AQUA FERRE (MUCHEA) PTY LTD TRADING AS MUCHEA WATER

DRINKING WATER SOURCE PROTECTION PLAN

RESERVE ROAD CHITTERING WATER RESERVE RURAL RESIDENTIAL WATER SUPPLY

Version	Date Approved
Version 13	August 2019

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Glossary

ADWG	Australian Drinking Water Guidelines
Aqua Ferre	Aqua Ferre (Muchea) Pty Ltd ACN 630 936 319 trading as Muchea Water
Arris	Arris Pty Ltd ACN 092 739 574
ATU	aerobic treatment unit
DOH	Department of Health, Government of Western Australia
DOW	Department of Water, Government of Western Australia (now DWER)
DWER	Department of Water and Environmental Regulation, Government of Western Australia (formerly DOW)
DWSPP	Drinking Water Source Protection Plan
ERA	Economic Regulatory Authority Western Australia
GL	gigalitre (1 billion litres)
ha	hectare
Harvis	Harvis Capital Pty Ltd ACN 149 096 284
kL	kilolitre (1,000 litres)
km	kilometre
m	metre
MEN	Muchea Employment Node
mg/L	milligram per litre
ML	megalitre (1 million litres)
mm	millimetres
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
pa	per annum
pH	a numeric scale used to specify the acidity or basicity of an aqueous solution
Riverside	Riverside Investments (WA) No 2 Pty Ltd, ACN 118 963 072
Riverside Development	the residential subdivision located at Lot 2 Reserve Road and Lot 9001 Rosewood Drive, Chittering, WA
RIWI Act	Rights in Water Irrigation Act 1914
TDS	total dissolved solids
WAPC	Western Australian Planning Commission
Water Corporation	Water Corporation of Western Australia
WTP	water treatment plant

Summary

This DWSPP has been prepared by Aqua Ferre as part of its plan to develop a reticulated water supply in the Chittering area. The DWSPP sets out basis of protection of the water quality of the water source to be utilised by Aqua Ferre.

Aqua Ferre intends supplying approximately 151ML of treated potable water to a new residential development at Reserve Road, Chittering, Western Australia, and to a commercial/industrial development at the adjacent MEN.

The Riverside Development is located 8km north east of the Muchea town site and 80km north of the Perth central business district. It is also in close proximity (4km) to the proposed MEN on the eastern side of Great Northern Highway. The development is in accordance with the Shire of Chittering's planning scheme (2004). The new residential development involves the creation of approximately 238 rural residential allotments in progressive stages. It is a requirement of the development approval that potable reticulated water is available.

Phase 1 of the MEN development is being undertaken by Harvis which is progressing in part because of its proximity to the development of the Perth–Darwin Highway. The highway is intended to enhance access to metropolitan Perth with linkage to developments in the north of the state. It is the intention of the MEN development that these lots also have a reticulated water resource.

Currently, the area does not have a public water supply scheme. The establishment of a new potable water supply scheme is in progress and this document is in support of the licence application process. This DWSPP is a requirement of DOH.

The Reserve Road property currently has a total water entitlement or allocation (licence to abstract water from an artesian aquifer) of 288,800kL/a, sufficient to meet the demands of the development. The developer, Riverside, has transferred the Water Licence GWL 59907(3) to the Water Corporation to enable the licence to be changed from an agricultural extraction to public water supply. This water entitlement will be transferred to Aqua Ferre when a Water Service Licence has been granted.

The water supply scheme will see water extraction take place from the confined Leederville Aquifer (and not from the unconfined superficial aquifers). This mitigates the risk of water supply pollution from superficial groundwater sources which is a concern in the Muchea region. The fact that the source is confined and at depth ensures it has a high level of water quality protection and security.

There is an existing production bore located within the Riverside Development that was previously used for wildflower irrigation, where the proposed potable WTP will be located. This bore although unused for >10 years has been equipped with a pump to enable water sampling for analysis (Table 6) in support of this document. In the past, water extracted from the Leederville Aquifer has been used for the irrigation of wildflowers at an abstraction rate greater than that now required for the proposed development. The aquifer therefore has the capability to supply the required potable water without interruption.

Current land use in the Chittering Shire is diverse, but dominated by agricultural activities, such as cropping, grazing and other horticultural ventures. The bore will be constructed to the "Minimum Construction Requirement for Water Bores in Australia" (3rd edition, National Uniform Drillers Licensing Committee, 2012). The confining layers of clays and shales that overlie the groundwater resource act as barriers to contamination protecting this valuable resource. Given that the drinking water from the production bore will be drawn from a deep confined aquifer and with an appropriately constructed and sealed bore, there is low potential for contamination from surrounding land uses.

The Riverside Development will be serviced with ATUs (approved by DOH) to treat domestic wastewater with onsite disposal of treated effluent on individual lots. The ATU will be installed in line with DOH guidelines and requirements (http://www.public.health.wa.gov.au/cproot/1331/2/

approved_aerobic_treatment_units.pdf). This meets the Shire of Chittering's requirement for onsite management and disposal of domestic wastewater. A system such as the Fuji Clean CE–1500EX (http://www.fujiclean.com.au/DomesticSystems.aspx), which is approved by DOH for single dwellings, is capable of removing nutrients down to 1.3mg/L phosphorus and 21.0mg/L nitrogen, equivalent to 4% and 58% reductions, respectively.

This DWSPP has been developed to identify the location and boundary of a public water source area, assign priority areas and protection zones. This has been done to assist in protecting the water quality of the Riverside Development water source. Currently, the Riverside Development area does not have a proclaimed public drinking water source area. This DWSPP:

- recommends to maximise the protection of the drinking water supply source
- recommends that the water source area should be protected and proclaimed as a water reserve. This involves a water reserve area of a minimum 30m around the bore at the ground surface to mitigate the risk of surface contamination
- recommends all proposed new bores sourcing water from the confined aquifer in the vicinity of the Reserve Road (Chittering) water reserve, should be assessed to determine their contamination or interference risk to the drinking water source, through DWER's groundwater licensing process (DWER, proponents)
- identifies potential drinking water quality contamination risks from land use activities within the water reserve
- provides strategies to manage these potential risks.

Aqua Ferre has engaged Arris (www.arris.com.au) to prepare the DWSPP. Arris is an experienced consulting firm which provides specialist technical expertise and advice for all types of water treatment systems and solutions around Australia.

This DWSPP has been independently reviewed (by Tony Laws, former Manager of Water Source Protection, DOW).

DWER has advised that it agrees with the assessment of this source and supports the water quality protection measures described in this DWSPP. This is subject to approval of the proposed development (which has now occurred) and of a water service provider licence for a potable water supply (with the application now being considered by ERA). DWER has advised that it will proclaim the Reserve Road (Chittering) water reserve as proposed in this DWSPP (Figure 2), once these conditions have been met.

1 Drinking Water Source Overview

1.1 Proposed water supply system

A potable water supply scheme is required to service the Riverside Development and the Phase 1 development of the MEN (Harvis) (Figure 1). The residential development covers an area of approximately 160 hectares comprising approximately 238 allotments. Each allotment is greater than 5,000m^2 and less than 10,000m^2 with the exception of the areas required to be set aside for public open space and the proposed biodiversity corridor.

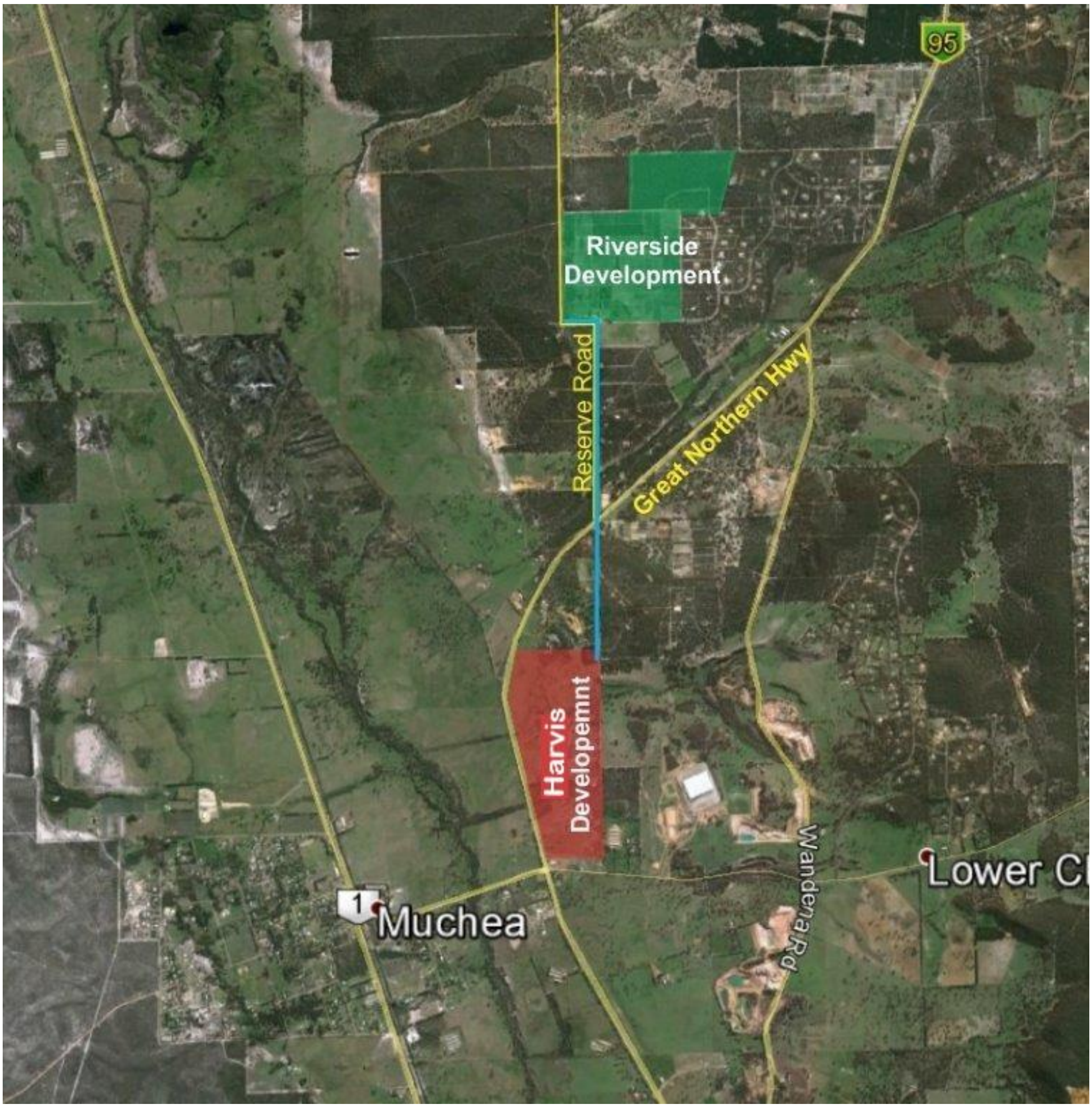


Figure 1: Location of Riverside Development and MEN

Aqua Ferre was established to be an independent water service provider and is proposing to oversee the design and build and subsequently operate the potable water supply system at the Riverside Development. Aqua Ferre will follow the required application process to obtain a 'Water Service Licence' from ERA. The proposed raw water for this scheme will be sourced from an existing bore due to be refurbished to optimise performance and from a new bore to be installed at the site. Both bores will extract water from the Leederville Aquifer. The licence to construct the new bore is attached as Appendix D. The aquifer is confined (Davidson, 1995, p.98) and is proposed as the source of high quality drinking water. The aquifer's water is sourced from deep valleys and some leakage from the overlying Mirrabooka Aquifer (Davidson, 1995, p.98 and p.125–127).

Further evidence that the aquifer is confined is contained in Appendix A, where it can be seen from the log of the existing bore, that the screened aquifer interval is confined below some +80m of shale. The screened interval is 225.7–241m below ground level, and standing water level is 87m; hence, the aquifer is pressurised confirming its confined nature.

The abstraction zone in the aquifer is 240m deep (Appendix A, p.26) and regarded as having a low vulnerability to contamination from agriculture, industrial and urban activity (Davidson, 1995, p.143).

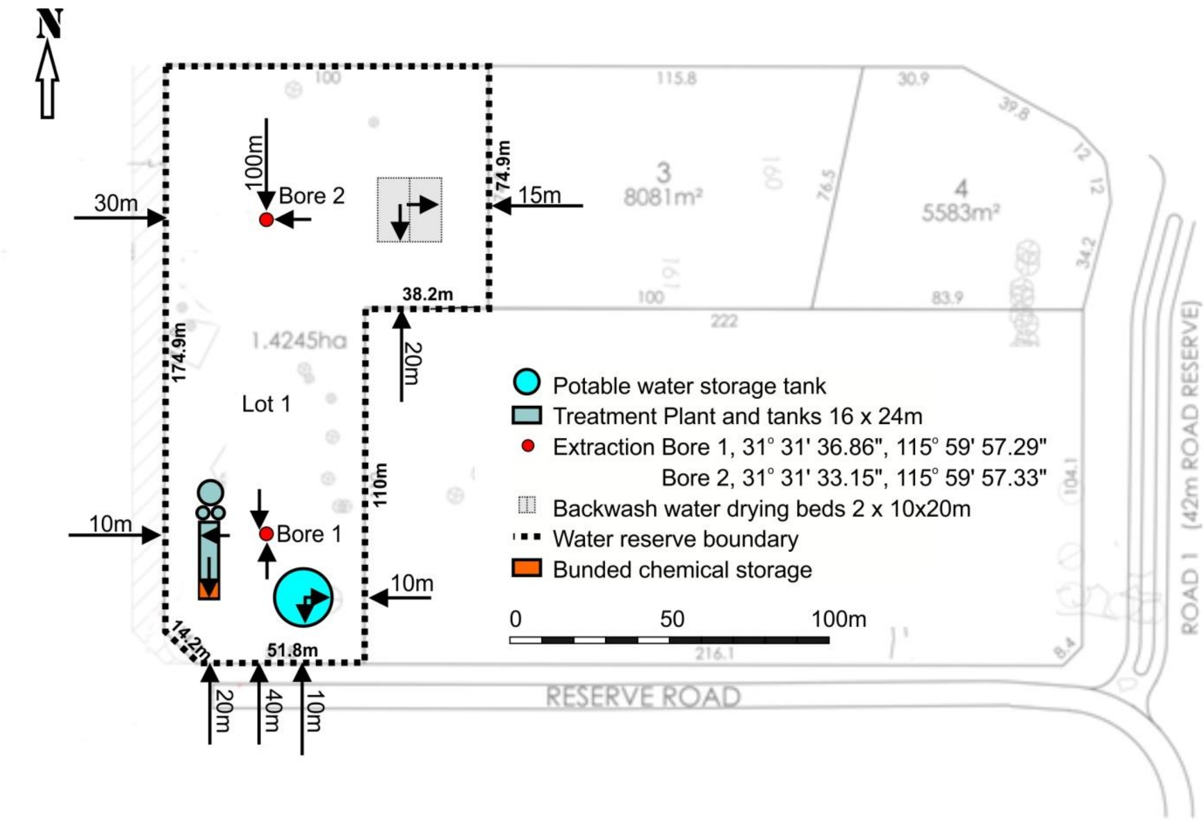


Figure 2: Lot 1 Reserve Road showing well layout and the proposed Reserve Road (Chittering) water reserve

Groundwater supplies are usually more reliable than surface water supplies because they are often not impacted by short-term fluctuations in rainfall and generally are not directly influenced by evaporation.

Table 1 shows the details of the Water Use Licence (licence to take water) granted to Lot 2, Reserve Road under Section 5C of the RIWI Act and subject to the Rights in Water and Irrigation Regulations 2000.

Table 1: Licence to take groundwater

Licence Number	Annual Water Allocation kL/a)	Aquifer
59907(4)	288,800	Perth – Leederville – Parmelia Artesian

The developer, Riverside, transferred the water licence GWL 59907(3) to the Water Corporation (now licence GWL 59907(4)). This licence will be transferred to Aqua Ferre when a successful Water Service Licence has been obtained from ERA. The WTP will be located at the Riverside Development on two specially designated lots of land leased by Aqua Ferre. This ensures the water services provider has security of tenure and unrestricted access.

1.2 Water treatment

Appropriate catchment and aquifer management is the first step in water source protection to ensure good quality water supply, as endorsed in the ADWG (NHMRC and NHMMC, 2011).

The proposed WTP design will comprise a pre-treatment stage that will include iron and manganese removal through the use of chlorination to the feed water. This dosing will also prevent taste and odour problems due to slime and bacteria growth. The water will then be pressure sand filtered to remove the precipitated material. A further green sands filter will polish the water by removing any remaining iron and manganese. Wastewater discharged from the oxidising tank and sand filter will be sent to sludge drying beds for dewatering prior to disposal.

The last stage in the treatment chain consists of UV and a chlorination module for primary and residual disinfection purposes. Due to the low pH of feed water, sodium hydroxide will be added to achieve a pH of 7 to 7.5.

Aqua Ferre has designed the treatment plant to provide a very high quality product that meets the ADWG – a requirement of DOH policies and guidance.

The potable water treatment train is described in detail in the "Reticulation System Design" document prepared by Aqua Ferre.

1.3 Catchment details

1.3.1 Physiography

The site lies within the Ellenbrook surface water catchment (Figure 3). The catchment area of Ellenbrook is 715 square km, approximately 50km long north-to-south and 20km wide east-to-west. The Ellenbrook flows south and joins the Swan River near Belhus (Smith and Shams, 2002, p.2).

Three local governments administer the catchment. These are from north to south, the Shires of Gingin covering approximately 21%, Chittering covering 47% and Swan covering 32% of the catchment. From north to south the town centres and residential subdivisions near or within the catchment are Gingin, Muchea, Bullsbrook and Ellenbrook.

The Ellenbrook catchment contains sites of environmental and cultural significance including lakes, wetlands and springs of high conservation value. Among this conservation sites are Lake Bambun, Chandala Lake, Twin Swamp and mound springs (Smith and Shams, 2002, p11). These features have conservation value because they provide habitat for endangered species and migratory birds, support rare fauna and flora and also have cultural or heritage values. A search of the Aboriginal Heritage Inquiry System (http://maps.dia.wa.gov.au/AHIS2/) shows that there are no registered heritage sites in the area to be protected by this DWSPP.

1.3.2 Climate

The catchment has a “Mediterranean-type climate”, with hot dry summers and cool wet winters. The average annual rainfall for the southern region of the catchment is approximately 820mm (Figure 4). This decreases to less than 600mm in the northern region of the catchment where the proposed development is located (Banfield, 2001). The change of season usually takes place between mid-April and mid-May and the growing season typically lasts for about seven months. On average, 90% of the average annual rainfall falls between May and October.

Average daily temperatures typically range between 17°C and 29°C in summer and between 9°C and 18°C in winter. Average annual pan evaporation is 934mm, and the average daily evaporation ranges from 10.8mm in January to 1.8mm in June.

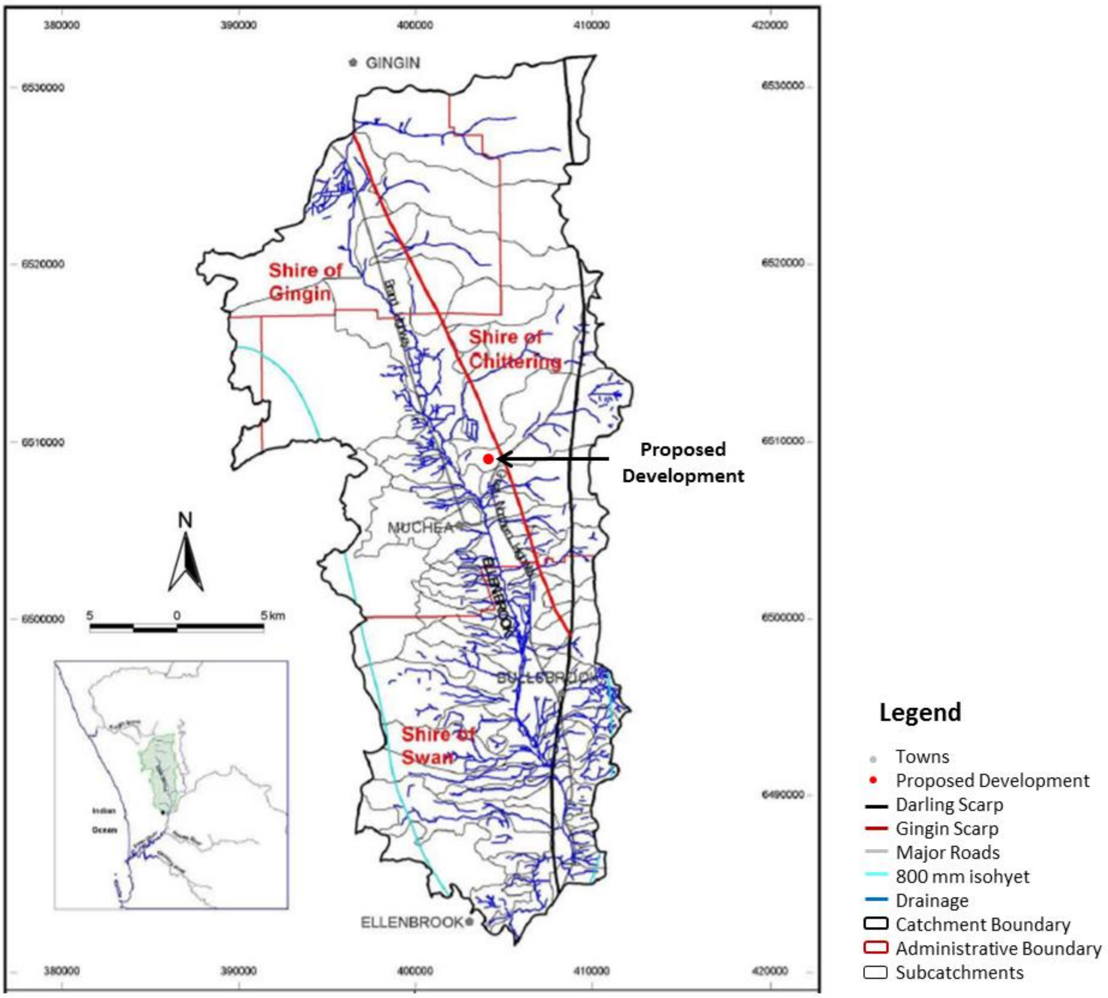
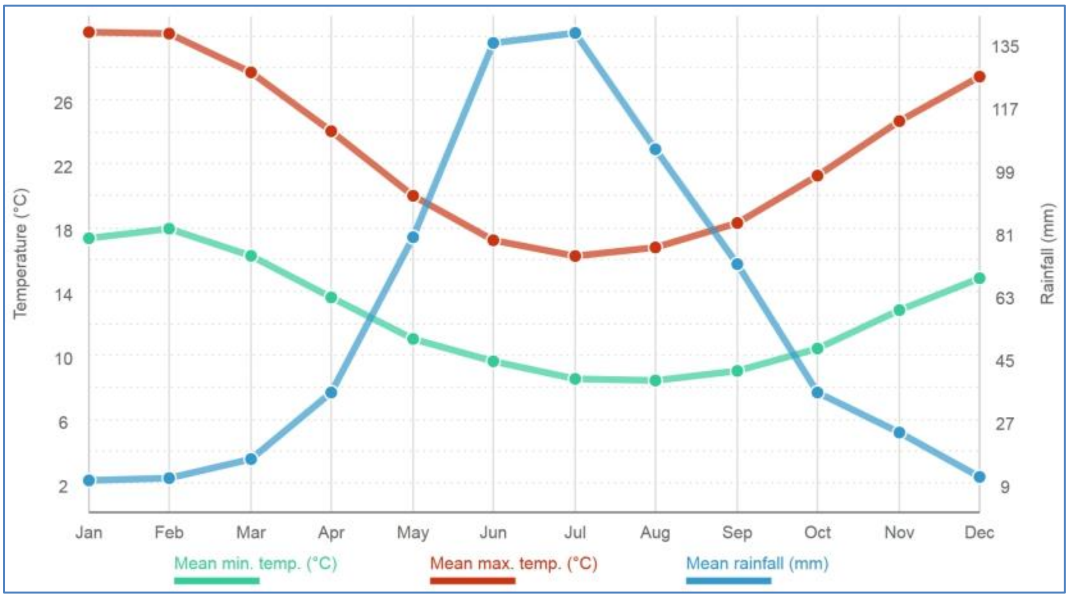


Figure 3: Ellenbrook Catchment (Smith and Shams, 2002)



Source: MLA Accessed 2015. (http://www.mla.com.au)

Figure 4: Mean monthly rainfall, minimum and maximum temperatures for Muchea

1.3.3 Hydrogeology

The hydrogeology provides a framework to identify groundwater distribution, flow and quality. The hydrogeology of the Ellenbrook catchment reflects the geology of the three physiographic units shown in Figure 5 and Table 2 (DOW, 1989; Banfield, 2001):

- Darling Plateau comprises crystalline rock, comprising mainly Precambrian gneiss and granite
- Dandaragan Plateau has a thin cover of Cretaceous sands and clay, and some small outcrops of Cretaceous and Jurassic sediments
- Swan Coastal Plain is formed by Tertiary – Quaternary sand and clay.

As the Riverside and MEN developments are located in the Dandaragan Plateau, this section will only refer to this physiographic unit of the catchment.

The surface geology of the Dandaragan Plateau comprises Cretaceous-age sands of Poison Hill Greensand and Molecap Greensand (Smith and Shams, 2002). The two formations are composed of fine- to coarse-grained, unconsolidated, yellowish-brown to greenish-grey, glauconitic, silty and locally clayey sandstone (Davidson, 1995). At the surface, they have weathered into laterite caps above deep sand.

The geology and stratification of the site area and its surroundings are shown in Figure 6 (DOW, 1989). Cretaceous-age sand forms the surface geology in the development site. The stratification shows layers of rocks with low permeability, fractured and weathered rocks.

Table 2: Riverside Development hydrogeology (DOW, 1989)

Hydrogeology	
Aquifer	Rocks of low permeability, fractured and weathered rocks – local aquifers
Lithology	Sand
Geological age	Cretaceous

There are a number of regional aquifers within the catchment. The property is underlain by the following aquifers (from surface): the Mirrabooka Aquifer, Leederville–Parmelia Aquifer and Yarragadee North (DOW, 1989; Davidson, 1995) (Table 3).

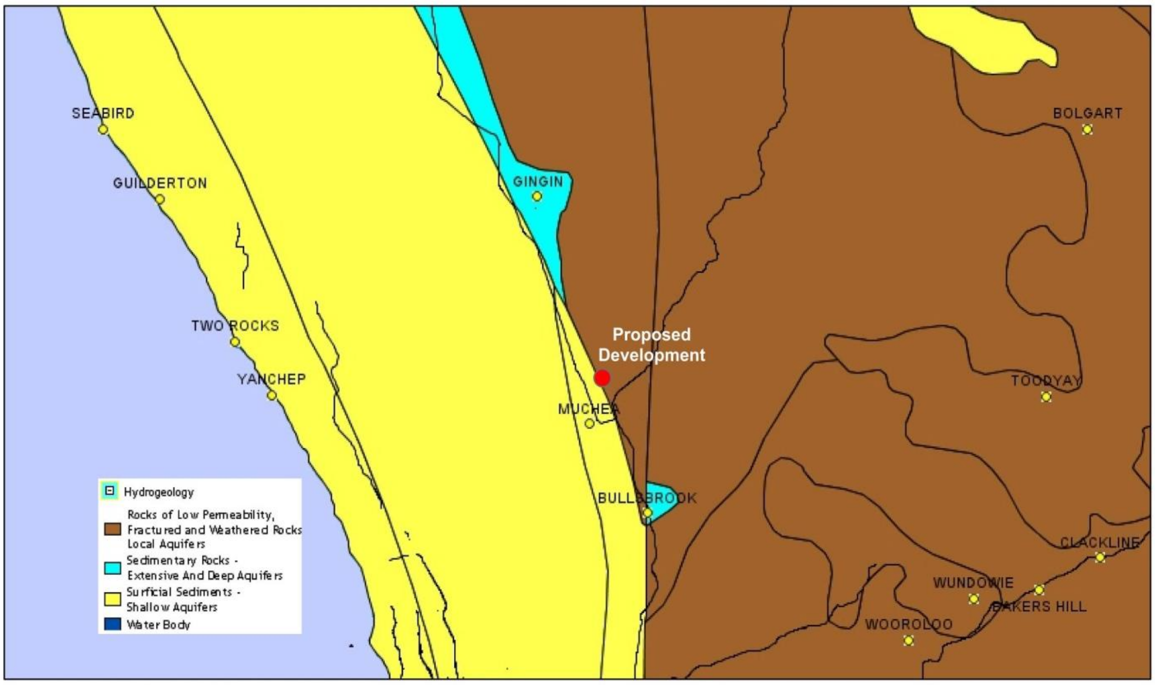


Figure 5: Riverside Development hydrogeology (DOW, 1989)

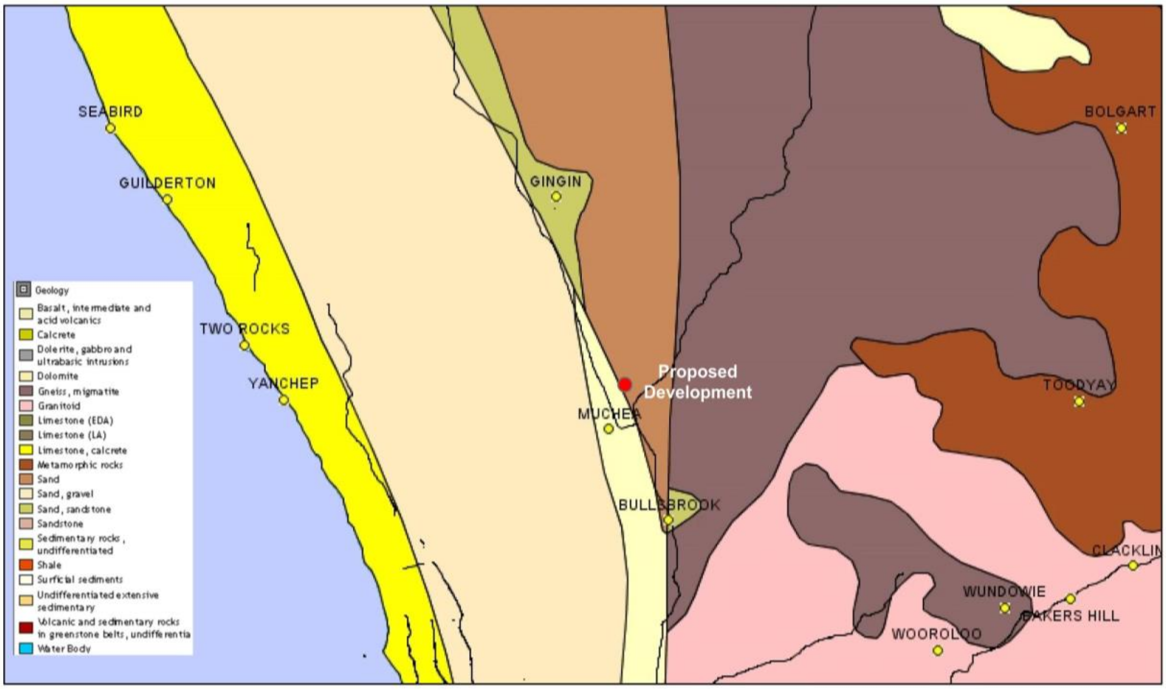


Figure 6: Riverside Development geology (DOW, 1989)

1.3.4 Aquifers

The aquifers in the region of the development are described in Table 3 and shown in Figure 7.

Table 3: Aquifers in the region of the development (adapted from DOW, 2015)

Aquifer	Description and Notes	Location
Leederville	• Deep aquifer (sandstone, shale), up to 550m thick • Semi-confined to confined aquifer • Variable water quality, generally fresh groundwater (<1,000mg/L TDS) • Good bore yields (up to 3000kL/day) • Provides base flow to Gingin Brook downstream of Mungala Brook confluence • Seawater interface is likely to be offshore	South of Wedge Island and west of the Brand Highway
Leederville – Parmelia	• Interconnected Leederville Formation and Parmelia Group (sandstone, shale) • Semi-confined to the north becoming confined to the south • Generally fresh groundwater (<1,000mg/L TDS) • Good bore yields (up to 3,000kL/day) • Recharged in north-eastern part of the Gingin groundwater area as well as in the Jurien and Arrowsmith groundwater areas • Contributes to base flow in headwaters of the Gingin Brook and downstream sections • Important for maintaining summer flows in the Moore River	East of the Brand Highway
Lesueur	• Mainly sandstone • Groundwater is fresh-to-brackish	Small area in the northwest of the plan area
Yarragadee	• Deep aquifer (sandstone, shale), up to 2,000m thick • Unconfined to confined aquifer • Generally fresh groundwater (<1,000mg/L TDS) however high groundwater salinity along the Darling Fault (Scarp) • Very good bore yields (up to 5,000kL/day) • Seawater interface is likely to be offshore	Present in most of the plan area

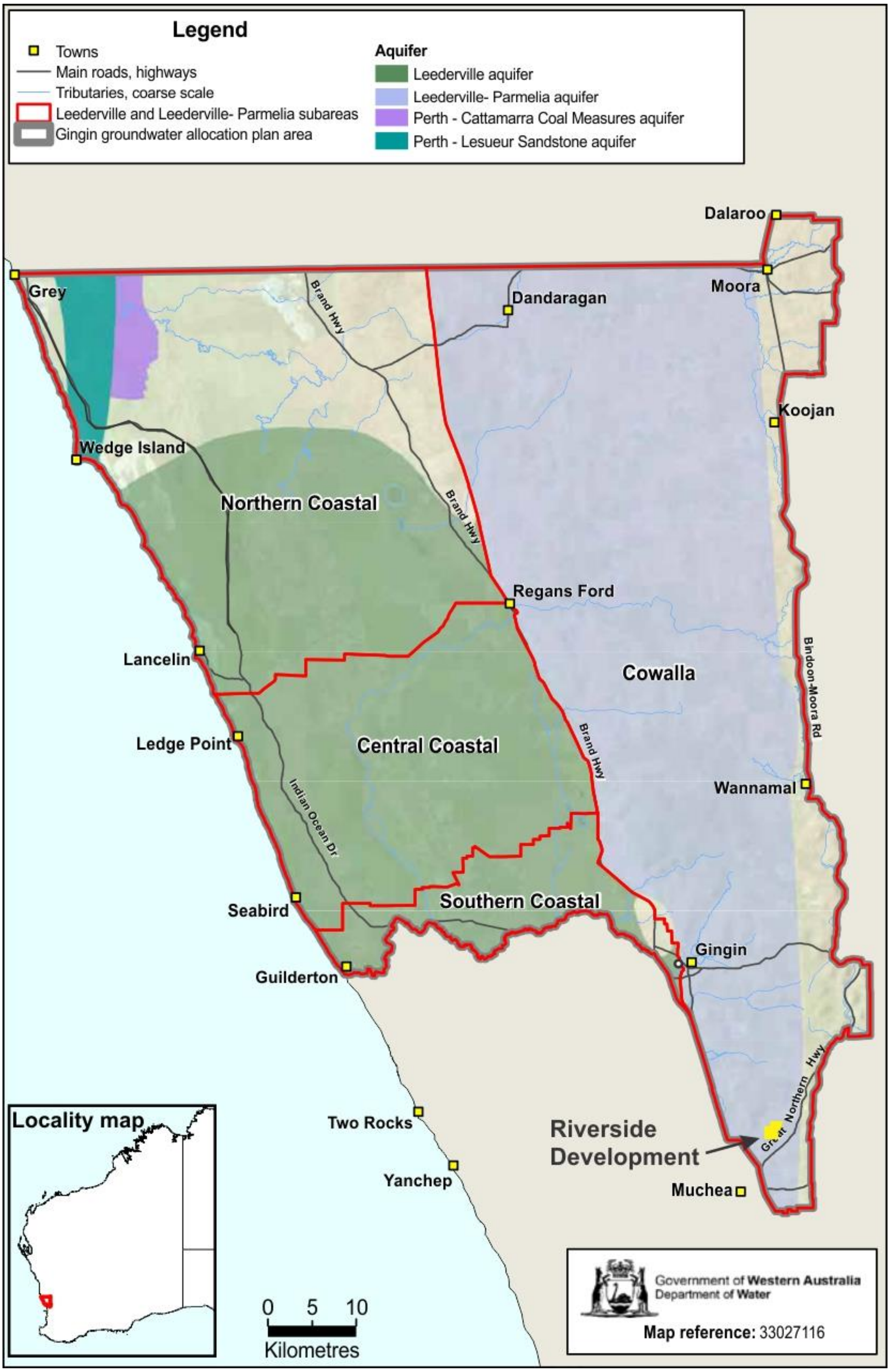


Figure 7: Aquifers in the Gingin Water Allocation Plan region in relation to the development (taken from DOW, 2015)

1.4 Future water supply requirements

There is no existing potable water supply at the development (Figure 7), and so Aqua Ferre proposes to refurbish the existing bore and construct a bore into the confined Leederville Aquifer to meet the potable water needs of the Riverside Development and the MEN. Analyses on the current bore at the site (Table 6) indicate that the quality of the water source is suitable and the fact that quantity requirements are less than that originally used for the wildflower venture indicates that the quantity required will be available from a properly constructed and developed production bore.

There is a total requirement of 151ML pa of water for the Riverside Development (101ML pa) and MEN (Stage 1) development (50ML pa) (per Section 3, Methods/Principles of Service Provision, Reticulation System Design; Aqua Ferre, 2019). This water will be sourced from the Groundwater Licence 59907 (Table 4), and represents approximately 52% of the total water licence of 288,800kL pa.

The water demand for the Riverside and MEN developments is described in detail in the "Reticulation System Design" document (Aqua Ferre, 2019) prepared by Aqua Ferre and its advisors in relation to its licence application to ERA.

1.5 Protection and allocation

1.5.1 Existing water source protection

As this is a new development, there are no existing strategies for water source protection for the site.

1.5.2 Current allocation licence

DWER is responsible for the administration of water resource use in Western Australia under the RIWI Act. Under this Act, the right to use and control surface and groundwater is vested with the Crown. The RIWI Act requires the licensing of groundwater abstraction (pumping water from a bore, spring or soak) within the Act proclaimed groundwater areas and all artesian wells throughout the state.

The proposed potable supply scheme falls within the Gingin groundwater area proclaimed under the RIWI Act. The Riverside Development site has a licence to abstract water from the Leederville Aquifer with a total allocation of 288,800kL pa. The developer, Riverside, has transferred the licence GWL 59907(3) (Table 4) to the Water Corporation (now GWL 59907(4)). This licence will be transferred to Aqua Ferre when a Water Service Licence from ERA has been granted.

Table 4: Licence information for the existing bore at the Riverside Development site

Licence Information	
Licence Number	GWL 59907(4)
Licence Type	Groundwater Licence
Issue Date	08.08.2013
Expiry Date	07.08.2023
Licence Allocation	288,800 kL/a
Party	Water Corporation
Groundwater Area	Gingin
Groundwater Subarea	Cowalla Confined
Aquifer	Perth – Leederville – Parmelia
Licence Address	Lot 2 Reserve Road, Chittering

Source: DWER website

1.5.3 Gingin groundwater allocation plan

DWER manages the volume of water that can be taken from rivers and groundwater aquifers by developing water allocation plans. The groundwater resources of the Gingin region are contained in a series of aquifers; namely, unconfined superficial and surficial aquifers, fractured bedrocks and the semi-confined and confined aquifers of Poison Hill, Mirrabooka, Leederville, Leederville Parmelia, Yarragadee, Cattamarra and Lesuer.

The Gingin Groundwater Allocation Plan (DOW, 2015) is a guiding document for the sustainable management of ground water resources that influence the extraction of water at Reserve Road, Chittering. The plan seeks to ensure:

- licensed entitlements can be met reliably in most years
- water source options to support growth in agricultural and horticultural industries are clear
- sufficient water is available to support population growth in local towns, as well as to provide a future groundwater source option for Perth's Integrated Water Supply Scheme
- groundwater-dependent ecosystems and watercourses are protected from over-abstraction.

This DWSPP has been prepared to assist and safeguard drinking water sources from risk of contamination and to ensure a reliable safe, good quality drinking water source is available to consumers now and into the future.

Figure 8 shows the Gingin Groundwater Allocation Plan (DOW, 2015) area and the location of the Riverside Development. According to report by the Waters and Rivers Commission ("Managing the Water Resources of the Gingin Groundwater Area", 2002), the Reserve Road site falls within the Leederville–Parmelia confined aquifer, sub-area Cowalla. (Refer also to Table 4, extract from DOW website regarding licence information.)

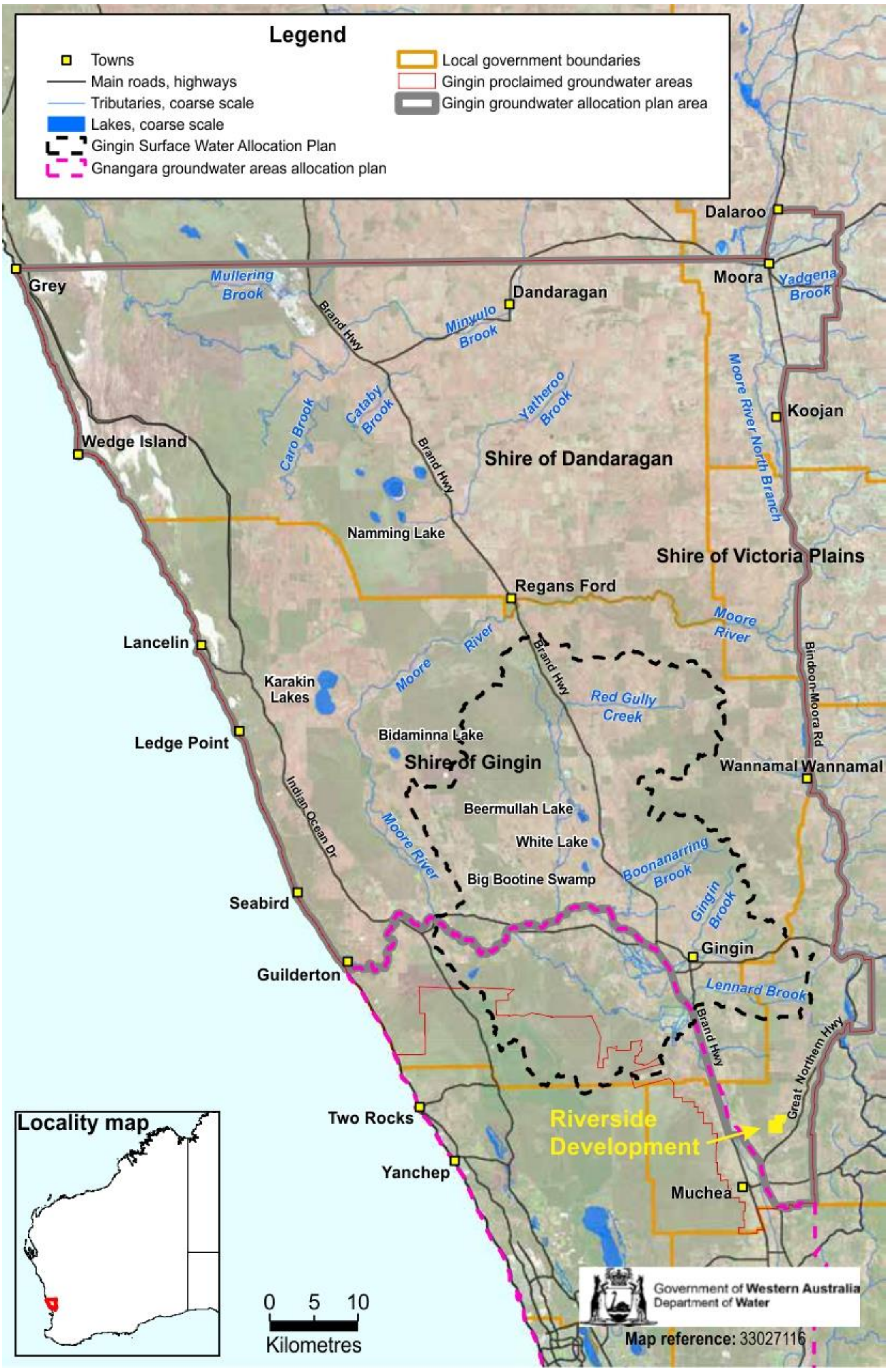


Figure 8: Gingin groundwater allocation area (DOW, 2015)

2 Water Quality Monitoring and Contamination Risks

Groundwater quality varies according to geology and position within the groundwater flow system relative to recharge and discharge. In addition, factors such as land use, groundwater abstraction and climate can also affect the quality of groundwater (Davidson, 1995).

DWER measures various water quality parameters in the groundwater reserves, such as salinity, nutrients, and groundwater acidification (Davidson, 1995). Salinity is one aspect of water quality which affects all water users (domestic, agricultural). Salinity can be expressed as TDS measured in mg/L or as electrical conductivity measured in deci-Siemens per metre.

2.1 Water quality

A bore exists on the land to be used for the Riverside Development (Table 5 and Figure 9). The log of the existing bore is found in Appendix A (provided by DOW). A new bore will be constructed under the *Minimum Construction Requirements for Water Bores in Australia* (National Uniform Drillers Licensing Committee, 2012) to meet the requirements of this development.

Table 5: Position and depth data for existing bore at the Riverside Development site

Existing Bore Information	
Easting	405153
Northing	6511488
MGA zone number	50
Depth of water abstraction	>225 metres

Water sampling has been undertaken from the existing bore to provide water quality results over time. The existing bore has been drilled into the confined Leederville Aquifer and the average values for several parameters are summarised in Table 6 and provided in detail in Appendix B. The average TDS is 294mg/L, well below the maximum set by the ADWG (NHMRC and NRMMC, 2011) for aesthetic purposes. All other parameters are well below the ADWG except for iron (Fe) and manganese (Mn). Thermophilic amoebae were detected in all samples. Consequently, the bore water will be treated to decrease the levels to meet the requirements as established in the ADWG and by DOH.

The potable water treatment train is described in detail in the "Reticulation System Design" (Aqua Ferre, 2019) document prepared by Aqua Ferre. This sets out the processes that have been included in the design to reduce iron and manganese concentrations and to remove thermophilic amoebae. It is noted that in the treatment of these contaminants there will be other non-targeted benefits to water quality. Management of drinking water quality, chemical and biological, has been undertaken in Aqua Ferre's Drinking Water Quality Risk Assessment which has been presented to the DOH.

Table 6: Summary table for analyses conducted on untreated groundwater sampled between April and November 2015 in comparison to the ADWG (NHMRC and NRMMC, 2011)

Bore Water Quality Analysis (GWL 59907)	Units	Average	Max	Min	ADWG Limits	
					Health	Aesthetic
pH in water	pH Units	**6.58**	7.2	**6.2**		6.5–8.5
Electrical conductivity water	µS/cm	**494**	520	460		
TDS (grav)	mg/L	**294**	310	270		500
Chloride in water	mg/L	**118**	120	110		250
Fluoride in water	mg/L	**0.3**	0.3	0.3	1.5	
Iodide in water	mg/L	**<1**	<2	<3	0.1	
Bromide	mg/L	**<0.5**	<0.5	<0.5		
Sulphate in water	mg/L	**12.1**	14	6	500	250
Total Cyanide	mg/L	**<0.004**	<0.004	<0.004	0.08	
Sulphide in water	mg/L	**<0.01**	<0.01	<0.01		
Nitrate as NO_3	mg/L	**<0.5**	<0.5	<0.5	50	
Nitrite as NO_2	mg/L	**<0.5**	<0.5	<0.5	3	
Ammonia as N	mg/L	**0.051**	0.15	0.019		0.5
Dissolved CrVI	mg/L	**<0.005**	<0.005	<0.005	0.05	
Hardness as $CaCO_3$	mg/L	**49.7**	58	46		200
Sodium – Dissolved	mg/L	**70.8**	78	66		180
Aluminium –Total	mg/L	**0.05**	0.05	0.05		0.2
Arsenic –Total	mg/L	**0.001**	0.001	0.001	0.007	
Barium – Total	mg/L	**0.0903**	0.1	0.082	0.7	
Beryllium – Total	mg/L	**<0.0005**	<0.0005	<0.0005	0.06	
Boron – Total	mg/L	**0.054**	0.07	0.042	4	
Cadmium – Total	mg/L	**<0.0001**	<0.0001	<0.0001	0.002	
Chromium – Total	mg/L	**<0.001**	<0.001	<0.001		
Copper – Total	mg/L	**0.033**	0.17	0.002	2	1
Iron – Total	mg/L	**10.31**	**16**	**1.7**		0.3
Lead – Total	mg/L	**0.004**	0.004	0.004	0.01	
Molybdenum – Total	mg/L	**0.003**	0.005	0.001	0.05	
Manganese –Total	mg/L	**0.261**	**0.49**	0.027	0.5	0.1
Mercury – Total	mg/L	**<0.00005**	<0.00005	<0.00005	0.001	
Nickel – Total	mg/L	**0.0034**	0.009	0.001	0.02	
Selenium – Total	mg/L	**0.003**	0.003	0.003	0.01	
Silver – Total	mg/L	**<0.001**	<0.002	<0.003	0.1	
Antimony – Total	mg/L	**0.001**	0.001	0.001	0.003	
Tin – Total	mg/L	**0.002**	0.003	0.001		
Uranium – Total	mg/L	**<0.0005**	<0.0005	<0.0005	0.02	
Zinc – Total	mg/L	**0.052**	0.19	0.013		3
Thermophilic Amoebae	cfu/100mL	**D**	**D**	**D**	95% nil	
Thermophilic Naegleria	cfu/100mL	**ND**	ND	ND	95% nil	
Thermotolerant Coliforms	cfu/100mL	**<1**	<1	<1	98% nil	
E.Coli	cfu/100mL	**<1**	<1	<1	98% nil	

*** Red indicates exceedances for both health and aesthetic ADWG values**

**** Blue indicates exceedances for aesthetic ADWG value but meets health values**

Aqua Ferre will monitor both the raw bore water and the final treated water to ensure DWER requirements and the ADWG are met. The treatment train will have inline monitoring to ensure that water quality meets the AWDG standards. This will be accompanied by water sampling and analysis to demonstrate compliance (Section 3, Methods/Principles of Service Provision, “Reticulation System Design”; Aqua Ferre, 2019).

2.2 Contamination risks

The risk of contamination to the Riverside Development water source and reserves from potential pollutants resulting from surrounding land uses and surface activities can be considered as low because the water is drawn from a confined aquifer at depth. Nonetheless, proper bore construction and maintenance are essential for existing bores and any new bores proposed to be located near drinking water production bores in order to prevent the bores from creating a contamination pathway between surface activities and the aquifer. Hence, all bores be constructed in accordance with “Minimum Construction Requirements for Water Bores in Australia (3rd Edition)” (National Uniform Drillers Licensing Committee, 2012).

The new production bore is located within the Riverside Development in the south east corner of Lot 2, and the proposed WTP will be constructed in the bore compound. Aqua Ferre will lease the property on which is it located and have unrestricted access to the site and security of tenure. Figure 9 shows the location of the bore and the location of surrounding bores. There are three bores located in a 1km radius from Lot 2, but there are several within a 2km radius from the site, particularly to the south and south east (Figure 9).

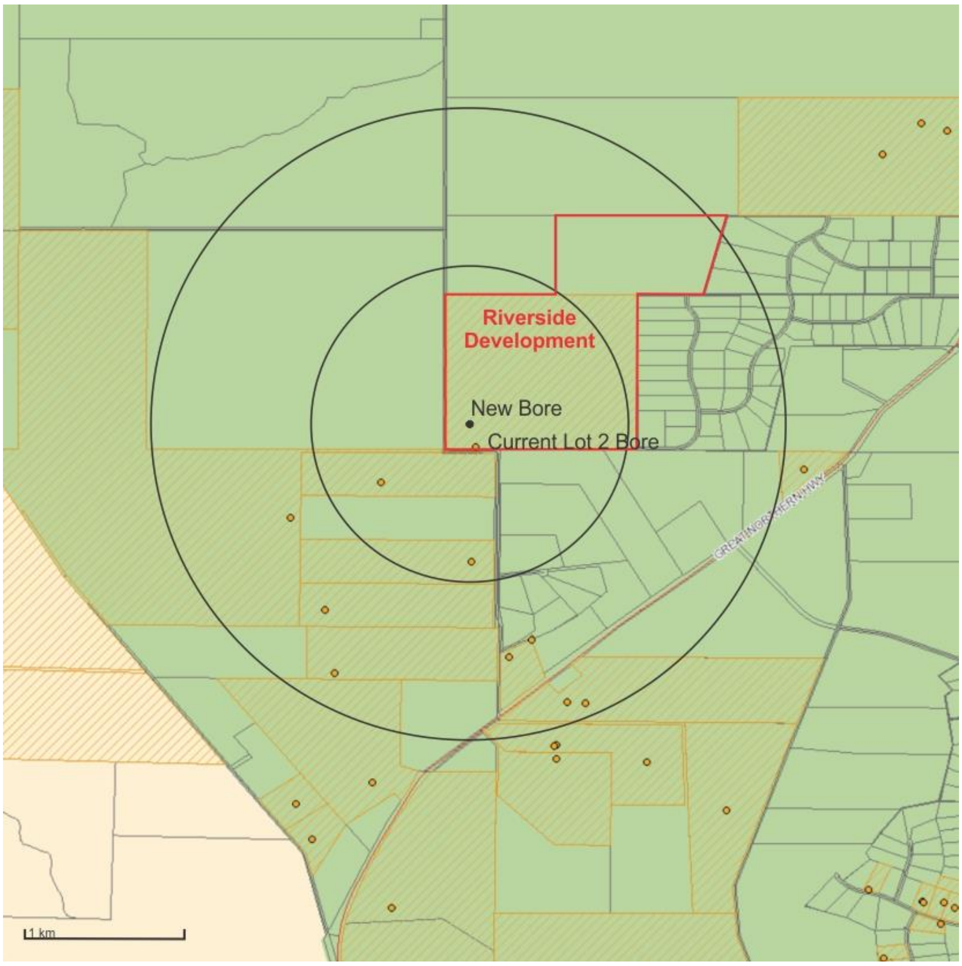


Figure 9: 2km and 1km radii bore search from Lot 2 Reserve Road licence

Figure 8, the urban area (Muchea town site) is well down gradient, and as such, is not considered to be a risk of contamination to the water supply. Any potential risk associated with existing and proposed land uses and activities in the area have been identified.

2.3 Contamination risks relevant to the drinking water source

2.3.1 Microbiological

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the faeces of humans and domestic animals.

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (eg salmonella, escherichia coli and cholera), protozoa (eg cryptosporidium, giardia) and viruses. Escherichia coli counts are a way of measuring these pathogens and are an indicator of faecal contamination.

Pathogen contamination of a drinking water source is influenced by the existence of pathogen carriers (ie humans and domestic animals such as dogs or cattle), their transfer to and movement in the water source and the ability of the pathogen to survive in the water. The percentage of humans in the world that carry various pathogens varies. For example, it is estimated that 0.6–4.3% of people are infected with cryptosporidium worldwide, and 7.4% with giardia (Geldreich, 1996).

The effect on people consuming drinking water that is contaminated with pathogens varies considerably, ranging from mild illness (such as stomach upset or diarrhoea) to death. Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk.

The confined nature of the aquifer to be accessed by Aqua Ferre, and the proposed drilling and construction requirements effectively limits any potential occurrences of microbiological contamination to issues within the treatment and reticulation systems. These risks will be mitigated though treatment and disinfection (Section 3 of the Reticulation System Design; Aqua Ferre, 2019).

2.3.2 Health-related

A number of chemicals (organic and inorganic) in drinking water are of concern from a health perspective because they are potentially toxic to humans. Chemicals that can occur in drinking water sources may be derived from chemicals attached to suspended material in the aquifer, such as soil particles, and may result from natural leaching from mineral deposits or overlying land uses (NHMRC and NRMMC 2004b).

Pesticides include agricultural and household chemicals, such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides and other chemicals may occur as a result of accidental spills and/or incorrect use, overuse or leakage from storage areas.

Nutrients (such as nitrogen) can enter drinking-water supplies as a result of leaching from fertiliser application, septic tanks, and from faeces of domestic animals (such as cattle grazing on the land). Nitrate and nitrite (ions of nitrogen) can be toxic to humans at high levels, with infants less than three months old being most susceptible (NHMRC and NRMMC 2004a).

Hydrocarbons (eg fuels, oils) are potentially toxic to humans, and harmful by-products may be formed when they are combined with chlorine in the water treatment process. Hydrocarbons can occur in water supplies due to vehicle accidents, spills during refuelling and leakage from storage areas.

The confined nature of the aquifer will mitigate against potential chemical contamination.

2.3.3 Aesthetic

Impurities in drinking water can affect the aesthetic qualities of water, such as its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, water that is cloudy and has a distinctive colour may not be harmful (NHMRC and NRMMC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water and salinity can affect the taste.

Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes. The *Australian Drinking Water Guidelines* (NHMRC and NRMMC 2004a) set out aesthetic guidelines to meet the aesthetic requirements of consumers and to protect water infrastructure.

The proposed treatment design and schedules for the intended water supply will ensure aesthetic concerns are controlled (Section 3 of the Reticulation System Design; Aqua Ferre, 2019)

2.3.4 Groundwater bores

All proposed new bores sourcing water from the confined aquifer in the vicinity of the proposed Reserve Road (Chittering) Water Reserve (Figure 2), should be assessed to determine their contamination or interference risk to the drinking water source, through DWER's groundwater licensing process (DWER, proponents).

The Aqua Ferre bores will be constructed in accordance with minimum construction requirements for water bores in Australia (National Minimum Bore Specifications Committee 2003).

Protection of the proposed drinking water source should also have regard for the protection of quantity as well as quality. This means that a possible restriction on the construction of further bores within the confined aquifer, within a limited zone (say 1,000m) from the proposed production bore, may need to be considered and developed with DWER.

3 Land Use Assessment

3.1 Existing land use

Land use in the shire is highly diverse (Figure 10). It can be grouped into:

- grazing
- horticulture
- fodder production
- timber production
- mining/basic materials extraction
- industrial
- urban and residential.

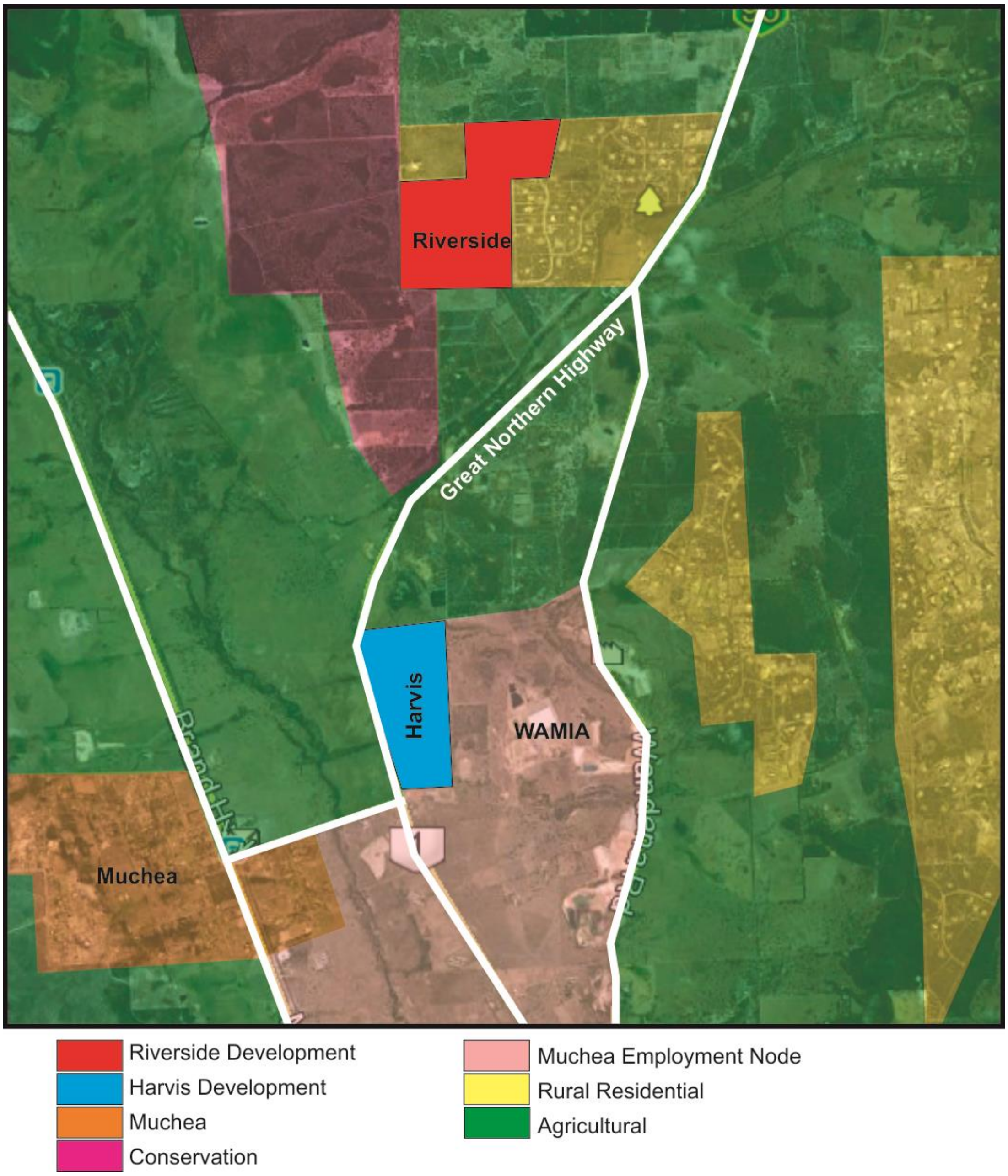


Figure 10: Site and surrounding land uses

The development site has been mainly used in the past as a commercial wildflower farm with small pockets of original bushland still present. The southern portion adjacent to the subject site contains houses, stores, farming equipment and wildflowers (Belleng VDM, 2006).

The predominant land use is agriculture and rural-residential living. The main form of agriculture other than wildflowers is grazing. East of the development is the locality of Chittering Rise, which is further low density rural residential living. To the west is predominantly native vegetation with small areas of grazing to the south and south east.

Careful examination of a 1km zone around the wellhead (Figure 11) shows that the predominant land uses are:

- grazing – there is a small area to the south east of the well head which is a low risk activity
- horticulture in Lot 2 – formerly a wildflower farm where there have been no chemical and or fertiliser inputs for ten years (*pers. comm*. Sean Carbone former landholder and current land manager)
- residential – this will largely be the new development on Lot 2, low density residential
- native vegetation – biodiversity corridor, to the west and south of the development which is a low risk land use activity.

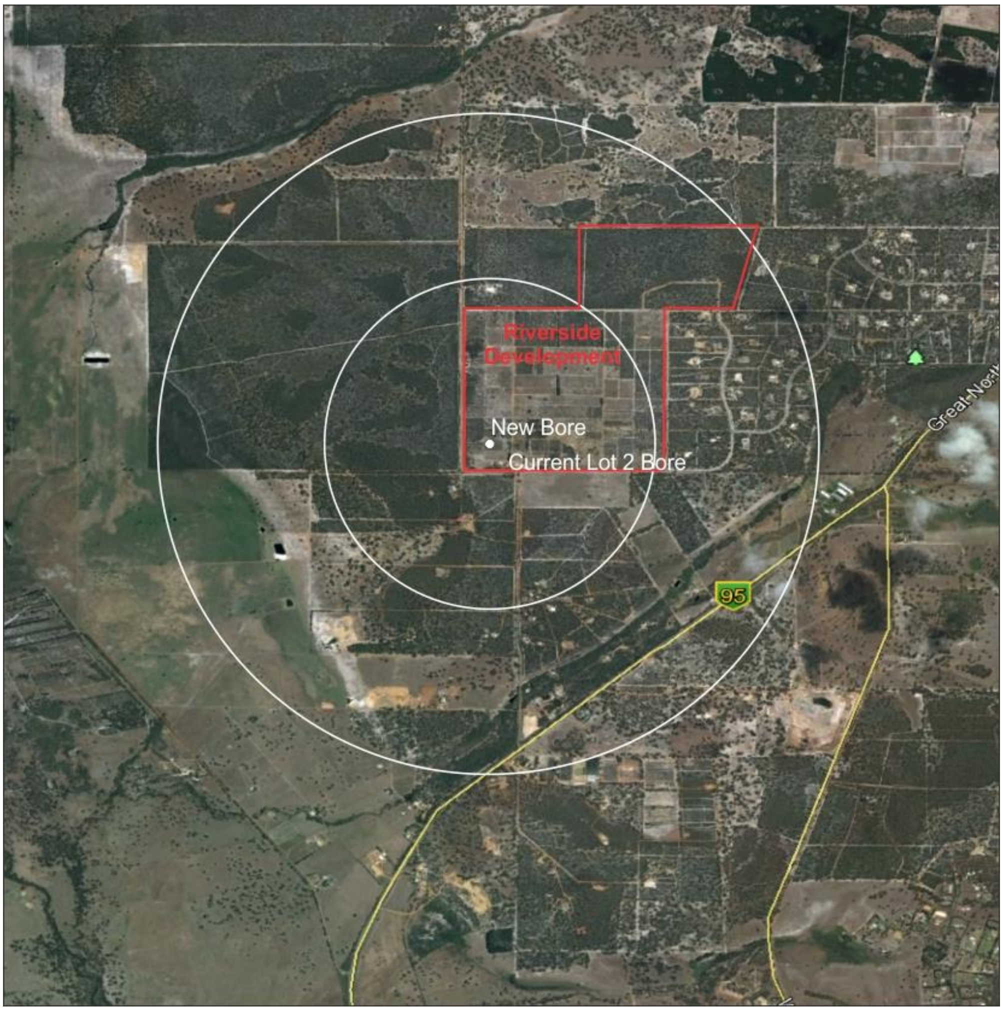


Figure 11: Map showing the 1km radius from the well head highlighting existing land use

3.2 Water source protection risk assessment

The purpose of the DWSPP is to ensure the protection of groundwater for the drinking water supply. It is therefore important to assess local land use and assess any risks that it presents to water quality (Table 7). The risk matrix has been developed for land uses within a 1km radius of the bore with other significant land uses in the general vicinity.

Given the confined nature of the aquifer, the depth of the abstraction zone, and the presence of thick shales above this zone, the potential for contamination from existing land-uses can be considered low.

Aqua Ferre will regularly monitor source water regularly from its bores to identify any changes in water quality. This monitoring will be undertaken to not only assess changes in water quality but also to ensure the water treatment process meets the requirements of the ADWG and mitigates unnecessary cost associated with chemical and further plant additions.

There are three main contamination risks:

- microbial – pathogens organisms that are capable of causing disease, including bacteria, protozoa and viruses
- health-related – these include a wide range of chemicals (organic and inorganic) that can contaminate drinking water. Sources of contamination may include agricultural herbicides and pesticides, inadvertent chemical spills, and nutrients from a wide range of sources
- aesthetic – impurities in water that can affect the aesthetic quality of water, including colour, taste, smell, and hardness. These may not be hazardous to health but may impact customers use and enjoyment.

The risk assessment in Table 7 was undertaken by key Arris staff and the findings were reviewed by Tony Laws, a former Manager of Water Source Protection, DOW.

Table 7: Land use risk assessment for the protection of the drinking water source for the Aqua Ferre treatment plant and reticulated water supply

Land Use	Potential for Water Quality Risk: Hazard	Potential for Water Quality Risk: Likelihood	Management Consideration	Preventative Measures	Protection Strategies
Residential • Existing residential development at Chittering • Riverside Development, 238 low density development	Nutrient contamination from septic tank systems and fertiliser use.	Low	The Riverside Development will use approved ATUs (DOH). The Fuji Clean CE1500, ie one such approved system with discharge capability of: • TP (% removal): 1.3 mg/L (84%) • TN (% removal): 21.0 mg/L (58%)	Monitoring of water quality from production bores.	Undertake community education regarding water quality protection and best management practices.
	Pathogen contamination from septic tank systems.	Low			
	Chemical contamination from use of household chemicals and pesticides.	Low			
	Hydrocarbon contamination from fuel and oil storage and spills.	Low			
Rural areas • Flower farm to the north of the Riverside Development • Grazing areas to the south and southeast of the Riverside Development	Nutrients from animal faeces (eg horses), septic tanks and fertiliser use.	Low	The rural area is currently unserviced and wastewater is disposed via septic tank systems. Low density livestock grazing activities. Native flower farming, requires low levels of fertiliser application compared to other irrigated horticulture.	Monitoring of water quality from production bores.	Undertake community education regarding water quality protection and best management practices.
	Pathogens from animal faeces and septic tanks.	Low			
	Use of household and agricultural chemicals and pesticides.	Low			
	Hydrocarbon contamination from fuel and oil storage and spills.	Low			

Land Use	Potential for Water Quality Risk: Hazard	Likelihood	Management Consideration	Preventative Measures	Protection Strategies
Commercial Developments	Increased chemical, nutrient and pathogen loading.	NA	The current land use options and zoning does not allow for commercial development.	None required.	
Recreation Recreation area will be established in the Riverside Development	Nutrients from fertiliser use.	Low	The recreational area consists of approximately 2ha. It will be an amenity and recreational area with low maintenance.	Monitoring of water quality from production bores.	• Follow best management practices as recommended in the WQPG Environmental Guidelines for the establishment and maintenance of turf and grasses areas (Swan River Trust 2014). • Pesticide use should be in accordance with Circular No: PSC88 – Use of herbicides in water catchment areas (DOH 2007).
	Chemicals from pesticide application and aquatic centre.	Low			
Roads	Hydrocarbons from accidents or spills.	Low	Being in a low density residential area there are a low number of local roads. The local emergency responds to spills and accidents.	• Monitoring of water quality from production bores. • Reserve Road is being sealed, as required in the development approval, and fenced bore compounds. • The bore adjacent Reserve Road is >220m deep. • Local Emergency response. • The Great Northern Highway is >1,600m from the extraction bores.	• Continue water quality monitoring program. • Follow best management practices recommended in the WQPN *Roads near sensitive water resources* (DOW 2006d). • Signage to indicate the water reserve boundary and emergency contact number should be installed. • Road drainage should be directed away from the bores.
	Chemicals from accidents or spills.	Low			
Waste Disposal	Increased chemical, nutrient and pathogen loading.	Low	The development will have Council waste services provided.	Monitoring of water quality from production bores.	Undertake community education regarding water quality protection and best management practices including the impact of accumulated and stored wastes.

Land Use	Potential for Water Quality Risk		Management Consideration	Preventative Measures	Protection Strategies
	Hazard	Likelihood			
WTP	Increased chemical loading.	Low	The treatment system has been designed to lower the requirement for chemicals being bought on site. Low volumes <700L of Hypochlorite will be stored. Back wash filter residue will be captured in a geo bag and waste water used for on-site irrigation.	Chemicals will be purchased in 20L containers and storages will have appropriate bunding.	Storage and Handling of Workplace Dangerous Goods NATIONAL CODE OF PRACTICE [NOHSC:2017 (2001)]

3.3 Land uses and activities

Land use and activities in the surrounding areas of the development site are not expected to change in the short term other than for the MEN Phase 1. Figure 12 shows the Local Planning Strategy (2001–2015) for the Shire of Chittering (2004).

Residential expansion is anticipated along the western side of the development and some areas are even considered as a priority for development in the shire. North of the development site is considered a reserve area for agriculture. Along the west side is the Gingin Scarp conservation area where horticulture and vegetation clearing are limited by the Shire.

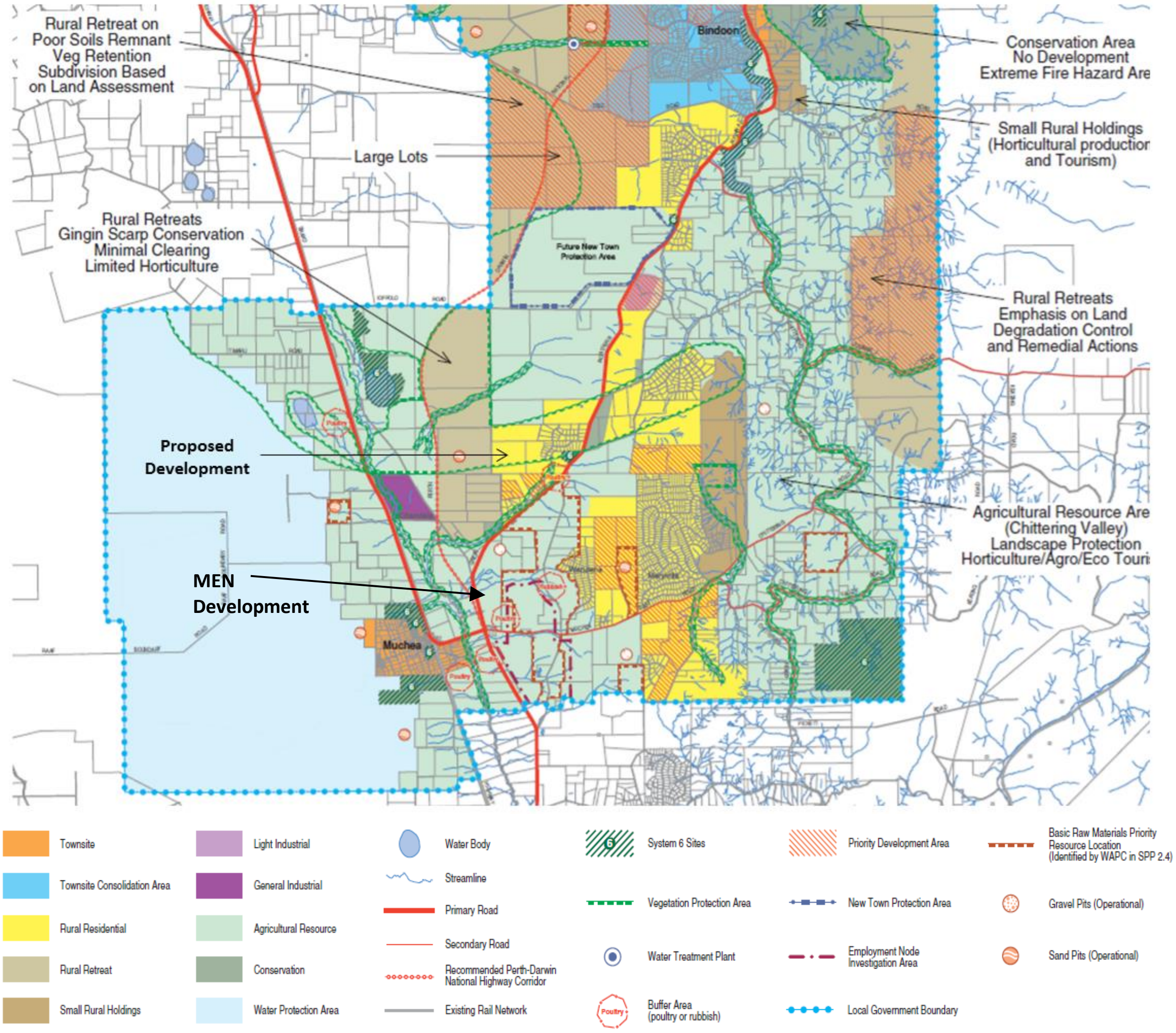


Figure 12: Local Planning Strategy for the Shire of Chittering 2001–2015 (Shire of Chittering, 2004)

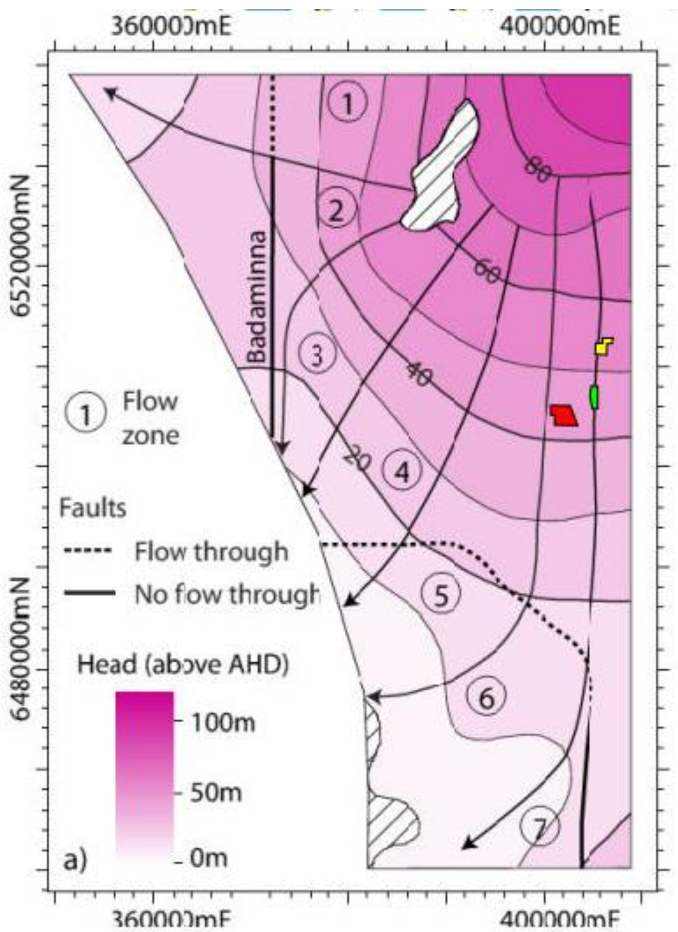
The proposed MEN is 4km south of the Riverside Development, at the intersection of the Brand Highway and Great Northern Highway. This area has been set aside for service-based uses, such as transport, livestock, fabrication, warehousing, wholesaling and general commercial (WAPC, 2011). The future land use is still under study.

As the MEN is developed, a detailed assessment of land use compatibility with water source protection should be performed due to its proximity to the Reserve Road (Chittering) water reserve.

It is highly unlikely that the township of Muchea and the MEN will impact water quality due to:

- The regional movement of groundwater from north to south (Figure 13, Leyland, 2011) means that the groundwater at the MEN or the town of Muchea will not interact with groundwater at the extraction bore.
- The separation distances between these areas and the extraction bore, see Figure 12.
- The relatively low extraction volumes which are unlikely to create a significant cone of depression causing the movement of groundwater from these areas towards the extraction bore.
- The groundwater is being extracted from a confined aquifer where the influence of the township and the MEN will be low.
- Site contamination controls imposed on new industries likely to be developed in the MEN are likely to be stringent further mitigating risks.
- The water quality at the extraction bore will be protected by the water source area being protected and proclaimed as a water reserve.
- Protection is mainly from the confined nature of the aquifer.

The proposed drinking water reserve is not expected to be subject to any impact as a result of existing and/or future land use activities because the Leederville–Parmelia Aquifer is confined.



Source Leyland, L. (2011)

Figure 13: Groundwater flows in the area of the Riverside and MEN developments and the Muchea townsite

Legend note – yellow = the Riverside Development (including the Reserve Road (Chittering) Water Reserve); green = MEN development; and red = the Muchea townsite

4 Water Quality Management, Monitoring and Reporting

A wide range of chemical, physical and microbiological properties can impact on water quality and therefore affect the provision of safe, good quality, aesthetically acceptable drinking water to consumers.

The water quality, monitoring and reporting policies and procedures will include:

- this DWSPP which will follow DOW's Community Drinking Water Sources – Protection and Management (2012)
- a water quality management approach which will be consistent with the ADWG Framework for the Management of Drinking Water Quality (NHMRC and NHMMC, 2011), adapted to a small system
- water quality monitoring procedures which will follow the "Small Community Model Assessable Sampling Grid" (DOW, 2011) and routine reporting which will follow the DOW Systems Compliance and Reporting Requirements for Small Community Water Providers (2011) with quarterly and annually reporting to the department
- procedures for materials that come in contact with water which will follow the DOH Materials and Substances in Contact with Drinking Water specifications (2013)
- emergency reporting procedures which will follow the DOH Systems Compliance and Reporting Requirements for Small Community Water Providers (2011)
- reporting procedures and actions on Amoeba Response will follow the DOH Amoeba Response Protocol (2010)
- analytical methods will follow the American Public Health Association's Standard Methods for the Examination of Water and Wastewater 22nd Edition (2012).

5 Groundwater Source Protection Strategy

5.1 Protection objectives

The objective of the DWSPP is to protect the Riverside Development drinking water, quality and quantity, in order to ensure a reliable, safe drinking water is supplied to consumers.

The measures and management practices recommended in the DWSPP are aimed at avoiding, minimising and/or managing the risk of groundwater contamination, depending on the susceptibility of the source to contamination, the nature of the resource and the existing and proposed land uses in the surrounding areas.

Protecting a drinking water source in not only about protecting its quality; it should also be about ensuring that the available quantity is not compromised. While this strategy can suggest methods of protecting quantity, it is beyond the scope of the report, or the responsibility of the proponent to legislate or restrict other users of groundwater in the area. The responsibility to manage the state's water resources and supply rests with DWER and regulatory authorities.

5.2 Proposed proclamation of Reserve Road water reserve

Water reserves, catchment areas and underground water pollution control areas are collectively known as public drinking water source areas. The protection of the areas relies on statutory and non-statutory measures for water resources management and land-use planning.

This DWSPP recommends proclaiming the boundary of the Reserve Road (Chittering) water reserve under the *Country Areas Water Supply Act (1947)*. This is to be the boundary of the bore field/treatment compound (Figure 2). This will enable DWER to control potentially polluting activities, to regulate land use, inspect premises and to take the necessary steps to prevent or clean up pollution (DOW, 2009c).

Importantly, that the water from the production bore is drawn from a deep confined aquifer protected by an overlying layer of Kardinya shale that sits above the groundwater resource and acts as barrier to contamination. The contamination risks from surrounding land uses to the Riverside Development water source and reserves are low. Nonetheless, proper bore construction and maintenance of existing bores and any new bores proposed to be located near drinking water production bores is required.

5.3 Priority areas

The Western Australian Government policy for the protection of public drinking water source areas includes a system that defines three specific priority areas:

- Priority 1 areas have the fundamental water quality objective of risk avoidance (eg state forest and other Crown land). These areas are managed to ensure that there is no degradation of the drinking water source by preventing the development of potentially harmful activities in these areas.
- Priority 2 areas have the fundamental water quality objective of risk minimisation (eg land that is zoned rural). These areas are managed to ensure that there is no increased risk of water source contamination/pollution.
- Priority 3 areas have the fundamental water quality objective of risk management (eg areas zoned urban, industrial or commercial). These areas are defined so as to manage the risk of pollution to the water source from catchment activities.

For further information, refer to *Water Quality Protection Note: Land Use Compatibility in Public Drinking Water Source Areas* (DOW, 2004).

The assignation of the priority area ought to be in accordance with current Western Australian Government policy. If the site is proclaimed as a water reserve, it is recommended that the land surrounding the production bore should be identified as a Priority 1. The main reason is because the water from this source is a strategic and fundamental supply to the development, then it should be assigned a high level of protection.

5.4 Land use planning

It is recognised under the *State Planning Strategy* (WAPC, 1997) that the establishment of appropriate protection mechanisms in statutory land-use-planning processes is necessary to secure the long-term protection of drinking water sources. As outlined in the *Statement of Planning Policy No 2.7 – Public Drinking Water Source Policy* (WAPC, 2003) it is appropriate that the Reserve Road Water Reserve, priority areas and protection zones be recognised in the Shire of Chittering. Any development proposals within the Reserve Road Water Reserve that are inconsistent with advice within the *Water Quality Protection Note – Land compatibility in Public Drinking Water Source Areas* (DOW, 2004a) or recommendations in this plan, should be referred to DWER.

The department's protection strategy for public drinking water source areas provides for lawfully established and operated developments to continue despite their location or facilities posing a level of risk to water quality which would not be accepted for new developments. The department may negotiate with landowners and operators on measures to improve these facilities or processes to lessen the level of water contamination risk.

In critical areas close to production bores, the department may negotiate to purchase land or development rights where the level of contamination risk is considered significant enough to have the potential to compromise the quality of water resources.

Land use and activities in the surrounding areas of the extraction bore site are not expected to change in the short- to medium-term, other than the Riverside Development. However, establishing appropriate protection mechanisms in statutory land use planning processes is important to secure the long-term protection of the water source.

WAPC's *Public Drinking Water Source Policy* (2003) recognises that appropriate protection mechanisms in statutory land use planning processes are necessary to secure the long-term protection of drinking water sources. Thus, in accordance with this policy, it is appropriate that the areas surrounding the source area should be recognised as a special control area in the Shire of Chittering Town Planning Scheme and associated planning approval processes. In addition, any development proposals in the surrounding areas should take into account the Water Quality Protection Note No 25: *Land use compatibility tables for public drinking water source areas* (DOW, 2016) and seek advice from DWER.

5.5 Best management practices

There are different ways to decrease water contamination risks of water sources by carefully considering design and management practices. There are tools available to provide guidelines for suitable bore construction methods to protect water sources, eg "Minimum Construction Requirements for Water Bores in Australia (3rd Edition)" from the National Water Commission (National Uniform Drillers Licensing Committee, 2012). Given that the aquifer to be developed is confined, with groundwater being under some reasonable pressure, adherence to this document and its recommendations for drilling, construction, and development is of paramount importance to ensure proper protection against contamination risk. Some specific best management practices to be applied are secure fencing to the bore compound and signage showing the name of water service provider and emergency contact numbers.

In addition, there are guidelines available for many land uses, including industry codes of practice, environmental guidelines and water quality protection notes (Appendix C). These guidance tools have been developed in consultation with stakeholders, such as industry groups, primary producers, state government agencies and technical advisors. The following water quality protection notes are recommended as best practice for water quality protection:

- agriculture – dryland crops near sensitive water resources
- contaminant spills – emergency response
- light industry near sensitive waters
- tanks for elevated chemical storage
- protecting public drinking water source areas
- rural restaurants, cafés and taverns near sensitive water resources.

The application and understanding of these guidelines will assist business and land managers to reduce the risk that their operations may cause unacceptable environmental impacts.

Education and awareness is another mechanism for water quality protection, especially for people visiting the area who are unfamiliar with the water source location.

A brochure will be produced, describing the Reserve Road water reserve, its location and the main threats to water quality and quantity. This brochure will be available to the community and will inform people in simple terms about the drinking water source and the need to protect it.

This brochure will be available from the Aqua Ferre website; further to this its availability will be included in water accounts.

5.6 Surveillance and bylaw enforcement

The quality of public drinking water sources within country areas of the state is protected under the *Country Areas Water Supply Act (1947)*. Declaration of these areas allows existing bylaws to be applied to protect water quality.

Appropriate signage on boundary fences of the proposed water reserve will advise the public about activities that are prohibited or regulated.

DWER considers bylaw enforcement, through surveillance of land use activities in public drinking water source areas, as an important mechanism to protect water quality.

5.7 Responding to emergencies

Water contamination may occur due to unforeseen incidents, as well from action taken (such as the use of chemicals) during emergency response.

The Shire of Chittering's Local Emergency Management Advisory Committee shall be familiar with the location and purpose of the water bore within the limits of the development. The fire and rescue services headquarters will be provided with a locality plan and this should be made available to the Hazardous Materials Emergency Advisory Team. Aqua Ferre will have an advisory role to any hazardous materials incidents in, or nearby Reserve Road, Chittering.

A map of the Reserve Road water bore will be made available to any personnel who deal with hazardous material related incidents in the area. Personnel should be highly aware of the potential of hazardous material on the water resource.

6 Recommendations for the DWSPP

The following recommendations are made for the Riverside Development (with the relevant stakeholder in terms of implementation is indicated in brackets at the end of each recommendation):

- proclaim the boundary of the Reserve Road (Chittering) water reserve under the *Country Areas Water Supply Act 1947* (DWER and Aqua Ferre). This is to be the boundary of the bore field/treatment compound (Figure 2)
- implement the water source protection strategies identified in this DWSPP to ensure the protection of water quality (Aqua Ferre)
- construct a sound boundary fence to the proposed reserve with a secure gate and signage informing any prospective buyers of the private drinking water source, the name and location of the water source provider and an emergency telephone number (Aqua Ferre)
- development and works proposals in the Riverside Development that are inconsistent with DWER's guidelines and Water Quality Protection Note should be referred to DWER for advice and recommendation (Shire of Chittering and Aqua Ferre)
- a surveillance program should be maintained to identify any incompatible land uses or potential contaminant threats within Reserve Road water drinking source (Aqua Ferre)
- new land uses not complying with WAPC *State Planning Policy No 2.7: Public Drinking Water Source Policy* (2003) and DWER's *Water Quality Protection Note 25 Land use Compatibility in Public Drinking Water Source Area* in proclaimed areas should be referred to DWER for assessment

- any bores proposed to be installed to use the aquifer in close proximity to the Reserve Road (Chittering) water reserve bore should be assessed to determine their location; construction and possible leakage do not pose a contamination risk to this drinking water source (DWER and Aqua Ferre)
- incidents covered under the *State Emergency Management Plan for Hazardous Materials Emergencies* (FESA, 2010) and occurred in the Reserve Road drinking water source should be addressed by Hazardous Materials Emergency Advisory Team, DWER and Aqua Ferre
- provide a copy of the DWSPP on the Aqua Ferre website (Aqua Ferre).

Implementation of these recommendations should be reviewed one year after the DWSPP is endorsed. A full review and update of the DWSPP should be undertaken by Aqua Ferre every five years.

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Appendix A – Log for Existing Bore at Reserve Road

FORML2889

FORM "L" COVER SHEET

DRILLING COMPLETION DATE: 25/02/1981

***BORE LOCATION ADDRESS:** LOT 2, 200 RESERVE ROAD, CHITTERING

PROPERTY PIN NUMBER: ______ (GIS Property Info.)

***BORE LOCATION CO-ORDINATES:**

MGA Zone Number: 50

Easting Number: 405153

Northing Number: 6511488

***Co-Ordinates Reliability:** Unknown
(Survey, DoW GIS, GPS, Unknown e.g. DoW GIS (WRL) (50m))

***GROUNDWATER SUBAREA NAME – DOW:** ECLIPSE HILL (e.g. Dardanup)

BASIN NUMBER: 616

LICENCE:

CAW Number: ______
(Not always shown or required, only used if no GWL #. If only a CAW Licence was issued write this number only and write 'Exempt' if the bore was exempt from licensing).

***GWL Number:** 59907

***GWL DPT ID Number:** 22593

MEDIA REFERENCE: SN1091 (File Number)

***GWL AQUIFER NAME:** ______
(If only a CAW Licence has been issued write this aquifer and CAW)

WIN AWRC NUMBER: 61602501

COMMENTS: SA

ELECTRONIC FILE NAME:

______ .pdf

Note: Fields marked with * must be completed.

Copy sent to WIN ☐
Scanned ☐

WIN SITE ID:
20025333

WATER AUTHORITY of Western Australia

27

Postal Address:
PO Box 265
Northam W A 6401

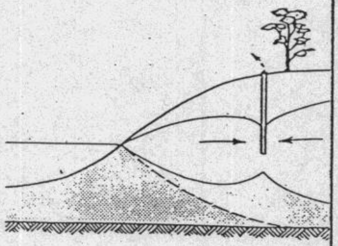
Telephone: 096 224 888

Facsimile: 096 222 696

A

FAX FROM

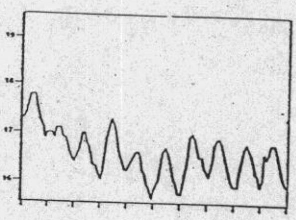
CON de BLECOURT
WATER RESOURCES OFFICER
CENTRAL REGION



TO: Groundwater & ENVIRONMENTAL

FAX NO: 09 4203176

DATE: 30/ 7 / 93.



NO OF PAGES (Inc. This Page) 18

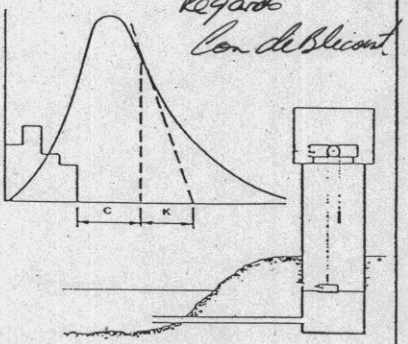
ATTENTION: ANDREW McCRAE.

MESSAGE

Attached more info on Bore 1/81 which is suppose to be located on Lot 6 GT NTH Hwy - Trading as Aust Wax Farms.

Also I have another lot info on Swan Loc M1313 a Mr Fewster he has an allocation of only 6,000 KL/a. There is no info on Lot 2 Reserve Rd Muchea. Their is Two bores on the Property and I believe one is artesian, depth of 250 metres.

Regards
Con deBlecourt



WARNING

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☐ We will forward the original documents by mail for your files.

☐ We recommend you photocopy (using a plain paper copier) the following documents and place the photocopies on your files not the facsmile copies.

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SUMMARY

Drilling Contractor: J. Weber, Muchea.

Drilling Rig: Mud rotary.

Date set up on site: [redacted].
Date test pumping completed: [redacted] Test rig removed 6 March 1981.

Test pumping: by P.W.D. driller B. Gerdai.

Test equipment supplied by P.W.D.:
22W cable tool drilling rig
Randolph deep well turbine pump Model F60.
Horsepower: 60
R.P.M.: 1760
Power unit: V-8 petrol engine.
Flow testing: Orifice tube with 64 mm orifice plate.

Procedure: Drilled pilot hole, uncased, to 216.4 m.
Electric log by Well Logging Services.

Deepened pilot hole to 259 m.
Electric log by Geological Survey of W.A.

Pilot hole reamed out for 6-1/8 inch I.D. (155.8 mm) casing having ¼-inch wall thickness. Casing was set at 12.7 cm above 228 m.

Cement grout used: 8 m^3, set overnight.
Top of plug: 225 m.

Screen: Length overall: 15.47 m.
Effective length: 15.15 m
Mesh: 30/thousands of an inch.
O.D.: 5-inch (127 mm)
Packer: Neoprene.
Top of screen: 225.70 m.
Bottom of screen: 240.97 m.

Development: by compressed air for approx. 2¼ days.

Static Water Level: 86.73 m below natural surface (284.55 feet).

Pump testing: Two step drawdown tests followed by final pumping test of 6 hours duration.

Pumping delivery rates during tests:
Step 1: 369 m^3/day (4299 galls/hour)

Step 2: 836 m^3/day (7663 galls/hour)

S.W.L. recovered very rapidly.

Final: 1012 m^3/day (1010.17 galls/hour)
maximum drawdown 10.10 m below the S.W.L.
Full recovery in 30 mins.

Salinity: Approx. 280 mg/l (by conductivity). Sample submitted to F[illegible]atechnics for analysis.

GENERAL

The bore was initially drilled by J. Weber to 710 feet, and electrically logged by J. Hayes of Well Logging Services. Both log and mud samples indicated that the bore had not reached the bottom of the Late Cretaceous - apparently in Osborne Fm equivalent. No usable pressure water aquifer had been intersected at depth, though one layer of apparently usable water existed at about 78-81 metres in a rather more sandy sequence than elsewhere. This water, because of the thin bed and also relatively shallow depth below the static water level, was considered unlikely to provide enough water for requirement. Clients had discussed a minimum need of 6000 gallons/hour and a salinity of probably 1200 mg/l or less.

Continuation of drilling the pilot hole to 850 feet (259 metres) was agreed to, and done on 12 Feb. 1981. The logging by G.S.W.A. indicated usable water in a section between roughly 225 and 240 metres, in a more sandy section than above. The lowest salinity was estimated at about 600 mg/litre and the average for the bed at probably 1200 mg/litre.

Consultants suggested developing this level to obtain a water supply. From the nature of the mud samples and the trace of the gamma-ray log, it seems likely that the stratum is a rather gritty silt which would have to be carefully developed to obtain best results.

The driller reported bottom as being shale (not reached by the logger because of blockage), and as there is a local history of increasing salinity with depth, deeper drilling was not thought advisable, at least at the time, because further water supplies might be too saline for use.

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Approval to convert the pilot hole to a production bore was obtained by telephone on 13.2.81.

PRODUCTION BORE

Pilot bore was accordingly reamed out for 6-1/8 inch I.D. casing (¼-inch wall thickness), which was set at five inches above 228 m, and pressure-cement grouted from bottom up to natural surface level, using 8 m^3 of grout over 35 minutes. The grout was allowed to set overnight, when the top of the plug was found to be at 225 m. The plug was drilled out and the screen set in position.

SCREEN DETAILS

Length overall	- 15.27 m.
Length of mesh section	- 15.1 m.
Packer	- double neoprene rings.
Slots	- No.30 slot, 0.75 inches.
Setting	- Top of packer 225.70 m.
	Bottom of screen 240.97 m.

DEVELOPMENT

Development started with compressed air, the air line being placed finally at 400 feet below surface, and continued for approx. 2½ days. Water cleared on the third day and remained clear.

SALINITY

After 1½ hours of air-development, salinity by conductivity was 600 mg/litre. After 2 hours, salinity 320 mg/litre. After 2 days, salinity 230 mg/litre. Final pumped sample approx. 280 mg/litre (by conductivity).

WATER LEVEL

At conclusion of development, static water level below natural surface was 86.73 metres (284.55 feet).

aR3

BORE NO. 1, MUCHEA 12 Feb. 1981

DRILLER: J. WEBER. Mud-rotary Rig.

Geophysical Logs: J. Hayes. Also G.S.W.A.

Geological Log

Depth (feet)	Description of Sample
0-10	Laterite, coarse quartz grit, clay. Red-brown.
10-20	As above.
20-30	As above.
30-40	As above.
40-50	Sand, coarse quartz grit, laterite fragments, very clayey, red-brown to yellow-brown.
50-60	As above, grit very rounded; with some yellow bands.
60-70	Sand and Grit, very clayey, lateritic, quartz grains well-rounded and coloured translucent, yellowish, and pale greenish. Yellowish to red-brown.
70-80	As above.
80-90	As above, with sparse dark-coloured rounded rock fragments, some pinkish quartz grains.
90-100	As for 60-70.
100-110	Quartzose grit, mainly translucent, very clayey, well-rounded, sparse hard lateritic gravel, yellowish to reddish-brown.
110-120	As for 100-110 but more lateritic; red-brown.
120-130	Grit, well-rounded and coarse, sandy, clayey, some laterite fragments, dark reddish brown.
130-140	As above.
140-150	As above.
150-160	Sand, Grit, well-rounded; and laterite, very clayey, red-brown.
160-170	As above.
170-180	As above.
180-190	As above.

190-200	Grit, translucent, well-rounded, sandy, very clayey, red-brown.
200-210	Clay, sand, and grit, well-rounded, yellow-brown.
210-220	Clay, sand, grit, and yellow laterite, reddish to yellowish-brown.
220-230	Clayey Sand and grit, well-rounded, some dark and bottle-green fragments, some laterite particles (probably contamination); black shaley material, dark brownish-grey.
230-240	Clay, dark grey, rounded greenish or dark sand and grit, dark grey.
240-250	Grit and Sand, very clayey, well-rounded, dark brown.
250-260	As for 240-250, with some grit fragments, very dark-coloured.
260-270	As for 240-250, some grit grains pinkish-white. Dark grey-brown.
270-280	As for 240-250.
280-290	As for 240-250.
290-300	Grit and clay, sandy, slightly pyritic, well-rounded particles, dark brownish-grey.
300-310	Grit, subrounded, translucent to black, with black clayey material, greenish black. Sample collected for palynological examination.
310-320	As for 300-310.
320-330	As for 300-310.
330-340	Grit, well-rounded, translucent to light green, some grey-white, very clayey, dark brownish-grey.
340-350	Grit and Sand, dark with some greenish subrounded fragments; and Black Clay, dark brownish-black.
350-360	Shale, sandy, with plentiful grit, dark brownish-black.
360-370	Shale, with subrounded grit, greenish-black.
370-380	Shale, black, plentiful subrounded grit, dark greenish-grey.
380-390	Shale, probably carbonaceous, subrounded grit and sand, dark greenish-black.
390-400	As for 380-390.
400-410	Shale, carbonaceous, with subrounded grit and sand, brownish-black. Sample for palyno examination.
410-420	As for 400-410.

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420-430	Shale, finely sandy, subrounded grit, carbonaceous, black.
430-440	As above.
440-450	Shale, sandy, some transparent to slightly greenish subrounded grit, black.
450-460	As for 440-450.
460-470	As for 440-450.
470-480	Shale, sandy, some subrounded grit, black.
480-490	As for 470-480.
490-500	Shale, with sand and some subrounded grit, some greenish grains, black.
500-510	As for 490-500. Sample for palyno examination.
510-520	As for 490-500.
520-530	Shale, subrounded grit, one thin flake of limestone, dark brownish-black.
530-540	Shale, probably carbonaceous, with subrounded grit, black.
540-550	As above, slightly pyritic.
550-560	Shale, sandy, gritty, black.
560-570	As for 550-560.
570-580	Shale, gritty, sandy, slightly pyritic, black.
580-590	Shale, sandy, gritty black.
590-600	Shale, gravelly, sandy, very gritty, black.
600-610	Shale, sandy, carbonaceous, gritty, black. Sample for palyno examination.
610-620	Shale, sandy, with rounded greenish grit, sparse flakes of limestone, black.
620-630	Sand, grit, and shale, with sparse limestone fragments, dark brown.
630-640	As for 620-630.
640-650	As for 620-630.
650-660	Sand, grit, shale, and some sandstone, dark grey.
660-670	Sand, shale, and grit, dark grey.

220

670-680	Sand, and grit, some small black fragments probably of shale, grey-black.
680-690	Sand, slightly, shaley, very dark grey.
690-700	Grit (subrounded), shale, and sand, very dark grey.
700-710	As for 690-700. Samples from 690-710 sent for palyno examination.
710-720	Shale, with plentiful subrounded pale greenish grit, black.
720-730	As for 710-720.
730-740	Shale, with plentiful subrounded pale green to translucent grit, some sandstone fragments, carbonaceous, black.
740-750	Silt, shaley and finely sandy, with subangular to subrounded grit, some black shale. Very dark grey.
750-760	Silt, some subangular grit, finely sandy, pyritic, some black shale fragments and small pieces of sandstone. Very dark grey.
760-770	Siltstone, finely sandy, shaley, subrounded coarse pale greenish quartz grit, slightly pyritic, dark grey.
770-780	Siltstone, finely sandy, frequent small fragments of black shale, coarse subrounded grit, dark grey.
780-790	Silt, finely sandy, very gritty (subangular to subrounded), fragments of black shale, dark grey.
790-800	Grit, subrounded to subangular, silty and finely sandy, thin bars of black shale, dark grey.
800-810	Grit, subrounded, fairly silty, sparse black shale fragments, dark grey. Sample for palyno examination.
810-820	Siltstone, soft, finely sandy, gritty. Some black shale fragments, fairly dark grey.
820-830	Silt, finely sandy, gritty, slightly pyritic, some black shale fragments, dark grey.
830-840	Silt, gritty, some black shale fragments, dark grey.
840-850	Silt, with subrounded to subangular grit, slightly pyritic, some black shale fragments, dark grey. Sample for palyno examination.

8 19
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True Depth: 850 feet (259 metres).

Electric log to 831 feet. 253m

Water recorded:

Depth (m)	Approx salinity (mg/litre) from electric log
78-84	700
228-246)	1200
234-240)	600

Comment: The water at 78-84 m is a very doubtful source of continuing supply in the amount needed.

Suggested screen placement is from 225 to 241 m.

~18

BORE 1/81 on Lot 2. Muchea

Test pumping by PWD. Driller Gerlai. – BG.

Pump: Randolph Turbine Model F60
H.P. 60
R.P.M. 1760
Power unit V8 car engine (petrol).

Pump Setting: Total length of pump and column 136.04 m.
Top of pump set at 133.74 m.

Drawdown measured by airline and pressure gauge.

Airline setting: 133.74 m.

S.W.L. 86.73 m. Air gauge records 47.0 m.

Orifice tube: 2½ inch (64 mm) orifice plate. Set level.

For first Step Drawdown Test, pumping rate 369 m^3/day, (4299 galls/hour). Pump ran a little irregularly for 30 mins, and had to be manually adjusted throughout the test.

25 Feb. 1981

Time (mins)	Airline pressure (m)	Drawdown (m)
0	47.0	0
2	44.40	2.60
3	44.20	2.80
4	44.15	2.85
5	44.15	2.85
10	44.20	2.80
15	44.20	2.80
20	44.45	2.55
25	44.45	2.55
30	44.40	2.60
	Pump shut off. Zero flow.	
31		
	Level recovering. No footvalve on pump, so pump is backdraining at 31 minutes.	
31	47.40	
32	46.60	
33	47.0	Full SWL recovery after 3 minutes.
35	47.0	

Second Step Drawdown test.

Pumping rate 836 m^3/day = 7663 galls/hour.

S.W.L. 87 m.

Time (mins)	Airline pressure (m)	Drawdown (m)
0	47.0	0
1	40.40	6.60
2	40.35	6.65
3	40.30	6.70
4	40.30	6.70

Pump was running a little raggedly throughout test.

~17

5	40.25	6.75
10	39.80	7.20
15	39.75	7.25
20	39.70	7.30

Pump shaft broke after 20 minutes.

Broken pump shaft was replaced, and main pumping test attempted on 26.2.81.

Pump delivery rate set at 1102 m^3/day.

S.W.L. 86.73 m below natural surface.

Airline pressure gauge 46.60 m.

Orifice tube level.

Time (mins)	Airline pressure (m)	Drawdown (m)
0	46.60	0
1	38.20	8.40
2	37.80	8.80
3	37.80	8.80
4	37.40	9.20
5	37.20	9.40
10	37.30 *	9.30
15	37.05 *	9.55
20	37.00	9.60
30	36.80	9.80
45	Pump stopped. Broken shaft.	

N.B. * These values are doubtful because pump was running raggedly and the pumping rate varied.

<u>27.2.81</u>

Broken pump shaft replaced, and airline reset at 103.30 m below natural surface.

S.W.L. now 85.9 m.

Airline pressure 17.4 m.

Pumping rate: 1102 cu. m/day.

Time (mins)	Pressure gauge (m)	Drawdown
0	17.4	0
1	8.30	9.1
2	7.80	9.6
3	8.20	9.2
4	9.60	8.8
5	17.10	Water ran very dirty, but stable flow.
6	20.3	?gauge sticking?
8	12.1	
9	0.8)	A hole has blown in the airline.
11	0.8)	Test abandoned.
15	0.8)	
20	0.8)	
30	0.8)	
45	0.8)	

3 March 1981 Second (abortive) final pumping test.

S.W.L. 85.9 m.

Pumping Rate set at 1102 cu. m/day.

Airline pressure 14.80 m.

Time (mins)	Airline pressure (m)	Drawdown (m)
0	14.80	0
1	12.6	2.2
2	11.0	3.8
3	10.4	4.4
4	10.3	4.5
5	10.1	4.7
10	8.9	5.9
15	8.9	5.9
20	8.8	6.0

Pump stopped. Dirty fuel.

4 March 1981 Third (abortive) final pumping test.

S.W.L. 85.9 m below natural surface.

Pumping rate set at 1102 cu. m/day.

Pressure gauge zero was 0.8 m, so all gauge readings from here on must be reduced by 0.8.

Time (mins)	Air pressure (as recorded on gauge)	Corrected pressure	Drawdown
0	14.9	14.1	0
1	13.2	12.4	
2	12.8	12.0	
3	12.6	11.8	
4	12.5	11,7	
5	12.4	11.6	
10	10.2	9.4	
15	9.1	8.3	5.8

Engine stopped. Dirty fuel.

5 March 1981 Final (successful pump test)

S.W.L. 86.73 m below natural surface.

Pumping rate set as 1102 cu. m/day.

Elapsed Time	Drawdown	Elapsed Time after pumping stopped	Recovery
1 (mins)	0.90 m	1 (mins)	4.80 m
2	1.60	2	6.20
3	2.30	3	7.10
4	3.40	4	8.20
5	4.80	5	9.00
10	5.50	10	9.70
15	6.60	15	10.00
20	7.80	20	10.05
30	8.40	30	10.10

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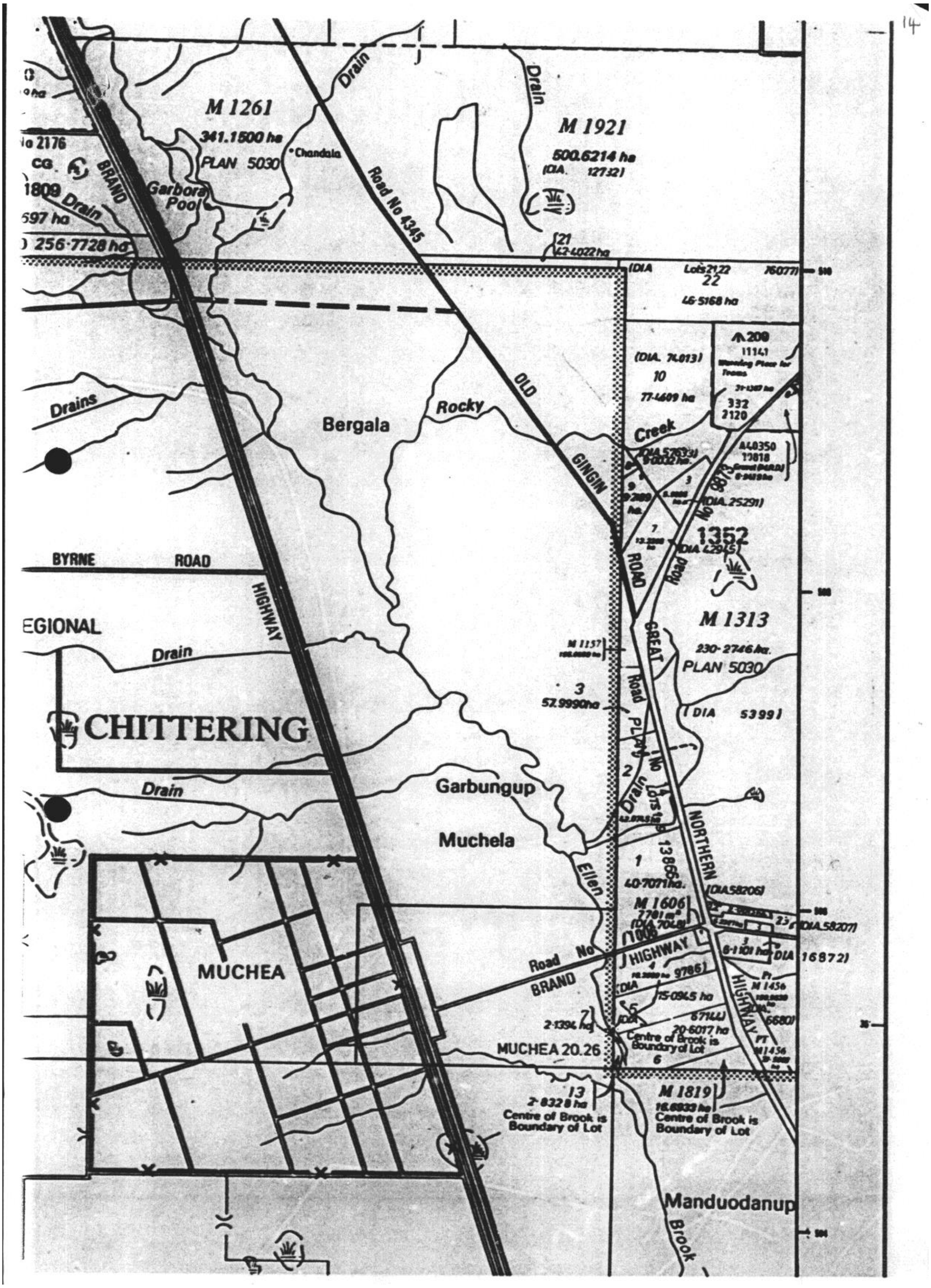
45	9.00
1 (hrs)	9.30
1¼	9.60
1½	9.80
1-3/4	9.90
2	10.00
2½	10.10
3	10.10
3½	10.10
4	10.10
5	10.10
6	10.10

Recovery complete after 30 minutes.

E.P.D. O'DRISCOLL,
Senior Consultant.


M 1261
341.1500 ha
PLAN 5030
Chandala
Drain
Road No 4345
M 1921
500.6214 ha
(DIA. 12732)
BRAND
Garbora Pool
Drain
256·7728 ha
22
46·5168 ha
(DIA. 74013)
10
77·4609 ha
332
2120
Drains
Bergala
Rocky
Creek
OLD
GINGIN
ROAD
1352
M 1313
230·2746 ha.
PLAN 5030
BYRNE ROAD
HIGHWAY
EGIONAL
Drain
3
57.9990 ha
(DIA 53991
CHITTERING
Drain
Garbungup
Muchela
GREAT
NORTHERN
Ellen
1
40·7071 ha.
M 1606
MUCHEA
Road No
BRAND
HIGHWAY
15·0945 ha
20·6017 ha
Centre of Brook is Boundary of Lot
MUCHEA 20.26
13
2·832 8 ha
Centre of Brook is Boundary of Lot
M 1819
Centre of Brook is Boundary of Lot
Manduodanup
Brook

13

Bob McGowan, GSWA, advised per telephone 29/12/88, that the top of the Leederville Fm was at -90m AHD. on lot 2 Reserve Rd Muchea.

Therefore, to remain within the Superficial Fm. a bore would need to be limited to RL + 90m.
240m.

Grouting would be required from bottom of production casing to GL.

[signature]
29/12/88

A/RSE
Licence & Letter for signature please.

RWRO

Appendix B – Bore Water Quality

The raw bore water is of excellent quality with low TDS of 300 mg/L. No parameters fall outside of the health requirements of the ADWG. The aesthetic levels of iron and manganese, which occur naturally in groundwater, are exceeded. Their concentrations are caused by the low oxygen content of the water. Neither of the elements causes adverse health effects and methods for iron and manganese removal that have been well established will be used on site.

Analyses of bore water taken from April to November 2015 are summarised in Table 8. It is evident that the raw water from the Leederville–Parmelia confined aquifer has an excellent quality. Most analytes are well below their respective drinking water quality criteria except for high concentrations of iron and manganese.

Table 8: Analyses of groundwater sampled from April to November 2015

Bore Water Quality Analysis (GWL 59907)	**Units**	**14 April**	**21 April**	**23 April**	**28 April**	**18 May**	**11 June**	**31 July**	**1 Sept**	**14 Oct**	**30 Nov**	**Average**	**Max**	**Min**	**ADWG Limits**	
															Health	**Aesthetic**
pH in water		7.2	6.7	7	6.4	6.2	6.7	6.5	6.2	6.5	6.4	**6.6**	7.2	6.2		6.5-8.5
Electrical conductivity water	µS/cm	470	500	470	490	460	500	520	510	510	510	**490**	520	460		
TDS	mg/L	280	300	280	290	270	300	310	300	310	300	**291**	310	270		500
Chloride in water	mg/L		120	120	120	120	120	120	120	110	110	**119**	120	110		250
Fluoride in water	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.3		0.3	0.3	**0.3**	0.3	0.3	1.5	
Iodide in water	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**<1**	<2	<3	0.1	
Bromide	mg/L						<0.5	<0.5	<0.5			**<0.5**	<0.5	<0.5		
Sulphate in water	mg/L	6	12	13	13	13	14	13	13	12	12	**12**	14	6	500	250
Total Cyanide	mg/L	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.005	**<0.004**	<0.004	<0.004	0.08	
Sulphide in water	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	**<0.01**	<0.01	<0.01		
Nitrate as NO_3	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**<0.05**	<0.05	<0.05	50	
Nitrite as NO_2	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	**<0.06**	<0.06	<0.06	3	
Ammonia as N	mg/L	0.15	0.02	0.03	0.05	0.04	0.05	0.055	0.044	0.019	0.051	**0.056**	0.15	0.02		0.5
Dissolved CrVI	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	N/A	N/A				**<0.005**	<0.005	<0.005	0.05	
Hardness as $CaCO_3$	mg/L	58	50	46	46	46	50	49	49	52	51	**50**	58	46		200
Sodium - Dissolved	mg/L	72	74	69	68	70	68	66	69	78	74	**70**	74	66		180
Aluminium-Total	mg/L	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	**0.05**	0.05	0.05		0.2
Arsenic-Total	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	0.001	0.001	0.007	
Barium – Total	mg/L	0.099	0.1	0.085	0.086	0.089	0.089	0.098	0.086	0.082	0.089	**0.092**	0.1	0.085	0.7	

Bore Water Quality Analysis (GWL 59907)	Units	14 April	21 April	23 April	28 April	18 May	11 June	31 July	1 Sept	14 Oct	30 Nov	Average	Max	Min	ADWG Limits	
															Health	Aesthetic
Beryllium – Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**<0.0005**	<0.0005	<0.000 5	0.06	
Boron – Total	mg/L	0.042	0.051	0.047	0.049	0.057	0.055	0.056	0.07	0.05	0.058	**0.052**	0.058	0.042	4	
Cadmium – Total	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	**<0.0001**	<0.0001	<0.000 1	0.002	
Chromium – Total	mg/L	N/A	N/A	N/A	N/A	N/A	<0.001	<0.001	<0.001	<0.001	<0.001	**<0.001**	<0.001	<0.001		
Copper – Total	mg/L	0.016	0.019	0.17	0.041	0.019	0.011	0.014	0.002	0.004	<0.001	**0.0414**	0.17	0.011	2	1
Iron – Total	mg/L	1.7	16	16	14	6.9	5.5	12	10	11	10	**10**	16	1.7		0.3
Lead – Total	mg/L	<0.001	<0.001	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.004**	0.004	0.004	0.01	
Molybdenum – Total	mg/L	0.005	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.003**	0.005	0.001	0.05	
Manganese – Total	mg/L	0.027	0.49	0.33	0.31	0.18	0.23	0.33	0.23	0.25	0.23	**0.266**	0.49	0.027	0.5	0.1
Mercury – Total	mg/L	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	<0.0000 5	**<0.0000 5**	<0.0000 5	<0.000 05	0.001	
Nickel – Total	mg/L	0.001	0.004	0.009	0.004	0.003	0.002	0.001	<0.001	<0.001	<0.001	**0.003**	0.009	0.001	0.02	
Selenium – Total	mg/L	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.003**	0.003	0.003	0.01	
Silver – Total	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**<0.001**	<0.002	<0.003	0.1	
Antimony – Total	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.001**	0.001	0.001	0.003	
Tin – Total	mg/L	<0.001	<0.001	0.003	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**0.002**	0.003	0.001		
Uranium – Total	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	**<0.0005**	<0.0005	<0.000 5	0.02	
Zinc – Total	mg/L	0.013	0.1	0.19	0.084	0.035	0.025	0.024	0.016	0.015	0.014	**0.061**	0.19	0.013		3
Thermophilic Amoebae	cfu/100 mL	D	D	D	D	D	D	D	D	ND	D	**D**	D	D	95% nil	
Thermophilic Naegleria	cfu/100 mL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**ND**	ND	ND	95% nil	
Thermotolerant Coliforms	cfu/100 mL	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	**<1**	<1	<1	98% nil	
E.Coli	cfu/100 mL	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1	**<1**	<1	<1	98% nil	

Appendix C – DWER Quality Protection Note

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Appendix D – DWER Licence to Construct or Alter Well

File No:
DWERVT3382

Government of Western Australia
Department of Water and Environmental Regulation

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Instrument No. CAW203365(1)

LICENCE TO CONSTRUCT OR ALTER WELL

Granted by the Minister under section 26D of the Rights in Water and Irrigation Act 1914

Licensee(s)	Riverside Investments (WA) No 2 Pty Ltd
Description of Water Resource	Gingin Perth - Leederville - Parmelia.
Location of Well(s)	Lot 2 On Diagram 52612 - Volume/Folio 1481/704 - Lot 2 Reserve Rd Chittering

Authorised Activities	**Activity**	**Location of Activity**
	Construct two artesian well(s).	Lot 2 On Diagram 52612 - Volume/Folio 1481/704 - Lot 2 Reserve Rd Chittering
Duration of Licence	From 13 September 2019 to 12 September 2020	

This Licence is subject to the following terms, conditions and restrictions:

1. The well must be constructed by a driller having a current class 2 water well drillers certificate issued by the Western Australian branch of the Australian Drilling Industry Association or equivalent certification recognised nationally by the Australian Drilling Industry Association.
2. The licensee shall construct the well using materials and methods for multiple aquifer wells described in "Minimum construction requirements for water bores in Australia, 3rd edition, National Uniform Drillers Licensing Committee (2012)".
3. The depth of the well(s) and the screened interval shall be limited to the Perth - Leederville - Parmelia aquifer.
4. Any well that is to be permanently decommissioned shall, within 30 days of completion of the new well, be sealed and filled to prevent the surface entry of contaminants and the vertical movement of water in the well, including water in the annular space surrounding the casing, using methods described in "Minimum construction requirements for water bores in Australia, 3rd edition, National Uniform Drillers Licensing Committee (2012)".

End of terms, conditions and restrictions

This Licence is granted subject to the Rights in Water and Irrigation Regulations 2000.