Identifying a Demonstration Site to Desalinate Brackish Groundwater for Agricultural Use

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Citation

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Photo

Google Earth 2023, *Loxton Research Centre*, viewed 27 October 2023

Acknowledgements

We acknowledge and pay respect to the Traditional Owners of the Murray-Darling Basin and their Nations. We pay respect to the Traditional Owners of the lands and the waters upon and around which our organisations are situated. We acknowledge their deep cultural, social, spiritual, environmental and economic connection to their lands and waters. We pay respect to their Elders – past, present and future.

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Executive Summary

The One Basin CRC is seeking to establish a demonstration site to evaluate opportunities and risks associated with identifying, sourcing and desalinating brackish groundwater for sustainable agricultural use. Farmers across the globe use desalinated water for agriculture, however only at a capacity of less than 2% (1,690 GL day) of water desalinated globally. This is surprisingly small considering approximately 70% of the earth's freshwater extraction is used for irrigation [1]. Whereas most desalination is large-scale sea-water desalination for municipal usage, this project is exploring the use-case of brackish groundwater (EC 1,500 – 7,000 µS/cm or TDS 1,000 – 11,000 mg/L) for inland regions. It is estimated the sum of the sustainable groundwater yield in NSW, SA, QLD and VIC for brackish (TDS 1,500 – 14,000 mg/L) groundwater is approximately 2,587 GL/year [2]. Whilst this is an overestimate of the sustainable groundwater yield across the Murray Darling Basin (MDB), it still highlights groundwater in the MDB is a significant, underutilised potential for Australian farmers.

Desalinated brackish groundwater represents an excellent opportunity for Australian horticulture due to the highly competitive domestic and international water market [1] that exists within the MDB. Motivations for the uptake of desalinated water in agricultural contexts can include to build resilience to cope with future changes in climatic and economic conditions (droughts, water market fluctuations), to expand production, or to tailor water quality parameters to a specific agricultural need. Aquifer reinjection and a low recovery case can be combined to achieve a desalination and disposal cost of less than AU$1/kL [2, 3].This is below the threshold that has been identified Australian farmers are willing to pay for agricultural water [2].

Despite reverse osmosis technologies being well established, famers face various barriers to adopting this technology, including uncertainty over the implementation process, the availability of brackish water, the ability to dispose of brine, implementation costs, and regulatory barriers. A broader concern is the potential for future water stress in the Murray Darling Basin due to overextraction of groundwater, future droughts and/or drying under a future climate.

This project seeks to identify the best possible location (or locations) for a trial demonstration site within the Murray-Darling Basin of South Australia, to serve as a mechanism to teach interested parties about using desalinated groundwater for agriculture. Site requirements are based on context, water quality, infrastructure and logistics, with the additional considerations of transferability and scalability. A key feature of the site will be the ability to show the potential to scale to other locations with the MDB.

A number of potential demonstration sites were considered within the South Australian MDB, including existing desalination schemes within the Langhorne Creek region (below Murray Bridge), salt interception schemes linked to two different disposal basins, and sites recommended from prior assessment, including in the Mallee region and the Loxton/Berri region (Figure 1) [1].

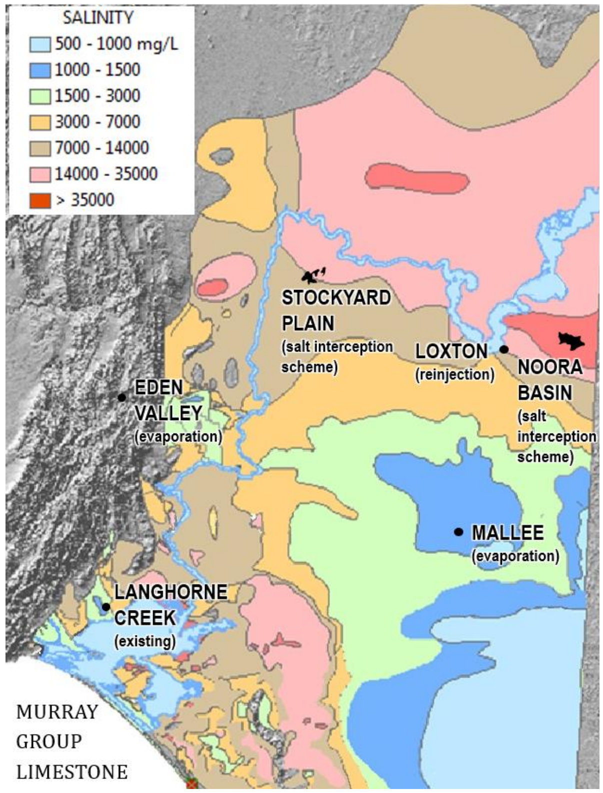

Figure 1: Potential case-study demonstration site locations that were considered in this report, within the Murray-Darling Basin in South Australia. These sites are overlain on a map of salinity of the Murray Group Limestone aquifer, which contains a significant brackish groundwater resource. Provided by S. Barnett, DEW, June 2023.

Ultimately, it proved to be unviable to utilise an existing desalination site, or salt interception scheme. Rather, it was determined that brine disposal via reinjection (managed aquifer recharge) was the preferred disposal pathway for desalination brine. This is due to its compatibility to demonstrate a low-cost low-recovery implementation of reverse osmosis. Additionally, compared to industries such as mining, disposal of water treatment wastewaters via managed aquifer recharge is underdeveloped in Australian agriculture meaning sites which could be suitable for aquifer reinjection may not use this technology, due poor understanding of this disposal mechanism. Thus, pursuing an implementation of this disposal method has the potential to achieve the greatest research impact. At a permeate capacity of 50-200 kL/day, the proposed demonstration site would be Australia's largest case of aquifer reinjection of desalinated brackish groundwater for agriculture.

The Loxton Berri region was identified as the preferred location for an aquifer reinjection demonstration site, due to its easy access via main transit corridors, the region’s focus on high-value irrigated horticulture, and suitable hydrogeological conditions.

A further advantage of the Loxton/Berri region is the presence of the Loxton Research Centre (LRC) and associated research farm, which is also a Hub location for the One Basin CRC. Locating the demonstration site at the LRC enables good accessibility for visitors, ease of demonstration and facilitates the ability to maintain the demonstration site into the future, beyond the competition of the QuickStart project timeline. The research nature of the farm is also beneficial to demonstrate agricultural application of the desalinated water.

Before the implementation of a demonstration site can commence, detailed investigations regarding site feasibility, detailed planning and approvals need to be completed. This report recommends completing a detailed design of managed aquifer recharge of brackish groundwater at the Loxton Research Centre farm and other sites in the region, which considers site hydrogeology, the technical desalination parameters that are required, within the constraints of desalination units that are available to this project, and the development of an agricultural use case.

Further, a high priority for the One Basin CRC, and for this project is establishing a dialogue with local First Nations groups. The First Nations convenor will be consulted on how best to open this dialogue. Solar energy has the potential to significantly reduce the energy costs associated with the ongoing operation of a reverse osmosis desalination plant. While beyond the budgetary scope of the current project, it is recommended that solar energy companies are consulted regarding the potential to utilise renewable energy in this project. The implemented demonstration site has the potential to serve as a catalyst for the greater implementation of desalination in Australian agriculture. The outputs of this case study will be utilised to inform outputs relating to brine management and future outlook across the MDB.

Contents

1 Introduction

The One Basin CRC's vision is that Australia's irrigation regions are the most productive, resilient and sustainable in the world. This project will undertake foundational activities to improve insight into the nature and scale of the opportunity associated with brackish groundwater, identify pathways to enable diversification of irrigated water sources, and assess any potential negative consequences and associated mitigating measures. This report investigates potential case-study demonstration sites within the Murray-Darling Basin in South Australia. It is aimed that, following this report, a physical demonstration site will be established, which includes extraction, desalination, disposal, watering and monitoring, using reverse osmosis of brackish groundwater for farm-scale application.

The primary motivation for establishing a demonstration site is to provide an implementation and 'proof of concept', that interested parties may inspect and learn from, to promote interest in brackish water utilisation across the MDB. This will enable the investigation and demonstration of technical feasibility, economic viability, and environmental sustainability of desalination for agriculture. Desalination will be achieved using reverse osmosis, the most commonly used desalination technology [3]. Osmoflo, the project's industry partner, has provided a reverse osmosis unit in-kind. Other benefits and motivations for the demonstration site and project include to:

- Increase water security and capacity to prepare for climate change projections of a hotter and drier climate with increased frequency and severity of extreme weather events, which threaten future water scarcity in the MDB.
- Develop infrastructure (e.g., boreholes, pumps, storage tanks) for an alternative water supply, which will increase water supply capacity for crop resilience and productivity.
- Encourage the adoption and growth of reverse osmosis on farms, to increase profit, sustainability, and resilience of businesses.
- Support implementation and both industry and community understanding of aquifer reinjection for brine management.
- Address soil health issues for sustainable agriculture through improving water quality and supporting best practice application of desalinated brackish groundwater.
- Enhance connections between industry and rural communities, including First Nations communities, across the Murray-Darling Basin through partnerships with stakeholders to provide accessible knowledge and resources.

To achieve these objectives and overcome barriers, the following criteria for a suitable demonstration site were created, and are discussed in Section 2:

- Access to brackish water (e.g., via a borehole). It is desirable to use an existing borehole, as the project budget has limited capacity for establishing new boreholes.
- A viable pathway for handling residual brine from the desalination process. Brine management is further discussed in Section 3.

- Ability to attach desalinated water to irrigation infrastructure for an agricultural crop, to demonstrate the feasibility of the system in an authentic manner.
- An accessible site that is able to receive visitors, as arranged by the One Basin CRC.
- Access to nearby existing mains power infrastructure or the ability to co-invest in the installation, or temporary installation, of solar panels, or depending on partner organisations.

The main barrier among these criteria is determining a viable brine management method (refer to Section 3). The three brine management options presented in this report are evaporation ponds, salt interception schemes and aquifer reinjection. Potential site locations are grouped according to these brine management options.

Based on the potential to demonstrate reinjection of brine, among a range of other factors, the Loxton/Berri region is a preferred option within South Australia for a demonstration site for this project. Within this region it could be possible to utilise existing boreholes, but this would require third-party involvement and negotiation of access. In contrast, the Loxton Research Centre and adjoining farm could be utilised if a borehole was drilled which would provide significant leverage of investment, higher visibility of the project and enduring value to the region through research farm activities. Details relating to the Loxton Hub site are outlined in Section 4.

2 Demonstration Site Requirements

The demonstration site is to be a tangible example that removes barriers to understanding the use of brackish groundwater in agriculture. The site should be able to receive visitors, use desalinated water for agricultural purposes and have a viable pathway for handling residual desalination brine. Table 1 elaborates on the criteria for site selection, including factors relating to operational context, water quality and quantity, infrastructure requirements and logistics.

Table 1: Criteria for the selection of a suitable site for a demonstration-scale reverse osmosis desalination plant.

<u>CONTEXT</u> **Operational Context** • Ability to use desalinated water for agriculture • Able to demonstrate technical feasibility **Scalability/ Transferability** • Can demonstrate upscale potential **Added Value** • Provides benefit to 3rd parties • Generates goodwill	**<u>WATER</u>** **Water Quality** • Salt levels of feedwater • Water quality (turbidity, pH, treatment needs) **Water Quantity** • Extraction amount • Recovery rate • Storage requirement
<u>INFRASTRUCTURE</u> **Brine Management** • Evaporation ponds • Reinjection borehole • Salt interception scheme **Infrastructure Requirements** • Access points • Pipework installation • Water storage, pumping • Site power access • Area available for 40 ft container • Cost • 3 Phase electric power supply • Mobile coverage	**<u>LOGISTICAL</u>** **Logistic** • First Nations dialogue • Regulatory approval • Environmental impact • Access agreements • Co-investment options **Accessibility** • Site located on main transit corridor • A public access point • Supervised access • Can receive visitors • Accessibility for semi-trailer and crane for unloading

2.1 Context

The demonstration site should 'add value' to third parties in an operational context, generate goodwill and provide insight to upscale to other sites across the basin.

Operational Context: Using the water for an agricultural crop will enable insight into process constraints (timing of water demand, maximum flow rates, the need for storage) and return on investment (benefit of the water, cost relative to the water price, capacity during drought). To maximise the number of potential demonstration sites, the project does not specify what type of crop the desalinated water needs to irrigate. Preferable crop types for demonstration, due to the cost benefit ratio, are high value horticulture such as almonds and wine grapes. Crop specific research studies on agricultural production utilising desalinated water could be conducted by other scientists.

Scalability/ Transferability: A favourable attribute is the site's capacity to showcase scalability. Scalability encompasses various aspects, notably the scale of brine management methods, such as the size and placement of evaporation basins—whether on private premises or regional setups alike to salt interception schemes. Additionally, the scale of the scheme might involve the number of participating growers, alike to irrigation trusts. Reinjection methods depend on the suitability of aquifers and regulatory requirements. The ability to reinject brine discharge into a saline aquifer represents an ideal case because it is cheaper than evaporation basins. The site's capacity to exhibit constraints, including cost, energy requirements, efficient brine management, and practical agricultural applications, influences the transferability of insights gleaned from the demonstration site.

Added Value: Ongoing value can be derived from the demonstration site, depending on the site chosen. This could be in the form of investment into an underutilised region, ability to address environmental concerns or the ability for future use of the demonstration site beyond this pilot project.

2.2 Infrastructure

Infrastructure requirements are a critical factor for feasible implementation since the deficit of a site in one or more aspects could become a deciding factor. The project has a limited budget that can provide for some but not all elements (bore holes, pipework, electrical wiring, storage), therefore existing infrastructure boosts the feasibility prospects of a site. If an ideal candidate site exists for operational reasons but lacks infrastructure, co-investment could be explored.

Brine Management: For the purpose of identifying a demonstration site, brine management is a highly influential criterion. Brine management significantly limits the feasibility of sites to be considered and typically forms the majority of the desalination cost. The three main options for brine management presented in the report are evaporation ponds, using the salt interception scheme, and aquifer injection. Whilst on-site evaporation ponds are the most common method for inland regions to manage brine, a large extent of regional evaporation basins from salt interception schemes could innovatively be repurposed for commercial purposes. Similarly, reinjection of brine is a less common and innovative option that has the potential to demonstrate reduced costs.

Infrastructure Requirements: An ideal candidate site has existing infrastructure, to minimise cost and to enable easier and faster establishment of the demonstration site. The most important infrastructure requirements are:

- **Brine disposal access points,** for example boreholes for reinjection or access points to a salt-interception scheme.
- **Existing pipework** for the feedwater source, brine management and/or irrigation network.
- **Water storage** for the output of the reverse osmosis plant. Required water storage capacity depends on the crop type and scale, for example a small-scale farm may require a water storage tank and large-scale farm may require a turkey nest dam.
- **The site footprint** needs room for up to two 40 ft containers (desalination plant), a pumping shed, water storage (tank), yard pipework/wiring, and space for the brine disposal. If the project scope was extended to include a solar farm, then planning should consider space for solar.
- **On-site power access** is essential for reverse osmosis and for pumping. The reverse osmosis unit requires three phase power. Renewable energy is not an essential requirement for this project but should be considered as an option for scope extension (including energy storage given the operation of the plant over 24 hours).
- **Mobile coverage** is required for maintenance of the Osmoflo equipment.

2.3 Water

Feedwater should meet a number of reverse osmosis water quality thresholds to avoid specialised pre-treatment and not exceed membrane limits. For sustainable feedwater extraction, the extraction volume, recovery rate and storage requirements should match the agricultural operating use-case.

Water Quality: A separate document by Osmoflo outlines water quality thresholds for the reverse osmosis unit. To prevent the need for a seawater membrane, feedwater salinity must be below 11,000 mg/L. To avoid specialised pre-treatment, anti scalant and feed water correction chemicals, numerous other water quality parameters are listed, for example the sum of iron and manganese must be below 2 mg/L. It is anticipated the unit will operate at 20—30% recovery. This depends on the salinity of the feedwater and salt tolerance of the crop being irrigated. A 30% yield implies a salinity increase of 1.42 x the feedwater salinity in the brine. It is noted different techniques exist to alter irrigation water salinity, including blending feedwater and permeate within the desalination unit or to shandy permeate.

Water Quantity: Water quantity (extraction amount, recovery rate and storage requirement) is site specific and involves a hydrogeological assessment. The reverse osmosis unit to be provided by Osmoflo is capable of processing up to ~1 ML/day of feedwater, with low recovery settings and maximum permeate output of 200 kL/day and 4000 mg/L. Maximum output will change depending on the low recovery case. The operational flowrate would be several factors lower due to agricultural requirements and if the operation is linked to solar energy the flowrate would be restricted by the available sunshine hours.

2.4 Logistical

A myriad of logistical and accessibility factors are highly relevant to site selection.

Logistic: Logistical considerations include First Nations dialogue, regulatory approval, environmental impact, and co-investment options.

Accessibility: It is essential that the site can receive visitors, as arranged by the One Basin CRC, for a minimum period of 12 months, but potentially longer upon agreement. As the purpose of the site is for demonstration, it is a priority that visitor accessibility is prioritised. Ideally for external access, the site should be located on a main transit corridor and/or bituminised road, as a site located on an infrequently used road, for example, along an unsealed road may inhibit access. Ideally the site should be a short walk from a public access point. Desirable locations are those nearer to the main entrance of a property rather than towards the rear of the property. One possibility is to locate the site at a public institution that has convenient access arrangements (for example a research hub or water utility). Accessibility is also important for set-up; the site must have room for a semi-trailer and crane.

It is envisaged that viewings of the demonstration site will be under supervision, and it is unlikely that unsupervised access will be required. The One Basin CRC and landowner will negotiate timeframes and timelines to view the demonstration site (for example one day notice required, one week notice required, visits only permitted on set dates, etc.). The One Basin CRC will cover insurance for personnel on site.

3 Brine Disposal Methods

For identifying a demonstration site, brine management is a highly influential criterion, as it significantly limits the feasibility of sites and typically forms the highest proportion of desalination cost [2].Consequently, a separate report discusses brine management in depth, regarding lifting this barrier and scaling across the basin. However, a brief overview has been provided here of the three primary brine management options: evaporation ponds, salt interception schemes and aquifer injection. While other disposal options exist, most of these relate to metropolitan cases where ocean outfall is possible and are therefore excluded here.

3.1 Evaporation Ponds

A traditional brine management solution for desalination is evaporation ponds. Evaporation ponds can operate on a range of scales, as it is possible to control the parameters of the disposal basin. Within the MDB of South Australia, many evaporation schemes exist at a variety of scales, including on-farm or regional. At the regional scale in the SA MDB, evaporation ponds are linked to salt interception schemes that use the Stockyard disposal basin and the Noora disposal basin (Figure 2). Scalability is limited by the availability of suitable land in agricultural regions: This is a considerable barrier because evaporation ponds require a large footprint. Areas for new evaporation basins could include within the Mallee and Eden Valley because they are not near a salt interception scheme and they are less favourite for aquifer reinjection, but they are significant agricultural region.

The cost of a new evaporation basin is governed by the area required for evaporation to occur, as this dictates the cost of excavation and basin lining. Typically, evaporation basins are more expensive than aquifer reinjection or using a salt interception scheme [4]. To reduce costs, it is possible to use an existing evaporation basin. A variety of existing evaporation basins, which may be potential demonstration sites, are located in Langhorne Creek, close to Lake Alexandrina and to the Murray mouth. Suitability of existing basins for this project will be governed by the basin volume. The required volume of the basin will depend on the yield of bore, desalination recovery settings, volume of brine to be produced and the agricultural water usage. Therefore, at each different site the design is highly variable and site feasibility needs to be assessed individually. Each site will also require its own regulatory approval for the necessary permits and compliance with environmental requirements.

An evaporation basin's functionality will depend on the local climate, including average temperature, humidity, rainfall volume, rainfall patterns and wind speed, which dictate the evaporation rate. Evaporation is faster under hot temperature, low humidity conditions. To ensure long-term functionality, ongoing management and maintenance is important, including mitigating the potential for overflow, preventing leakage, and removal of accumulated salts. Regular checks are crucial to mitigate negative environmental impact that may arise from altered soil chemistry and salinity.

3.2 Salt Interception Schemes

Salt interception schemes were established in 1988 by the South Australian, New South Wales, Victorian and Australian Governments to prevent saline groundwater and drainage water entering the River Murray. The River Murray has 18 salt interception schemes, the locations of which are shown in Figure 2. Most use a bore and pump system to relocate groundwater to a salt management basin further away from the river. The salt interception schemes annually prevent approximately half a million tonnes of salt entering the River Murray [5]. Along the salt interception scheme locations, due to groundwater extraction, the groundwater table has been lowered.

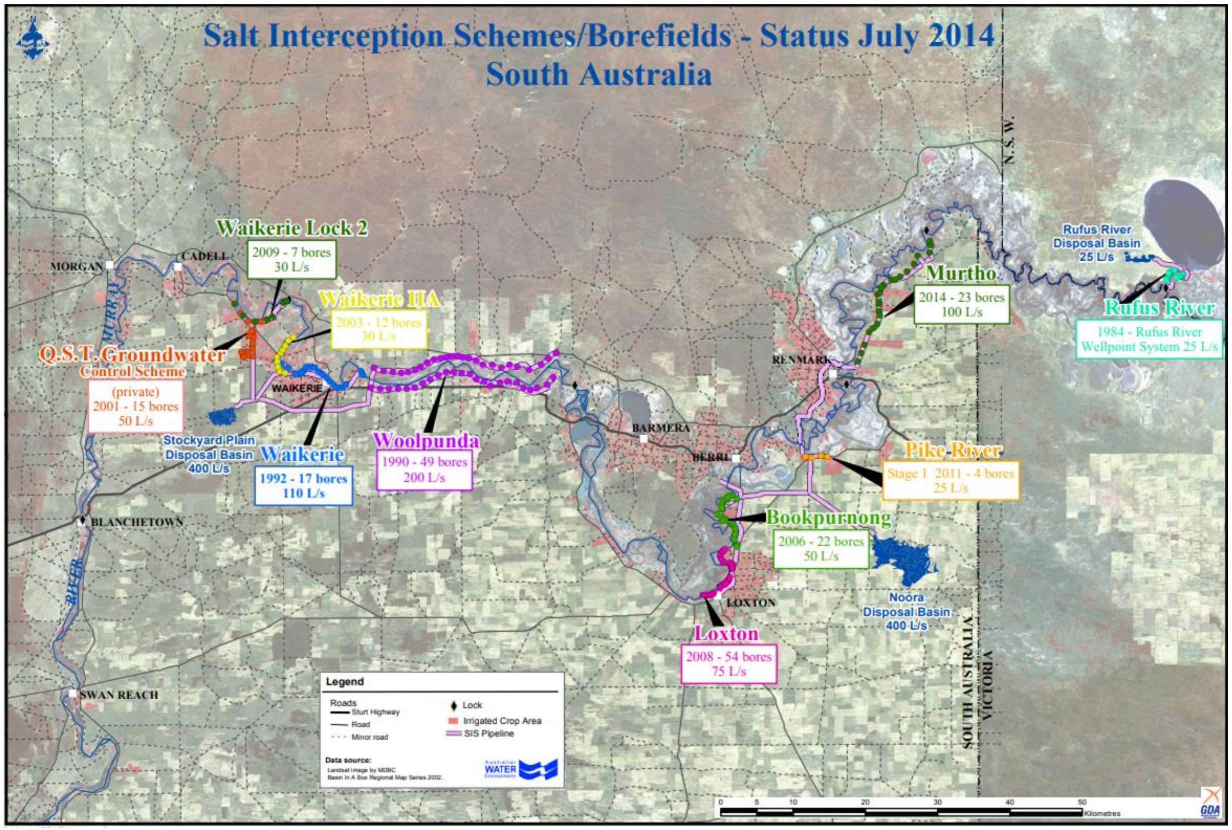

Figure 2: Map of the Salt Interception Scheme (SIS)

The scalability of salt interception schemes for this project depends on the location of existing schemes, or potential new schemes that might utilise existing saline basins. In contrast to evaporation basins for individual operators, the SIS disposal basins exist at a regional scale and only for specific regions where a basin exists. Using a saltwater interception scheme has the benefits of using existing infrastructure, the accessibility of a water source and the ready availability of a brine disposal pathway. While these basins have some associated existing infrastructure, they also have numerous constraints: The governance and operation of the disposal pipeline is not established to meet commercial interests and the scale of existing infrastructure may be insufficient for user needs, e.g. the size of the pipeline or the size of the disposal basin.

3.3 Aquifer Reinjection

Compared to the previously outlined alternative methods, aquifer reinjection appears to be a more favourable means of managing brine. In contrast to evaporation basins, aquifer reinjection proves cost-effective. Unlike the salt interception scheme option, the scalability of aquifer reinjection is not tied to additional land requirements or constrained by existing scheme locations; instead, it relies on hydrogeological conditions. However, due to the necessity for in-depth hydrogeological understanding and regulatory compliance in risk management, aquifer reinjection remains an avenue that is less explored at present.

Hydrogeological considerations: Aquifer reinjection is highly dependent on the location of existing aquifers and their corresponding salinity levels. Specifically, this process necessitates an aquifer with higher salinity than the brine itself. Moreover, the selected aquifer must maintain hydrogeological stability to receive additional water without triggering unintended consequences such as salt mobilization or alterations in chemical composition. Conducting a comprehensive hydrogeological study is imperative to understand the potential consequences of reinjection. Assuming there is no aquifer interconnectivity, and that the injected water is of a similar quality to that of the receiving aquifer, the injected water would likely cause no environmental harm.

Long-term monitoring: Sustained, vigilant monitoring of aquifer extraction is pivotal to prevent excessive groundwater resource depletion. This becomes especially crucial considering the expected increase in water demand due to projected changes in rainfall patterns and extended droughts associated with climate change. Ensuring the aquifer retains water reserves is essential for safeguarding crop health and food security during future droughts.

Ongoing monitoring of the aquifer into which reinjection occurs is important to ensure that no environmental harm occurs over the lifetime of the scheme's operation. This is especially important if the saline water table could rise over time to be in contact with the surface.

Regulations: Navigating government regulations poses another challenge in executing aquifer reinjection projects. Obtaining necessary permits for drilling new boreholes and managing drainage and discharge requires navigating various agencies, adhering to procedural guidelines, and meeting specified timelines and cost requirements.

Community: Ensuring proper consultation with local community, environmental and industry groups could be critical to maintaining a social licence to operate. Dialogue with First Nations groups, for example, is of high importance.

Identifying suitable locations: Discovering viable locations for aquifer reinjection necessitates a comprehensive hydrogeological assessment spanning various regions. Once a potential demonstration site emerges, the next crucial steps involve water quality testing and further hydrogeological investigations. These measures aim to ascertain critical parameters to the highest degree of certainty possible, including salinity of the aquifers, salinity of the brine to be discharged, the anticipated flow rate, and the corresponding chemical composition. Understanding these specific parameters is pivotal in managing risk deciding whether the conditions align favourably for successful implementation of aquifer reinjection at the site of interest.

4 Preferred Region and Sites

4.1 Loxton/Berri Region

A favourable area identified for aquifer reinjection within the Murray-Darling Basin of South Australia is the Loxton/ Berri region. Within South Australia, Loxton is one of the most agriculturally productive and ecologically diverse areas. Globally, Loxton is a leader in agriculture, producing premium food and wine, with the region generating billions of dollars for the Australian economy annually [6]. Being located at the downstream part of the Murray-Darling Basin, this area is vulnerable to climate change increasing the local temperature and dryness which limits the availability of local water resources [7]. Therefore, for this region, a reliable water source for irrigation during drought is crucial [5]. This identified region is represented by the River Murray and Mallee Aboriginal Corporation (RMMA) who will be consulted regarding First Nations perspectives.

The Loxton/ Berri region contains three aquifers, the Loxton/ Pliocene Sands aquifer, Murray Group Limestone aquifer and Renmark Group aquifer. The Loxton/ Pliocene Sands aquifer and Murray Group Limestone aquifer offer the potential for sustainable aquifer reinjection based on their stable hydrogeological properties. The formation of these aquifers, including layering and relative depths is shown in Figure 3.

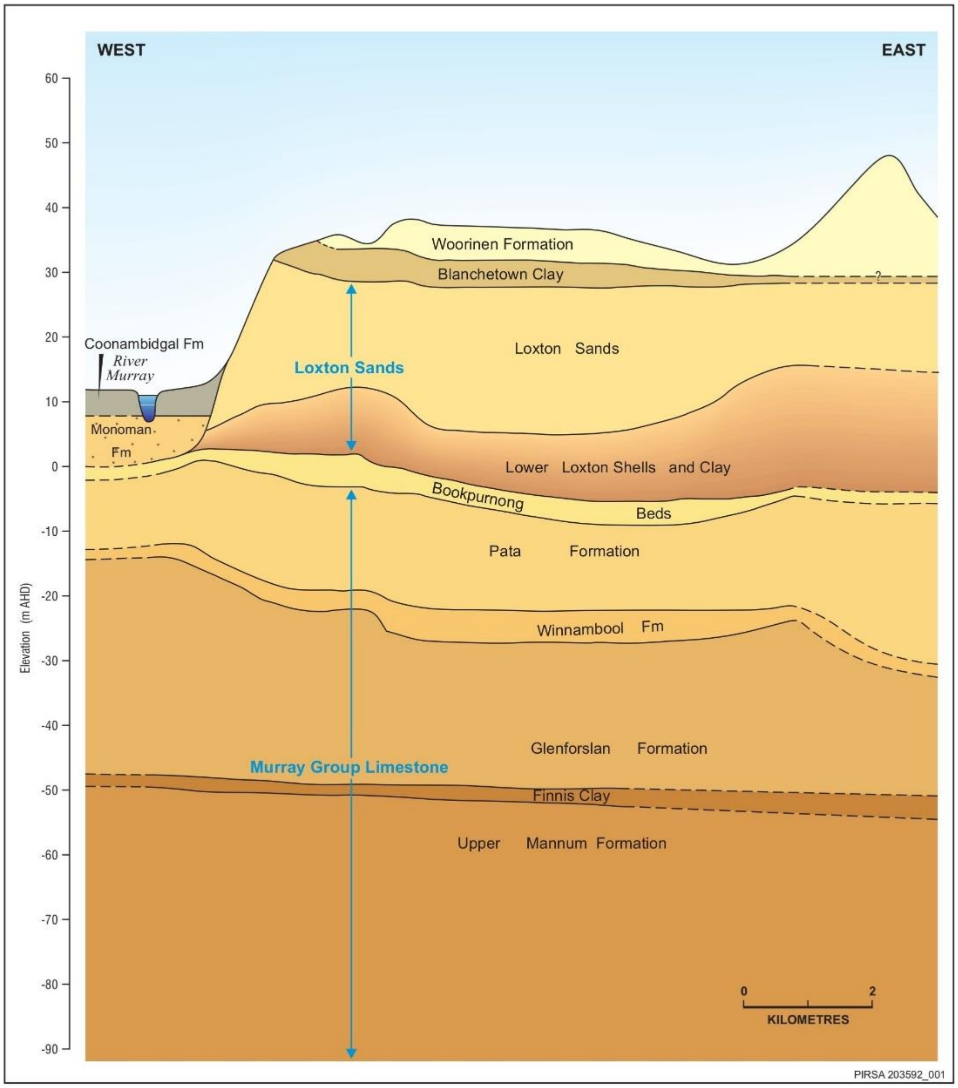

Figure 3: Overview and cross sections of the geology of the Loxton/ Berri region Adapted from [8].

Within the Loxton/ Berri region, the Murray Group Limestone aquifer and Loxton Sands aquifer can facilitate the extraction and reinjection of water, as they are separated by the Bookpurnong beds (refer to Figure 3). This layer is thick and impermeable enough to prevent connectively between the aquifers, hence avoiding adverse environmental effects like salt mobilisation or a reduction in water quality (Refer to Figure 3). Based on the thickness of the formations, it is anticipated the Loxton Sands aquifer and Murray Group Limestone aquifer can be respectively accessed from a bore 1-50 m deep and a bore 60-160 m deep. Bores drilled into these aquifers are expected to return salinities in the ranges shown in Figure 4.

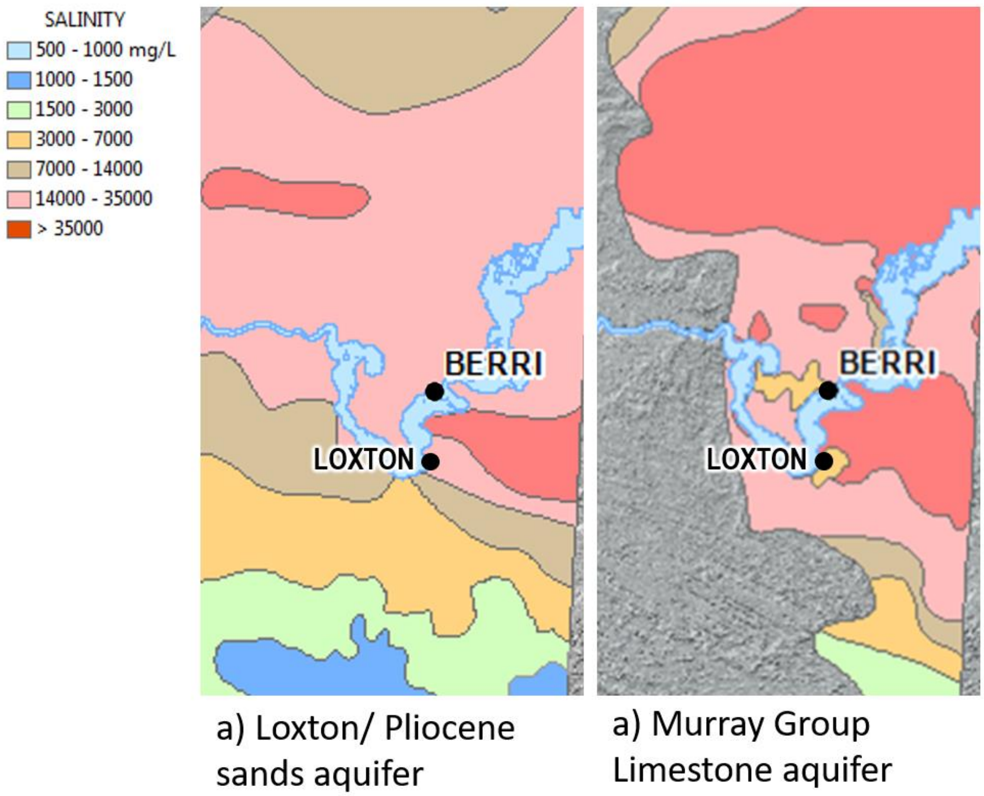

Figure 4: Groundwater salinity in the Loxton/ Berri region. Provided by S. Barnett, DEW, June 2023.

As observed in Figure 4, within the Loxton/ Berri region, the Murray Group Limestone aquifer (upper) is less saline than the Loxton/ Pliocene sands aquifer (lower). Therefore, in this region, aquifer reinjection of the concentrated brine is possible. The Murray Group Limestone aquifer would be used for extraction (for desalination), with reinjection into the more saline Loxton/ Pliocene Sands aquifer.

4.2 Loxton Research Centre Farm and 1BCRC Hub

Within the Loxton/ Berri region, a favourable location for a demonstration site for the desalination of brackish groundwater and aquifer reinjection is the Loxton Research Centre Farm/ One Basin CRC (Cooperative Research Centre) Loxton regional hub. Being located at the One Basin CRC hub is desirable to demonstrate an agricultural context to a wider audience. The One Basin CRC Loxton hub is a focal point for research and communication across the Basin and attracts regional communities, businesses and industries, which can inspire the uptake of brackish water across the Basin. Key topics for research at the hub are agriculture and natural resource management, making this project well suited to the interests of the hub [9]. Furthermore, the Loxton Research Centre is a public institution allowing convenient access arrangements for visitors.

The LRC farm has an area of 30 hectares [10]. Focuses of the farm are viticulture, almonds and citrus, which are good potential crops for irrigation with brackish water [10]. In particular, a viable choice are almonds. Almonds have a large water demand, so to ensure a reliable water source, almond farmers are likely to invest in desalination technology. Current crops grown at the LRC are shown in Figure 5. Having a variety of crops at the LRC is an advantage compared to other potential sites, because no constraint was defined for the agricultural use of the water, which will attract a larger variety of interested parties to the project.

Figure 5: A map of the Loxton research centre farm, providing an overview of the diverse range of crops grown. Provided by, P. McGee, SARDI/ PIRSA, September 2023.

The primary hurdle of the LRC involves the lack of existing boreholes. This necessitates the drilling of two new boreholes: one for extraction and at least one other for reinjection. The drilling expenses will consume most of the project budget, leaving only a small portion for additional infrastructure needs. However, an indicative cost assessment has concluded that the LRC represents a financially viable case study site. Moreover, opting for the LRC over farms with already established bores is a strategic move for long-term investment. Given the research-oriented nature of this public institution and its frequent hosting of gatherings, it will facilitate prolonged interest in the project.

To determine whether to proceed with the LRC, there is a separate document informing LRC detailed design. This document includes the specifics for drilling the boreholes, choosing settings for the desalination unit and estimated parameters (e.g. salinity, yield) for the feedwater, permeate and brine streams. Based on indicative values, a major limiting factor for the LRC feasibility is the boreholes having insufficient yield. This will be investigated by desktop evaluations and water sampling from surrounding bores as part of a hydrogeological evaluation.

4.3 Sites near Loxton

The most favourable region for aquifer reinjection is in the region south of Loxton. This is based on local hydrogeology which shows comparably lower salinity in the Murray Group Limestone aquifer [11]. In this region there are many farms and hence many potentially suitable demonstration sites. The suitability of these farms depends on the requirements discussed in Section 2. Most notably as the project has limited budget, it is desirable to find a site with existing bores, and explore possibilities for co-contribution. Compared to the Loxton Research Centre, other sites may have bores with higher yield, better water quality and available data. Each farm grows different crops, which presents different agricultural uses for the water. However, each farm typically grows a small variety of crops, and the project stakeholders are interested in variety of crops, so being limited to one crop could restrict stakeholder interest in the project. Additionally, the use case for desalination depends on the type of crop being irrigated: a site with more limited crop variety could limit the potential to investigate the feasibility of desalination under different use cases. For example, irrigating a high value crop with desalinated water may be feasible under drought conditions. Irrigating other crops presents different motivations for establishing a desalination scheme for agriculture, such as expansion of production.

In addition, the potential demonstration sites may pose logistical challenges. One logistical challenge may be landowner/s and the One Basin CRC needing to negotiate property access and access to the demonstration site. Another potential challenge is the proximity of three-phase power, which may require investigating solar powered options. To better understand these challenges, and hence feasibility of a farm as a demonstration site for this project, it is essential to have preliminary discussions with landowners then undertake a site feasibility assessment.

5 Summary and Recommendations

The aim of this project is to establish a demonstration site for desalination of brackish groundwater using reverse osmosis in an agricultural context. Reverse osmosis is not a new technology, and in response to the millennium drought, within the MDB various farms installed reverse osmosis units. At present the desalination units at only a few of these farms are operational. These farms would provide an excellent illustration of the operation and implementation of desalination for agriculture and uncover many remaining barriers. This would allow others to understand the operation of such schemes. Ideally the chosen site will provide innovation and ongoing opportunity for research. The chosen site would also demonstrate a pathway that scales across the basin.

Potential demonstration sites within South Australia were assessed on the set of criteria in Section 2. Given the wide range of locations and potential implementation challenges, the criteria are varied. One key criterion and challenge relates to the method of brine management. The brine management option with limited development in Australia is reinjection, which was seen as a novel opportunity. Reinjection was identified as feasible in the Loxton/Berri region, which has a lower aquifer (Murray Group Limestone) that is less saline than the upper aquifer (Loxton Sands).

Within the Loxton region, the specific site should be selected to maximise the value of the demonstration. The best location, based on accessibility and the ongoing potential to leverage the value of the desalination plant, was the Loxton Research Centre (LRC) farm. The LRC has the ease to readily arrange site tours and establish a variety of future trials utilising the water. To establish this site requires boreholes to be drilled, which without knowing the specific yield and water chemistry has a large associated expense. Therefore, alternative sites have been identified which utilise existing bores and require only moderate development. Despite this, these sites are undesirably tied to a specific operating context. To proceed with the project, there are five recommendations:

1. That a managed aquifer recharge demonstration site for brackish water is established in preference to other disposal mechanisms. This approach is innovative and cost-effective in an agricultural context.
2. The demonstration site is established in the Loxton region due to favourable hydrogeology of this region.
3. Now that a general region has been identified, i.e. the Loxton region, local First Nations groups should be consulted to develop an understanding of their perspective.
4. The project proceeds to a detailed design stage for a small number of sites in the Loxton region (the LRC farm and a site South of Loxton). The detailed design will determine cost and operational parameters including the site hydrogeology, parameters for desalination (such as water quality and quantity), and agricultural use. The detailed design will provide the basis for the final decision on which location is the most beneficial. In other words, a final decision cannot be made until all parameters are fully understood. The finalised plan will be submitted to the SA Government for approval.
5. That the potential for the project be extended to utilise renewable energy (currently out of scope due to budgetary reasons) is investigated by contacting solar energy companies. This is likely not essential to the project, but is an added opportunity.
6. That the implemented demonstration site be utilised to inform outputs relating to brine management and future outlook across the basin.

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