canning Basin
5. Identifying and summarising key hydrogeological data and knowledge gaps.
6. Providing recommendations to guide planning for future groundwater resource investigations.

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Olga Barron	20 days	Groundwater	>30 year	CSIRO Land and Water
Andrew Taylor	20 days	Groundwater	10 Year	CSIRO Land and Water
Tania Ibrahimi	15 days	GIS Analyst	10 year	CSIRO Mineral Resources
Shane Mule	10 Days	Geophysicist	10 year	CSIRO Mineral Resources

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Nil				

GISERA
Gas Industry Social and Environmental Research Alliance

Budget Summary

Source of Cash Contributions	2020/21	2021/22	2022/23	% of Contribution	Total
GISERA	$71,756	$0	$0	75%	$71,756
- Federal Government	$71,756	$0	$0	75%	$71,756
Total Cash Contributions	$71,756	$0	$0		$71,756
Source of In-Kind Contribution	**2020/21**	**2021/22**	**2022/23**	**% of Contribution**	**Total**
CSIRO	$23,919	$0	$0	25%	$23,919
Total In-Kind Contribution	**$23,919**	**$0**	**$0**	**25%**	**$23,919**

7. Project Impact Pathway

Activities	Outputs	Short term Outcomes	Long term outcomes	Impact
Framework development	The framework for the groundwater baseline characterisation	The framework will define the data requirement for the effective baseline characterisation and assist in data collection process as well as data gap analysis.	The project will improve Industry's knowledge and provide unconventional gas guidance on groundwater data requirement and data availability for the Basin	Environmental Impact - *Potential to guide the future planning, investment and management of water resources and infrastructure to aid in the maintenance of current water security for existing users and the environment.* Economic Impact - *will guide and underpin future planning and investment by both the regulator and industry in water infrastructure and monitoring.*
Data collation	Database of information suitable for the groundwater characterisation in the Basin	Database provides a knowledge base to guide future planning and investment in water infrastructure by both the water regulator and proponents in industry		
Reporting	The report	Summary of the main finding, critical gaps in current knowledge and provide initial recommendations for future work	The project will inform Governments, regulators & policy-makers on issues regarding limitation and opportunities for groundwater resources development, informing policy & legislative framework for the gas industry	

8. Project Plan

Project Schedule

ID	Activities / Task Title (should match activities in impact pathway section)	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Framework development	Olga Barron	15/07/2020	01/09/2020	None
Task 2	Data collation	Andrew Taylor	15/07/2020	23/12/2020	None
Task 3	Reporting	Olga Barron	04/01/2021	25/02/2021	Task 1 and 2

Task description

Task 1

TASK NAME: Framework development

TASK LEADER: Olga Barron

OVERALL TIMEFRAME: 15 July to 1 September 2020 (1.5 months)

BACKGROUND: The aim of the project is to explore and summarise the current state of knowledge related to groundwater systems in the Canning Basin and to identify needs for future groundwater systems investigations, characterisation and monitoring.

TASK OBJECTIVES: Develop a framework to guide data collation

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The framework for the groundwater baseline characterisation will be developed, based on the regulators' requirements and best practice. The framework will define the data requirement for the effective baseline characterisation and assist in data collection process as well as data gap analysis.

Task 2

TASK NAME: Data collation

TASK LEADER: Andrew Taylor

OVERALL TIMEFRAME: 15 July to 23 December 2020 (5.5 months)

BACKGROUND: Within the framework, the project team will source, systematically review and evaluate data, currently available to directly or indirectly characterise groundwater systems in the Basin. It is anticipated that the data are available from various sources, at various scales and uncertain quality and will require quality control and further data integration.

TASK OBJECTIVES: Collate available data suitable for the groundwater characterisation in the Basin

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Review and collation of the available data, suitable for groundwater resource characterisation.

Task 3

TASK NAME: Reporting

TASK LEADER: Olga Barron

OVERALL TIMEFRAME: 1 January to 25 February 2021 (2 months)

BACKGROUND: The project will produce a report as well as data, gathered during the project life

TASK OBJECTIVES: Summarise the data availability and gaps

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The report will summarise the main finding, critical gaps in current knowledge and provide initial recommendations for future work.

Project Gantt Chart

			2020-2021							
Task	**Task Description**	**Task Leader**	**15-Jul-20**	**Aug-20**	**Sept-20**	**Oct-20**	**Nov-20**	**Dec-20**	**Jan-21**	**28-Feb-21**
1	Framework development	Olga Barron								
2	Data collation	Andrew Taylor								
3	Reporting	Olga Barron								

9. Technical Reference Group

The project will establish a Technical Reference Group (TRG) aimed at seeking peer-to-peer technical advice on contextual matters and to discuss research needs as well as outputs as the project progresses. The TRG will most likely be composed of representatives from:

- Geological Survey of Western Australia (GSWA)
- Geoscience Australia (GA)
- Department of Mines, Industry Regulation and Safety (DMIRS)
- Department of Water and Environmental Regulation (DWER)
- Department of Prime Industries and Regional Development (DPIRD)
- Gas, petroleum and minerals industries
- Kimberly Land Council
- Western Australian Farmers Federation

10. Communications Plan

Stakeholder	**Objective**	**Channel** (e.g. meetings/media/factsheets)	**Timeframe** (Before, during at completion)
Regional Community/Wider public, government and industry	To communicate project objectives and key messages from research	Fact sheets (including development of one at commencement of project which will explain in plain English the objective of the project and another at project completion). Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities.	At project commencement and at project completion. Periodically
Regional Community/ Wider public, Government, Scientific community and Industry	To report on key findings	Final Report	At completion

11. Budget Summary

Expenditure	2020/21	2021/22	2022/23	Total
Labour	$95,175	$0	$0	$95,175
Operating	$500	$0	$0	$500
Subcontractors	$0	$0	$0	$0
Total Expenditure	**$95,675**	**$0**	**$0**	**$95,675**

Expenditure per Task	2020/21	2021/22	2022/23	Total
Task 1	$16,006	$0	$0	$16,006
Task 2	$53,729	$0	$0	$53,729
Task 3	$25,940	$0	$0	$25,940
Total Expenditure	**$95,675**	**$0**	**$0**	**$95,675**

Source of Cash Contributions	2019/20	2020/21	2021/22	Total
Federal Government (75%)	$71,756	$0	$0	$71,756
Total Cash Contributions	**$71,756**	**$0**	**$0**	**$71,756**

In-Kind Contributions	2019/20	2020/21	2021/22	Total
CSIRO (25%)	$23,919	$0	$0	$23,919
Total In-Kind Contributions	**$23,919**	**$0**	**$0**	**$23,919**

	Total funding over all years	Percentage of Total Budget
Federal Government Investment	$71,756	75%
CSIRO Investment	$23,919	25%
Total Other Investment		
TOTAL	**$95,675**	**100%**

Task	Milestone Number	Milestone Description	Funded by	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year Completed	Payment $ (excluding CSIRO contribution)
Task 1	1	Framework development	GISERA	Jul-20	Sep-20	2020/21	$12,005
Task 2	2	Data collation	GISERA	Jul-20	Dec20	2020/21	$40,297
Task 3	3	Reporting	GISERA	Jan-21	Feb-21	2020/21	$19,455

12. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
	N/A	N/A	N/A	$
				$
Ownership of Non-Derivative IP (clause 12.3)	Not Applicable			
Confidentiality of Project Results (clause 15.6)	Project Results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Not Applicable			
Distribution of Commercialisation Income (clause 13.4)	Not Applicable			
Commercialisation Interest (clause 1.1)	**Party**		**Commercialisation Interest**	
	CSIRO		N/A	
	Other		N/A	

13. References

Annetts, D, Munday, T, George, R, Wright, N, Raper, GP & Cahill, K 2017, The application of AEM to mapping the aquifer and groundwater characteristics of the La Grange groundwater area, WA: final report, report EP165299, CSIRO, Perth

Bahar, M. and Triche, N.E., 2013. Shale Gas Volumetrics of Unconventional Resource Plays in the Canning Basin, Western Australia, SPE Unconventional Resources Conference and Exhibition-Asia Pacific. Society of Petroleum Engineers.

Dawes WR, Taylor AR, Harrington GA and Davies PJ (2018) Groundwater flow modelling of the Grant Group and Poole Sandstone aquifer – Fitzroy Trough, Western Australia. A technical report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments. CSIRO, Australia. https://doi.org/10.25919/5b86ed8ebc095

Dent, LM 2016, Characterization and correlation of lower Permian strata, Canning Basin, Western Australia, and implications for CO2 sequestration: Geological Survey of Western Australia, Report 149, 104p.

Haig, T., 2008. The Pilbara Coast Water Study, Department of Water, Hydrogeological Series, Report HR 267, 184 pp.

Harrington, G.A., and Harrington, N.M. (2016). A hydrochemical assessment of groundwater recharge and flow in the Broome Sandstone Aquifer, La Grange Area, Western Australia. A report prepared for Department of Agriculture and Food, Western Australia by Innovative Groundwater Solutions

Harrington, GA 2015, Preliminary isotope assessment, La Grange Groundwater Area, report to Department of Agriculture and Food, Western Australia, Innovative Groundwater Solutions Pty Ltd, Middleton

Leech, R.E.J., 1979. Geology and groundwater resources of the Southwestern Canning Basin, Western Australia. Geological Survey of Western Australia. Record 1979/9. Perth 1979. ISBN No. 072448034X.

Lindsay R.P. and Commander, D.P., 2005, Hydrogeological assessment of the Fitzroy alluvium, Western Australia, Department of Water, Hydrogeological Record Series HG 16.

Mory, AJ 2010, A review of mid-Carboniferous to Triassic stratigraphy, Canning Basin, Western Australia: Geological Survey of Western Australia, Report 107, 130p.

Parra-Garcia, M, Sanchez, G, Dentith, MC and George, AD. 2014, Regional structural and stratigraphic study of the Canning Basin, Western Australia: Geological Survey of Western Australia, Report 140, 215p.

Paul, RJ, George, RJ & Gardiner, PS 2013, 'A review of the Broome Sandstone aquifer in the La Grange area', Resource management technical report 387, Department of Agriculture and Food, Western Australia, Perth

Paul, RJ, Raper, GP, George, RJ, Wright, NJ, Lillicrap, AM & Gardiner, PS 2019, 'Groundwater investigations to support irrigated agriculture at La Grange, Western Australia: 2013–18 results', Resource management technical report 398, Department of Primary Industries and Regional Development, Perth

Playford, P E, Hocking, R M and Cockbain, A E 2009, Devonian reef complexes of the Canning Basin, Western Australia: Geological Survey of Western Australia, Bulletin 145, 444pTaylor AR, Harrington GA, Clohessy S, Dawes WR, Crosbie RS. Doble RC, Wohling DL, Batlle-Aguilar J, Davies PJ, Thomas M and Suckow A (2018) Hydrogeological assessment of the Grant Group and Poole Sandstone – Fitzroy catchment, Western Australia. A technical report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments. CSIRO, Australia. https://doi.org/10.25919/5b86ed7e26b48

Taylor A, Barry K, Dawes W, Davies P, Gonzalez D, Harrington G, Hughes J, Page D, Petheram C, Vanderzalm J and Yang A (2018) Chapter 5: Opportunities for water resource development in the Fitzroy catchment. In: Petheram C, Bruce C, Chilcott C and Watson I (eds) (2018) Water resource assessment for the Fitzroy catchment. A report to the Australian Government from the CSIRO Northern Australia Water Resource Assessment, part of the National Water Infrastructure Development Fund: Water Resource Assessments. CSIRO, Australia. https://doi.org/10.25919/5b86edd13ce23

2 Variations to Project Order

Changes to research Project Orders are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

The table below details variations to research Project Order.

Register of changes to Research Project Order

Date	Issue	Action	Authorisation
16 November 2020	There were delays in establishing the TRG and greater consultation being undertaken than anticipated, this impacted the delivery of milestones 2 & 3.	Milestone 2 & 3 extended by two months	

3 Progress against project milestones

Progress against milestones are approved by the GISERA Director, acting with authority provided by the GISERA National Research Management Committee, in accordance with the National GISERA Alliance Agreement.

Progress against project milestones/tasks is indicated by two methods: Traffic Light Reports and descriptive Project Schedule Reports.

1. Traffic light reports in the Project Schedule Table below show progress using a simple colour code:
   - **Green**:
     - Milestone fully met according to schedule.
     - Project is expected to continue to deliver according to plan.
     - Milestone payment is approved.
   - **Amber**:
     - Milestone largely met according to schedule.
     - Project has experienced delays or difficulties that will be overcome by next milestone, enabling project to return to delivery according to plan by next milestone.
     - Milestone payment approved for one amber light.
     - Milestone payment withheld for second of two successive amber lights; project review initiated and undertaken by GISERA Director.
   - **Red**:
     - Milestone not met according to schedule.
     - Problems in meeting milestone are likely to impact subsequent project delivery, such that revisions to project timing, scope or budget must be considered.
     - Milestone payment is withheld.
     - Project review initiated and undertaken by GISERA Regional Research Advisory Committee.
2. Progress Schedule Reports outline task objectives and outputs and describe, in the 'progress report' section, the means and extent to which progress towards tasks has been made.

Project Schedule Table

ID	Activities / Task Title (should match activities in impact pathway section)	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Framework development	Olga Barron	15/07/2020	01/09/2020	None
Task 2	Data collation	Andrew Taylor	15/07/2020	26/02/2021	None
Task 3	Reporting	Olga Barron	04/01/2021	23/04/2021	Task 1 and 2

Project Schedule Report

Task description

TASK 1

TASK NAME: Framework development

TASK LEADER: Olga Barron

OVERALL TIMEFRAME: 15 July to 1 September 2020 (1.5 months)

BACKGROUND: The aim of the project is to explore and summarise the current state of knowledge related to groundwater systems in the Canning Basin and to identify needs for future groundwater systems investigations, characterisation and monitoring.

TASK OBJECTIVES: Develop a framework to guide data collation

TASK OUTPUTS AND SPECIFIC DELIVERABLES: The framework for the groundwater baseline characterisation will be developed, based on the regulators' requirements and best practice. The framework will define the data requirement for the effective baseline characterisation and assist in data collection process as well as data gap analysis.

PROGRESS REPORT:

This milestone is complete.

The Technical Reference Group (TRG) has been established and representatives include:

- **Andrew Heap -** Chief of Minerals, Energy & Groundwater Division, Geoscience Australia
- **Sandie McHugh (Josephine Searle) -** Acting Director, Science and Planning, Department of Water and Environmental Regulation (DWER) (also represents WA EPA)
- **Richard George** - Senior Principal Research Scientist, Water Science, Department of Primary Industries and Regional Development
- **Arthur Mory** - Senior Geologist, Geological Survey and Resource Strategy Division, Department of Mines, Industry Regulation and Safety
- **Richard Chopping** -Manager Geoscience Mapping Through Cover, Department of Mines, Industry Regulation and Safety
- **Lana Volkova** -Environmental Manager, Theia Energy
- Members of the CSIRO project team

The project team developed the framework for the groundwater baseline characterisation and introduced it to the TRG at their first meeting which was held on 23 September 2020. The framework aims to define the data requirements for the effective baseline characterisation and assist in the data collection process as well as data gap analysis. The TRG members generally agreed with the proposed approach, summarised as a framework, and commented on the data availability and their respective organisations interests in this project. The TRG did express some concerns about the very short timelines for the project as well as the ability of the project and staff members to undertake the significant tasks of stakeholder engagement as well as collate, review and summarise key datasets for a basin of 400,000 km^2 in six months. This followed with additional comments that perhaps the project

should focus on key areas in the basin where competition for water resources associated with regional development (energy, minerals and irrigated agriculture) will be greatest. The project team is currently following up with the individual TRG members (instead of initially proposed a second TRG meeting), further exploring potential contribution from the relevant organisations to data collation and groundwater baseline characterisation across the Canning Basin as well as better capturing their key interests. The project team is currently summarising the outcomes of these individual meetings and closely monitoring both the time spent on the project and the progress towards delivering future milestones. Given this milestone is one month overdue it is likely that both the data collation and reporting timelines will need to be adjusted to better account for: (i) the longer than expected time required to form the TRG, (ii) the significant stakeholder engagement process, and (iii) appropriate Christmas/New Year leave arrangements for project staff.

A summary of the framework is provided below:

	Baseline characterisation should address the following objectives	**Data requirement to achieve stated objectives (and likely data custodian)**	**Important considerations**
Hydrogeological systems	• Geological framework of the basin including the extent and type of geological units • Hydrogeological characteristics including aquifer properties, degree of confinement and hydrological interconnectivity • Characteristics of the superficial cover in the basin via which the basins aquifers receive recharge (i.e. thickness, porosity and hydraulic conductivity)	• Known aquifer maps: top and bottom (DPIRD, DWER, GA?) • Geological formation, likely to be aquifers: top and bottom (GSWA) • Major tectonic features (GSWA) • Geophysical data (GeoView, GA EftF, other National Data) • Petroleum exploration data, including porosity/permeability data (WA DMP, industry) • Water bore data (DWER, DPIRD, others) • Depth to regolith (sources?) • Palleovalley map (GA)	• *Depth of aquifers and hydraulic head* • *Reporting Basin's elements* • *Usefulness of GSWA geological model* • *Sources of porosity/permeability data for the less known aquifers (WA DMP, industry)*

	Baseline characterisation should address the following objectives	Data requirement to achieve stated objectives (and likely data custodian)	Important considerations
Groundwater Processes	• Baseline is representative of the climatic cycles of the area and of the geological and geomorphological variation across the region • An inventory of associated surface systems, including terrestrial ecosystems and bodies of surface water, with which the groundwater body is dynamically linked • Estimates of the directions and rates of exchanges of water between the aquifers and associated surface systems • Estimate the long term annual average rate of overall recharge (where possible, recharge zones)	• Climate data (BoM) • Surface water features (streamlines, lakes) (BoM) • Surface water monitoring data (DWER, industry) • Runoff data (AWLA, BoM) • GW discharge zone associated with GDEs locations (GDE Atlas, WA DBCA, DPIRD, DWER, GISERA projects) • Groundwater motoring data (DWER, DPIRD, industry, others) • Environmental tracers and chemistry data and interpretation (DWER, CSIRO, DPIRD, industry) • National recharge assessment data (CSIRO)	• *Spatial distribution of existing monitoring infrastructure* • *Spatial and temporal data sufficiency to address historical variability* • *Unknown water balance components*
Groundwater Quality	• Chemical composition of the groundwater, including specification of the contributions from human activity • Key water quality indicators, specific for regional development (irrigation, gas, mining, tourism, town water supply)	• Surface water quality (WA DBCA, DPIRD, DWER, industry, others) • Groundwater quality (DWER, DPIRD, CSIRO, industry, others)	• The most important water quality parameters for individual stakeholders

	Baseline characterisation should address the following objectives	Data requirement to achieve stated objectives (and likely data custodian)	Important considerations
Groundwater dependencies	• Determine locations of ecologically important perennial and temporary waterbodies and dry season aquatic refugia • Characterise the wet season surface water flow regime • Characterise the dependency or degree of influence on ecosystems by groundwater, and their likely sensitivity to new water extraction • Characterise inter-annual and seasonal water quality variability, with particular focus on dry season aquatic refugia. • Determine locations of culturally important assets or groundwater services • Characterise the dependency or degree of influence of groundwater availability on local economy and their likely sensitivity to new water extraction	• National and state important environmental assets • GDEs Atlas (BoM) • Other sources for GDEs locations (WA DBCA, DPIRD, DWER, WABSI, GISERA projects) • Surface/groundwater monitoring data in the proximity of the GDEs (WA DPIRD, DWER) • Culturally significant assets (WA DBCA, DPIRD, DWER, KLC) • Current groundwater use (WA DPIRD, DWER) • Characterisation of groundwater dependencies (WA DBCA, DPIRD, DWER, WABSI)	• Data source for culturally significant dependencies • Groundwater dependency measurements, as defined by stakeholders

TASK 2

TASK NAME: Data collation

TASK LEADER: Andrew Taylor

OVERALL TIMEFRAME: 15 July 2020 - 26 February 2021

BACKGROUND: Within the framework, the project team will source, systematically review and evaluate data, currently available to directly or indirectly characterise groundwater systems in the Basin. It is anticipated that the data are available from various sources, at various scales and uncertain quality and will require quality control and further data integration.

TASK OBJECTIVES: Collate available data suitable for the groundwater characterisation in the Basin

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Review and collation of the available data, suitable for groundwater resource characterisation.

PROGRESS REPORT: This milestone is 100% complete.

Between October 2020 and February 2021, the project team has extensively engaged with the following key stakeholders to collate the data required to assess the groundwater baseline for the Canning Basin:

- Department of Water and Environmental Regulation (DWER)
- Geological Survey and Resource Strategy Division, Department of Mines, Industry Regulation and Safety (DMIRS)
- Theia Energy
- Buru Energy
- Department of Primary Industries and Regional Development (DPIRD)
- Geoscience Australia (GA)
- Energy business unit, Commonwealth Scientific and Industrial Research Organisation (CSIRO)
- Innovative Groundwater Solutions (IGS)

This engagement has resulted in the acquisition of 7.5 GB of spatial data and 2.0 GB of scientific literature which includes interpretation of some of the datasets. This data and literature is currently being systematically reviewed and evaluated in regard to its quality and therefore benefit for characterising and understanding groundwater systems across the basin.