ALATYEYE WATER SUPPLY REPORT

SEPTEMBER 1992

CENTRE FOR APPROPRIATE TECHNOLOGY

Robert Genders
Development Engineer

ALATYEYE WATER SUPPLY REPORT

Introduction

This report has been prepared to summarise the proposed development at Alatyeye in relation to its water supply, assess the use of a reverse osmosis plant that has been recommended by 'Solarvolt' for the community, review other options for supplying water to the community, and present a number of recommendations based on this information.

Appendix 1 contains bore data.

Appendix 2 is a draft report on Reverse Osmosis.

Appendix 3 is a report on four Reverse Osmosis units in S.A and N.T

Existing Water Supply

The water supply at Alatyeye is obtained from two sources; rainwater and groundwater.
Rainwater is collected in several small tanks from roof runoff from one house and a shed. This water is used for drinking purposes.
Groundwater is pumped from Bore No 15241 near the house, to an overhead tank. This water is used for other than drinking purposes as it is unsuitable for drinking. This water is also considered to be responsible for skin rashes that come after washing in the water.

Anticipated Development at Alatyeye

There are two houses at Alatyeye and a third house is being built. Approximately four or five people may live here on a permanent basis now, but they state that it is the lack of an adequate water supply that is limiting their numbers. They foresee that there could be about 40 people living at Alatyeye if there was an adequate water supply.

Water Requirements for Anticipated Development

The community would like to have a water supply that will meet all their domestic requirements and possibly some additional water for gardening purposes.

Domestic Requirements

A minimum quantity to use would be about 110 liters per person per day, or 4400liters per day for the community. This quantity of water would be obtained from treated groundwater and rainwater. Either pit toilets or toilets flushed with untreated borewater would be used to control the use of clean water.

Irrigation Requirements

Water quantities for irrigation have not been specified,but the community want a water supply that they can use to carry out some agriculture on their land.From inquiries made with Dept of Primary Industries and Fisheries, groundwater from Punch's Bore (Bore No 15989) is suitable for flood or trickle irrigation for some native pastures.However this water (TDS 3620 mg/l) is above the salinity level (TDS 3500 mg/l) that is regarded as the maximum for safe watering of most salt tolerant plants.The concentrate from a RO unit using this bore will have a higher salinity than the feedwater. Therefore concentrate from a RO unit on Bore No 15989 will not be suitable for irrigation.

Cattle can drink water with a TDS 8000 mg/l but they do not thrive on this quality water.As they drink a maximum quantity of 40l/day in mid summer, this usage could not be considered a useful application for high salinity water.Therefore the only water that would be useful for irrigation purposes is any surplus water produced by the Reverse Osmosis unit.(if Punch's Bore is the water supply)

Greg Campbell from the Dept. of Primary Industries and Fisheries has advised that Barley Mitchell Grass can be irrigated using saline water with a TDS level of 3200 mg/l.If 6,000 litres of water is available, 5 hectares of Barley Mitchell grass could be irrigated and the seed harvested. Hand harvested seeds have been purchased by The Conservation Commission for $40 per kilogram. Well grown Mitchell grass,grown under natural conditions, planted at 2.5 plants per square metre,will yield 50 kg of seed per hectare. Under irrigation, it is possible to harvest twice in a year. Five hectares could yield 500 kg in a year, and would be worth $20,000.

Groundwater

There are three bores on the property, but only two are considered to be suitable for water production. Bore No 15241 is close to the existing houses.A summary of data for Bore No 15421 and Bore No 15989 is given in Appendix 1. Bore No 15241 has the better quality water but lesser quantity of water than Bore No 15989.

The two bore sites are approximately 0.5 km apart with Gillen Creek passing between them.

Bore No 15241 has TDS 1600mg/litre, and a flow rate 0.6 l/sec from a depth of 35 metres.

Bore No 15989 has TDS 3620mg/litre, and a flow rate 1.0 l/sec from a depth of 13 metres.

Rainwater

Rainfall has been recorded at The Gardens since 1954. A summary of the rainfall data is provided in Table 1. The median rainfall indicates that 50% of monthly rainfall recordings exceeded that figure. The mean rainfall is the average rainfall in that month for the period that rainfall has been recorded. This data indicates a variability in rainfall patterns, with some heavy rainfall periods during the summer. Rainwater tanks would be sized on mean rainfalls and roof areas so that rainfall collected in the wetter months could maintain a certain water supply throughout the year.

Reverse Osmosis to treat Borewater at Alatyeye

The community has approached the company "Solarvolt", for information on a reverse osmosis unit that would supply 20,000 litres per day using groundwater from Bore No 15989. They anticipate that surplus water would be used in agricultural pursuits on the community. Following is a review of the proposal presented by Mr Rob Foster Solarvolt and with additional information from others, including Gil Deane from Memtec,and Chris Wallace from Suntec.

Review of the 20,000liter per day R.O unit

General

Solarvolt,Darwin have presented to this community a water supply system that will produce 20,000 litres of drinking water per day from Bore No 15989 (Punch's Bore). A bore pump will pump groundwater to a water storage tank at ground level. This header tank (approximately 15-20 000litres) would supply water to the ro unit via an in line pressure pump to maintain a feed pressure of approximately 100-200kPa to the ro unit, and an in line filter to prevent any solid particles entering the ro unit. The ro unit has an additional pressure pump to maintain a pressure of 1200kPa at the membranes. The permeate water would be collected in a 20000 l ground tank for distribution to future houses near the tanks as well as houses near Bore No 15241. A pump and pipeline would transfer clean water from this tank to the existing elevated tankstand at Bore No 15241.
The system was to be powered by a 8.5kVA Lister diesel generator.

The RO unit, tanks, generator will be approximately 300m from the bore.
Pumps and ro unit will be operated by float switches in the tanks
The reverse osmosis unit will be operating with a recovery rate of 40%
The proposal included a 3mx3m shed with concrete floor to house the generator and ro unit

Cost of Water Supply System

The estimated cost of the system was $57940.Estimated life:10 years.

Pretreatment

Apart from pre filtration, no pretreatment using chemical additives was included.
The borewater analysis shows the presence of iron. The removal of iron to a level of 0.05mg/l will require some pretreatment. Aeration will be insufficient and Memtec are looking for an additive that will come out with the concentrate stream. Memtec are recommending two in line filters to ensure turbidity is less than 1 NTU. These filters replace a standard back flushing sand filter that might complicate the equipment in a remote location.

Membrane performance

This unit is designed to operate with a high pressure to achieve approximately a 40% recovery using three membranes in series. The community's water usage rate cannot be specified but it is estimated that in the future there could be about 40 persons living at Alatyeye. Based on 110litres per person per day for domestic requirements, there will be a water usage of 4400litres per day. This will mean that a 20000 litres/day unit would operate for approximately 5 hours per day or one day in every 4 days to meet future anticipated domestic requirements.(Daily operation is preferred by Memtec)

Salinity of the concentrate

The concentrate from the RO unit would have a TDS 6000mg/l, and there would be 20,000 liters to be disposed of each day. Inquiries have been made to determine if this water can be utilised for irrigation.

Information from Mike Last from PITJ Council suggests that water with this salinity is unacceptable for distribution over land areas and should be disposed of in an evaporation pond.He considers that disposing of saline water over the land will be polluting the environment at the rate of 120kg of salt per day.

Discussions with Dept of Primary Industries and Fisheries indicate that saline water greater than about TDS 3500 mg/l is not suitable for use in irrigation. There are some area where saline water can be used to some degree,but generally the plants do not grow that well. Cattle can drink water with TDS up to approximately 8000 ppm. Cattle will drink a maximum of 40 litres per head per day.

Consequently, it is unlikely that any water pumped from Bore No 15989 will be suitable for agricultural purposes. The concentrate is therefore waste water and the installation of a reverse osmosis unit using this bore water should include an evaporation pond from which the salt can be removed and disposed of in an appropriate manner.

Power Supply

The power supply is a 8.5 kVA Lister diesel generator that will supply power to the bore pump, feed pumps and RO unit. The diesel will be manually started each day to provide power to the water supply system. Fuel consumption is 2.5 litres/hour. Estimated cost per kW hour is 25 cents.

Maintenance

Normally a reverse osmosis unit is designed to be monitored daily, recording production rates to determine condition of filters,operation of dosing equipment, and condition of membrane.This installation has been designed to operate with a monthly cleaning of membranes and replacement of filter cartridges to be undertaken by a trained technician. Memtec have carried out a simulation of the operation of this unit over a three year period to determine the running costs for the unit. Their determinations are based on a membrane life of 3 years and the unit operating at 24 hours per day. If less water was used ,there would be a proportional reduction in fuel, cost of chemicals and frequency of maintenance calls by a service technician. The model likewise doesn't account for any catastrophic failures of membranes which have been a source of concern in other situations where the reverse osmosis has been used in remote communities.

Cost of Water

For 16,000 litres per day, the running cost for the reverse osmosis unit is $3.00 per 1000 litres, or $48.00 per day.

1 fuel
2 equipment replacement
3 antiscalant
4 service technician If, as recommended, a service technician maintained the ro unit on a monthly basis,there would be 12 visits per year, at an estimated cost of $300 per visit.This has been included in the above cost of operation.

Total cost per day at 16000 litres/day - $3.00 per 1000 litres, or $45.00 per day.

Total cost per dayoperating te reverse osmosis unit for 6hours per day to produce 4000 litres/day - $4.0 per 1000 litres, or $16.0 per day

If the unit was to be replaced after say 10 years, the annual cost would be increased by $5794 or $16 per day.

Alternative Water Supply Systems

1. Reverse Osmosis unit using water from Bore No 15241

Equipping Bore No 15241 with a 20,000 litre Reverse Osmosis Unit with 40% recovery will increase salinity of the concentrate to TDS level 2700 ppm. At this concentration, the water is suitable for irrigation of some salt tolerant plants. At this bore this level the salinity level of the concentrate may be reduced by mixing it with untreated borewater. Cost of water production would be similar to the cost at Bore No 15989.

If Bore No 15241 was equipped with a reverse osmosis unit,with a maximum discharge of 4000litres/day, operating at 15% recovery, the concentrate from the unit would discharge at the rate of 16000 litres/day with a TDS level of 1900 mg/litre.This water would also be suitable for irrigation purposes.If this water was put to some purpose, the entire quantity of water pumped would be used, compared with 40% of water pumped if Punch's Bore is used.

If only drinking water is considered, the cost of water per 1000 litres would be $6.10, or $24.40 per day.
If total water could be used, the cost of total water per 1000 litres would be $1.50, or $24.40 per day.

2. Rainwater

Rainwater collected from roofs of houses at Alatyeye could provide a significant supply of clean water to the community. As the community grows there will be more houses built. Each house should be equipped with a rainwater collection tank that is suitable for the rainfall pattern in this area. Rainwater tanks will reduce the dependance on the groundwater to supply water to the community. Rainfall data collected at The Gardens show that this area has a mean annual rainfall of 250mm

If 10 houses were built and each had a roof area of 200m2,and 75% of the rain that fell was collected, the volume of water collected each year would be 375,000 litres, that could sustain a usage rate of 1000l per day.

A South Australian company, Nomad Enterprises, manufactures a shed tank that has a roof area of 720m2 and three 6000 gallon tanks to collect runoff. The kit is made from lightweight members so that it can be put togetherwithout the use of a crane.It has a Catagory 2 wind rating which is suitable for inland Australia. Based on collecting 75% of the rainfall,the shed tank would supply 135,000 litres per year which could support a useage rate of 370 litres per day.

Cost of the shed tank kit, including three tank kits,each with a capacity of 5000gal $36300

Cost of the shed tank kit, including two Southern Cross squatter tanks, each 8000 gal. $48500

Another product from this company is a roof kit for a Homestead house. The roof is constructed and equipped with gutters, downpipe and squatter tanks, so that a house can be built beneath at a later date. The roof area is 266m2 which would increase the available annual yield by 49,900 litres per year, which could support a useage rate of 140 litres/day.

Cost of roof kit	$13,000
Cost of gutter kit	$ 434
Cost of tank kit- each 3000gal	$ 1,200

This rainwater supply could be used within a dual water supply using borewater from Bore No 15241 as the second source of water.

There may be occasions when water has to be carted in and some estimate could be made on the cost to maintain a particular water usage rate throughout the year using rainwater augmented by carted water.

3. Carting water

From a recent assessment of water cartage by Ingkerreke to outstations, the actual cost for this supply of water is $71.20 per kilolitre. At this price carted water would only be considered for an emergency supply to supplement a drinking water supply obtained from rainwater tanks.It is difficult to give an annual cost to this water which would be part of the cost for the supply of a guaranteed supply of drinking quality water from rainwater tanks

Water for Irrigation

There are two supplies of water from a Reverse Osmosis unit, the permeate (purified water) and the concentrate.

The permeate is the end product of the unit, and it has been shown that daily operating costs increase with increased production of purified water. This water is used for domestic uses, and as a water supply for plants grown for profit in a glasshouse. Generally,it would be considered to cost too much to operate a reverse osmosis unit to provide for the much larger amounts of water required for open irrigation.

The concentrate, as a source of irrigation water, is dependant on what crops can be irrigated with water at its salinity level, and what quantity of this water is available.

The choice of a RO unit is dependant on the demand for purified water, the need to minimise maintenance of the unit, and the need to control the salinity level in the concentrate to protect the local environment. If the concentrate water can be put to some use, this is a bonus to the system. However, it cannot be the driving factor because it is an inefficient way to supply irrigation water.Simply pumping borewater to the surface would be cheaper and be less saline than using the concentrate from a RO unit.

At Alatyeye,a reverse osmosis unit using borewater from Bore No 15241 will have a concentrate that can be used for irrigation.The amount of water required for domestic use will determine the amount of water available for use in an irrigation program.

A Reverse Osmosis unit on Bore No 15989 will produce a concentrate that is unsuitable for irrigation.

Provision of water for irrigation should be separated from the provision of a domestic water supply.

At Alatyeye,the two bores can be used to irrigate salt tolerant plants. Bore No 15989 (Punch's Bore) could be equipped with a pump to irrigate several hectares of Barley Mitchell grass, or similar salt tolerant plants. Bore No 15241 is presently irrigating salt tolerant shade trees. There may also be a suitable site for a catchment runoff dam. The provision of an irrigation water supply looking at available water, soils and areas suitable for cultivation needs to be reviewed.

Recommendations

Based on the available information, I would recommend:

1. That a reverse osmosis unit should not be installed on Bore No 15989. The RO process using this bore will increase the salinity of the concentrate to a level that is unsuitable for irrigation purpose.

2. That the community discuss the issue of running costs and the operatonal issues which could arise from intermittant use of a Reverse Osmosis unit;

3. That water quality and water yield from Bore No 15241 be tested by P.A.W.A. These tests are requested because Fe levels have never been checked, and the pumping rate given in the previous test does not compare with pumping rates that have been achieved by the community;

4. Depending on information from (3) and community agreeement toproceed with the Reverse Osmosis option, that a reverse osmosis unit with a capacity of 16000 litres/ day be installed at Bore No 15241 to operate on a daily basis to meet the community's water requirements at the time;

5. That a detailed strategy integrating rainwater catchment, surface runoff and water treatment be compiled in conjunction with drawing up a specification for the Reverse Osmosis instalation.

APPENDIX 1

Data From Bore Nos 15989 and 15241

THE NORTHERN TERRITORY OF AUSTRALIA

Control of Water Act

PUNCH'S BORE

FINAL STATEMENT OF BORE

NAME OF OWNER : BILL TURNER	REGISTRATION No : 15989
NAME OF BORE : ALATYEYE.	INDEX/MAP No : 16/2344
INTENDED USE : CATTLE.	ADVICE No :
LOCATION : BETWEEN ALCOOTA & GARDEN STN.	PERMIT No :

From	To	Particulars of strata
0	8M	Sands & gravels.
8	9M	Clay
9	13M	Hard packed clayy gravels
13	17M	Very hard drilling stony.

Name of Contractor	PITJANTJATJARA COUNCIL
Name of Driller	R.E. HALL
Date Commenced	12/3/91
Date Completed	15/3/91
Depth Drilled	17m's (m)
Completion Depth	17m's (m)

METHOD OF DRILLING

☐ Rot. ☐ Rev. Circ. ☑ Cable ☐ Others

HOLE DIAMETER			DRILLING FLUID
From	To	Diameter	Type
0	9m's	10"	
9m's	17m's	8"	

PARTICULARS OF CASING				PARTICULARS OF PERFORATIONS OR SCREEN STRINGS				
From	To	Diam (ID)	Type	From	To	Diam (ID)	Aperture	Type
0	17m's	150mm	CL12 PVC.	11m's	17m's	150mm	SLOTTED PVC. (2mm.)	
0	9m's	8"	STEEL.					

Casing Suspended : ☐ Yes ☑ No

Method :

Casing above GL : (m)

TOP OF PACKER SET AT : (m)

LENGTH OF PACKER : (m)

METHOD OF PACKER CONNECTION :

CEMENTING/GRAVEL PACKING

From	To	Type

AQUIFERS (Water Bearing Strata)

Depth (m) From	Depth (m) To	Yield (L/s)	SWL (m)	Duration (Hr)	Quality	SC	pH	Bottle No.
11	17	1	N.K	N.K.				NIL

STRATA AND WATER SAMPLES

☐ Have been ☐ Will be

Left at : No Samples

Completion Yield : 1 (L/s) Method : Bailer Duration :

Completion SWL : N.K. (m) Depth Lift : N.K (m)

POWER AND WATER AUTHORITY
WATER RESOURCES

WATER CHEMISTRY LABORATORY
G.P.O. Box 1096, Darwin N.T. 0801
Telephone: (089) 82 6413
Telex: AA85644
Facsimile: (089) 82 6410

TL43 | 19/11/304

Date Received in Lab	Time Sampled	Date Sampled
15/5/91		1/5/91

Location and Details ALATYEY COMMUNITY ON ALCOOTA STATION R/N 15989 TURNERS BORE SAMPLER C.L.C.
R/N° ENRCA RSP219

ANALYSIS — PHYSICAL

☐ pH	[423]	7.1	☐ Colour (Hazen units)	[204A]	
☐ Electrical conductivity (microsiemens/cm at 25° C)	[205]	5850	☐ Turbidity (NTU's)	[214A]	
☑ Total dissolved solids (mg L^{-1} - dried at 180° C)		3620	☐ Suspended solids (mg L^{-1})	[209C]	

ANALYSIS — CHEMICAL (mg L^{-1})

☑ Sodium, Na	[303A]	693	☑ Chloride, Cl	[407A]	1500
☐ Potassium, K	[303A]	36	☑ Sulphate, SO_4	[G]	492
☐ Calcium, Ca	[311C]	226	☐ Nitrate, NO_3	[418A]	2
Magnesium, Mg	[303C]	225	☐ Bicarbonate, HCO_3	[403]	358
☑ Total Hardness (as $CaCO_3$)	[314B]	1489	☐ Carbonate, CO_3	[403]	
☐ Total Alkalinity (as $CaCO_3$)	[403]	294	☐ Fluoride, F	[413E]	0.1
☐ Iron, Fe	[303A]	0.2	☐ NaCl (calc from chloride)		2472
☐ Silica, SiO_2	[425D]	33			

ANALYSIS — ADDITIONAL (mg L^{-1})

☐ Copper, Cu	[304] [303A]		☐ Lead, Pb	[303A] [304]		☐ Arsenic, As	[303E]	
☐ Manganese, Mn	[303A] [304]		☐ Zinc, Zn	[304] [303A]		☐ Cadmium, Cd	[303A] [304]	
☐ Selenium	[303E]		☐			☐		

This report relates specifically to the "sample tested as received".

The test methods used (denoted within brackets) refer to the 16th edition of "Standard Methods for the examination of Water and Wastewater". A.P.H.A. Except [G] which refers to the method of R. Goguel, Anal.Chem. 1969, 41, 1034.

DATE: 29 MAY 1991

CHECKED: J. M. Hume

SIGNATORY: E. Czobin

Boxes marked thus indicate:

☐ Levels are within the limits as quoted in the "Guidelines for Drinking Water Quality in Australia", 1987 N.H. & M.R.C. and the A.W.R.C.

☑ Levels exceed non-health related limits.

☒ Levels exceed health related limits.

NATA

This Laboratory is registered by the National Testing Authorities, Australia. The tests have been performed in accordance ...

WATER ANALYSIS

POWER AND WATER AUTHORITY
WATER DIRECTORATE

Laboratory Register No.	88/89/0010
Date received in Laboratory	29/6/88

Bottle No.	Time of sampling	Date of sampling
PJ45		21/5/88

LOCATION AND DETAILS ALCOOTA R/N 15241 DEPTH 61m MAP SF 53-10

G.R. 211136

P/N° 8152 RSP219

ANALYSIS — PHYSICAL

pH	7.5	Colour (Hazen units)	
Specific conductance (microsiemens cm at 25° C)	2650	Turbidity (NTU's)	
Total dissolved solids (mg/1 - by evaporation at 180° C)	1600	Suspended solids (mg/1)	

ANALYSIS — CHEMICAL (mg/1)

Sodium, Na	225	☒ Chloride, Cl	650
Potassium, K	10	Sulphate, SO^4	186
Calcium, Ca	140	Nitrate, NO^3	8
Magnesium, Mg	110	Bicarbonate, HCO^3	286
Total Hardness (as $CaCO^3$)	801	Carbonate, CO^3	
Total Alkalinity (as $CaCO^3$)	235	Fluoride, F	0.5
Iron, (total) Fe	UNSUITABLE FOR ANALYSIS	NaCl (calc. from chloride)	1071
Silica, SiO^2	29		

ANALYSIS — ADDITIONAL (mg/1)

Copper, Cu	Lead, Pb	Arsenic, As
Manganese, Mn	Zinc, Zn	Cadmium, Cd
	☐	☐

NATA

This Laboratory is registered by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of registration. This document shall not be reproduced except in full.

Date 8/11/88

Boxes marked thus ☐ Indicate levels are within the limits as quoted in the "Guidelines for Drinking Water Quality in Australia", 1987; issued by the National Health and Medical Research Council and the Australian Water Resources ...

☒ Levels exceed non-health related ...

☒ Levels exceed health related limits

Darwin NT 5794

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THE NORTHERN TERRITORY OF AUSTRALIA

FINAL STATEMENT OF BORE

ulation 8

m To	Description of strata
0-6	Clay
6-78	Schist

INDEX NO Home Station 16/2277

RN 15241

Name of Bore -

Name of Property -
ALCOOTA

Description of Property -
CATTLE

Name of Owner -
T. WEBB

Name of Contractor -
JACK HUGHES DRILLING CO P/L

Name of Driller -
JACK HUGHES

Date of Commencement -
21-5-88

Date of Completion -
21-5-88

Total Depth -
78 mtrs

Particulars of Casing - Const 8" PVC
73.5 mtr 6" PVC

Particulars of Perforations or Scre...
0 mtrs on Bottom

ocation of Bore for supply sketch on the
ack hereof -

..20...km

AN. 673?

(a) N NE
(S) SE of (b)..MUD...TANK...PARK.........
E NE ....
W SW ....

(a) Circle appropriate direction
(b) Use known point such as existing bore, homestead, outstations etc.

Additional information of interest about bore.

Grid Reference - 200 123 419645E/7448035

Map Number - SF 53-14 ALICE SPRINGS 1:250,000

Samples of Strata and Water Supplies.

have been* will be*
left at the following place -

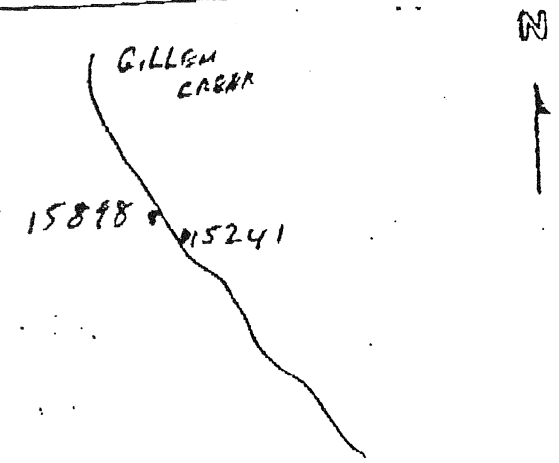
..........................A/S..........................

Signature

*Delete non applicable

For Office use only -

Water	1st Supply	2nd Supply	3rd Supply
Struck at	61m		
Standing Water Level	33 m		
Pumping Supply Litres/sec	0 6		
Duration of Pump Test	4 hrs		
Water Level During Test	AIR LIFT		
Quality			

LOCATION SKETCH OF BORE	LOCATION DESCRIPTION OF BORE
	1 m/Km ☐ E ☐ S ☐ SE ☐ NE ☐ W ☐ N ☐ SW ☒ NW OF: RN 15241

FINAL CONSTRUCTION STATUS

☑ Capped ☐ Casing pulled ☐ Left for Observation ☐ Abandoned

☐ Equipped ☐ Backfilled ☐ Others ( )

ADDITIONAL INFORMATION OF BORE

Signature of Licenced Driller R. E. Hall Date 8 / 5 / 91

FOR OFFICIAL USE ONLY

HOW LOCATED : ☐ GPS ☐ TST ☐ SURVEY ☑ HAND PLOTTED ☐ OTHER ( )

ELEVATION OF BORE AHD : (m) From ☐ GL ☐ TOC

DESCRIPTION OF PROPERTY ☐ Rural ☐ VCL ☐ Min ☐ Pastoral ☐ Reserve ☐ SPL ☐ EL ☑ Other

Lease No : Lot No : Hundred of :

Portion No : Sect. No : Town of :

CLASS OF BORE ☐ TOWN ☐ DOM ☐ AGR ☐ MIN ☐ COMM ☑ PAS ☐ OTHER

USE OF BORE ☐ INV. ☑ PROD. ☐ OBS. ☐ MON. ☐ IRR. ☐ EXC. ☐ R/H ☐ ROAD

GRID REFERENCE ☑ AMG ☐ CLARKE Zone : 53 Scale : 1: 100,000

EASTING : 41093 NORTHING: 74084	LATITUDE : LONGITUDE :	MAP NAME : LAUGHLEN. MAP NUMBER : 5757

AWRC STREAM BASIN No : TECTONIC UNIT NAME :

GEOPHYSICAL LOG RUN YES / NO Date : / / Depth : (m)

☐ Gamma ☐ SP ☐ Camera ☐ Density

☐ Point Res. ☐ Caliper ☐ Other ( )

Date Registered : 8 / 5 / 91 Plotted on the map : Yes / ~~No~~

Officer R. Darby Signature : R. Darby

Remarks

APPENDIX 2

REVERSE OSMOSIS

Introduction

Reverse Osmosis is a water treatment process that uses a membrane to transfer water molecules through intermolecular spaces in the membrane under pressure. It was developed from the observation that water molecules will pass through a membrane from a container of pure water into a container of saline or brackish water. The observed difference in the depths of the liquids in each container after some time is called the osmotic pressure for that saline solution. Reverse osmosis sends this process in the reverse direction by applying a pressure greater than the solutions osmotic pressure to the container with the saline solution so that water molecules move from the saline solution to the clean water container. This pressure increases with increasing salinity.

In a reverse osmosis unit, there is a flow of saline water across the surface of the membrane through which the water molecules pass. The loss of water molecules concentrates the salts on one side of the membrane . The flow of saline water washes this concentrated solution from the membrane and replaces it with the feed water which then undergoes the same process.If the unit is operated at a relatively low pressure (greater than the osmotic pressure) there is only a small yield of clean water. As the pressure increases there is an increase in the proportion of product water to feed water. However with increasing pressures there is a proportion of salts that will also pass through the membrane

Variability of output(4)

Recovery Rate - Factors influencing recovery rate are systems pressure, age of membranes, temperature and salinity of feed water

Pressure - As the pressure increases, the recovery rate increases for a particular TDS. The converse is also true.

Feedwater salinity- As TDS rises the throughput rate will fall for a particular pressure.

Feedwater Temperature - a significant reduction in the permeate flow rate will occur when the feed water temperature falls below 25 degrees C

A designed decrease in recovery rate will normally result in an improvement in the quality of the permeate. Certain materials such as calcium sulphate and calcium carbonate tend to come out of solution from some waters as they pass through the membrane modules, resulting in severe fouling problems. A reduced recovery may prevent this.

Increasing the recovery rate reduces the amount of water wasted and also improves the power efficiency

The membranes

The membrane of the reverse osmosis unit is the critical item in the process. The two basic materials used in commercial reverse osmosis are anisotropic thin film composite membranes (polyamide type) and assymetric cellulose acetate blend membranes.

Anisotropic Thin Film Composite membranes have superior chemical properties to cellulose acetate blend membranes and have gained wide acceptance for use in systems where low energy and high temperature operations are prime considerations. Composites do not suffer degradation due to hydrolysis. However the membrane film thickness is extremely thin and is vulnerable to inexplicable structural failure.

Thin film composite membranes
1. The pH of the water must be within the range 4-11 for TFC membranes.
2. The membranes are chlorine sensitive.
3. They are susceptible to organic fouling that is a result of their surface charge-positive or negative, but
4. Membranes are not affected by bacterial attack.
5. Care is required to select polyelectrolytes and other chemicals for pre treatment and for membrane cleaning, especially if they contain surfactants.
6. Water Temperature Limit is 45 deg C

Cellulose acetate blend membranes
1. The pH of the water must be 5-7 for CA membranes
2. The membranes are chlorine tolerant.
3. Cellulose acetate membranes are susceptible to degradation due to bacterial activity. This is controlled by maintaining a constant residual chlorine level in the ro feedwater of 1 mg/l.
4. Water Temperature limit is 35 deg C

Low pressure membranes produce high recovery rates from low salinity feedwater.
power savings
less expensive feed pumps
lower pressure rating pipes
less membrane area

There are different membranes for differents applications that corespond to the components in the feed water and the water quality of the clean water or permeate. In general, cellulose acetate membranes are preferred for treating water containing high biological levels.(2)Membranes may be hollow core modules or spiral wound modules.Spiral wound modules are less prone to fouling by less soluble species (eg $CaSO_4$), or from direct chemical interaction with the membrane surface. Siliceous colloids are notorious in this respect.

Memtec desalinators are fitted with the latest type of thin film polyamide membranes in the spiral wound configuration. (4)

Installation

The machine should be protected from direct sunlight and weather. Membranes are sensitive to excessive temperature and should not be operated at temperatures exceeding 45 degrees C except during chemical cleaning. It should be located where water can be spilt without causing a problem

feed water supply - capable of maintaining a designated flow rate at a delivery pressure of between 100-400kPa, preferably at least 250kPa.The feed supply should not contain black iron pipe or fittings. An isolating valve should be provided on the supply pipework to facilitate servicing

waste water - The pipework should have no back pressure or suctionand contain no valving to avoid inadvertant shutoff

permeate pipework - as short as possible
no valving
outlet open, not submerged
minimum head
no black iron components
be located above the outlet of the storage tank

The storage tank should be sized to suit the daily output of the machine

Constituents affecting ro systems (3)

1. pH
2. Turbidity - particularly colloidal matter such as organic material in surface waters, or fine clays from groundwaters
3. Iron hydroxide - usually derived from soluble ferrous salts in groundwater becoming oxidised in storage to ferric salts which precipitate as a colloidal hydroxide
4. Calcium and magnesium salts which can precipitate as carbonate, hydroxide or sulphate scales
5. Silica - can also precipitate on the the membrane surface
6. Bacterial and algal growth, not usually present in groundwater, but which can develop in storage tanks.

Care of ro systems

Fouling of membranes can be minimised by suitable pretreatment:

1. Fine filters will remove turbidity and iron hydroxide, but must themselves be regularly cleaned or replaced, otherwise the pump suction will 'starve'.
2. If the percentage recovery is limited, then calcium and magnesium compounds may not reach the precipitation levels. If a small amount of a suitable sequestrant such as Flocon 100 or AF100 can be continually dosed into the feed water then the permissible percentage recovery can be increased.
3. If groundwater is particularly hard, it may be necessary to install an ion exchange column ahead of the ro unit, but this must be regenerated at regular intervals by strong salt solutions.
4. Microbiological growth can be controlled by chlorination, but in that case the membranes must be specified to be chlorine resistant. Sodium bisulphite has been used as an alternative disinfectant.

Silica is rejected by ro however silica is not a problem in drinking water

Chloride ions-difficult to meet chloride ion concentration criteria guideline of less than 250mg/l for drinking water. To achieve from seawater(19800mg/l chloride ion conc.) using ro at 30% recovery requires a membrane chloride ion rejection of greater than 99%
Some ions that are found in brackish water can damage the membrane physically, chemically, and biologically. This results in the membrane becoming blocked or being broken down; either way the unit will fail to operate.To protect the membrane a pretreatment of the feed water may be required. This may be in the form of:

1. A filtration unit to remove small particles that will block up the intermolecular spaces through which the water particles flow
2. A microfiltration unit
3. Chemical additives to remove harmful ions like Fe (Iron)
4. To prevent scaling on the surface of the membrane.
   a-operation of ro system not to exceed solubility of scale forming salts
   b-pretreatment by ion exchange or lime softening
   c- acidification for reduction of alkalinity
5. Chemical additives to adjust pH of the feed water to control precipitation of salts and/or the passage of salts through the membrane.

Pretreatment(5)

Fe, Mn

Oxidation of these metals occurs as they are exposed to air.Precipitated oxidisation products are removed by filtration but there is no guarantee that all Fe and Mn have been oxidised prior to the filtration unit.They will oxidise downstream of the filter creating precipitates prior to entry to,and during passage through, a reverse osmosis membrane. This is a major cause ofinorganic fouling in the membrane, and it is largely irreversible.

1. precipitates formed before the ro train will foul all lead end elements
2. oxidation within the ro modules will cause precipitates to form throughout the membrane on the membrane surface. The problem is further aggravated as manganese oxide deposits act as catalyst for further oxidation thereby increasing the rate of oxidation local to the deposit. For these reasons it is imperative to remove dissolved heavy metals down to approximately 0.01ppm Fe and 0.02ppm Mn if long membrane life is to be achieved.

At Coober Pedy Fe and Mn are removed using a manganese greensand filter medium. The bed is continuously regenerated with potassium permanganate. Chlorine is dosed as it can replace almost all of the theoretical demand for permanganate demand.

Scale Inhibitors - sequestrant

sodium hexametaphosphate(SHMP) acts to prevent precipitation of scale
problem - once prepared in a solution ,tends to hydrolyse,severely impairing its effectiveness. Orthophosphates are formed during hydrolysis. These may then precipitate as insoluble calcium phosphate

Flocon 100 - product of Pfizer
hydrolytically stable and effective over a wide range of pH
The chemical functions as a scale inhibitor in a similar manner to SHMP ie, by a threshold mechanism in which the normal growth of crystals in supersaturated solutions is impeded. The polymer attaches to microcrystaline nuclei as they form, inhibiting further crystalline growth and shifting the solubility equilibrium to favour dissolution. As a result calcium carbonate, calcium sulphate, strontium sulphate, calcium fluoride and barium sulphate are held in suspension beyond their normal solubilities.
(Coober Pedy dose rate 5 ppm.

Routine monitoring

To ensure that the membrane is operating satisfactorily and prevent damage to the membrane, the reverse osmosis unit must be monitored regularly. Units that are operating under high pressure to achieve high yields of cleaned water require more frequent monitoring than units that operate at low pressure.The monitoring programme indicates the condition of the membrane. A membrane should last about three years if the machine is well maintained with an appropriate pretreatment to provide a clean feedwater source. In a remote location with little attention and a simplified pretreatment, a 12 month life expectancy may be more appropriate.

Routine checks

Data logging - to record the permeate flow rate When the adjusted permeate flow rate falls by more than 15% from level established in the first 24-48 hours, chemical cleaning of the membranes must be carried out

Inspect for water leaks and rectify

Check main system pump for leaks and noisy operation

Check condition of cartridge filter. If feed pressure reading drops by 50 - 100 kPa the filter will usually be clogged and requires replacing. If not done, the machine will eventually lose feed pressure and shut down automatically. The cartridge is not as effective when operating at high differencial pressures, and may not offer suitable protection to the system.

Check that pressure switch is operating satisfactorily

Shutdown

If the unit is not to be used for a few days, it should be run for at least 10min each day to prevent bacteria breeding in the membrane elements.
If the machine shutdown is to be for more extended periods, the unit should be preservatised. The membranes are left immersed in a solution containing 'Vivanol'

Cleaning ro modules (3)

Modern membranes can stand dilute acid being pumped through them, to dissolvecalcium carbonate or iron hydroxide. Alkali solutions, detergents and EDTA are also used. However if the module is allowed to become completely clogged, the passages are so fine that the cleaning agent may not penetrate, and a new module will have to be purchased.
t
The ease with which bacteria can grow inside the module when it is not running must be recognised. Stagnant conditions enable the bacteria to form a slime. If the unit is to go out of service for more than a couple of days, it must be flushed with a special disinfectant and allowed to stand in that conditon.

One of the important requirements for efficient operation of a reverse osmosis unit is the power supply. A diesel generator may have been sized for the reverse osmosis unit. Then additional appliances may be included that reduce available power to the unit, or makes the generator operate inefficiently. Unexpected breakdowns can cause the reveerse osmosis unit to be idle for some time without carrying out the shutdown procedure. It is therefore preferable to have a power unit that only operates the Reverse Osmosis unit

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APPENDIX 3

REVIEW OF FOUR EXISTING REVERSE OSMOSIS UNITS

Introduction

Recently, three reverse osmosis plants were visited, at Yalata, Nullabor Roadhouse, and Coober Pedy. An assessment of the Reverse osmosis plant at Mulga Bore is also included

Yalata

At Yalata, an "Aquapore" reverse osmosis unit is treating feed water with a TDS 13000 mg/l and producing a permeate with a TDS 700 mg/l. There is filtration and pre treatment of feed water with sulphuric acid,to adjust the pH of the feedwater, Flocon 100 (a scale inhibitor). Permeate water is dosed with caustic soda to balance the pH. Of 100litres in feed supply, 50 litres of permeate is produced. The system runs automatically. Membranes are thin film polyamide membranes.

Nullabor Roadhouse

At Nullabor Roadhouse, a "Memtec" reverse osmosis unit is treating feed water with a TDS 13000 mg/l and producing a permeate with a TDS 100-200 mg/l. The feed water has a high iron content that would be damaging to the membranes. The iron is removed by aeration and passing the feed water through a sand filter. A microfiltration unit is also used. The feed water is then dosed with Flocon 100. Of 60litres of water in feed supply, 15 litres of permeate is produced. Estimated cost of clean water is 14-18 cents/litre. This unit operates for three days continuously and then is turned off for five days. When it is turned off the membranes are cleaned and immersed in a preserving solution to prevent fouling by organic matter. While it is operating the unit is monitored daily.

Coober Pedy

At Coober Pedy, the reverse osmosis unit has been designed by Roger Stokes, Adelaide.The unit treats feed water with a TDS 3000-4000 mg/litre and produces a permeate with a TDS 400 mg/litre.Pretreatment includes chlorination and dosing with potassium permanganate to control iron and manganese.It is also pretreated after filtration with sodium metabisulphite, sulphuric acid and Flocon 100. SMBS reduces the small amounts of excess oxidant to ensure that any dissolved iron or manganese that escapes the filters will not be oxidised whilst passing through the ro membranes. Acid is used to bring pH to a value of 6.6 This is to ensure the prevention of calcium carbonate scale formation. Of 100litres of feed water it produces 75litres of permeate. Permeate flows to the degasser towerwhere CO2 is removed and pH is corrected to the range 7-9. The system requires a technician in attendance who records the quality of the feed supply after pretreatment and filtration to ensure that pretreatment measures are working. The reverse osmosis membranes used are a spiral wound type using cellulose acetate membrane material.

Mulga Bore

The ro unit at Mulga Bore was designed by Chris Wallace and Memtec. It was designed to treat bore water with a TDS 900mg/l.which is low. Its main purpose was to remove nitrates which were high in relation to WHO guidelines. The unit was designed to produce 400l/day of high quality drinking water at a remote location where there would be no daily monitoring of the unit. This unit is operating satisfactorily with a maintenance check approximately every 2-3 months. The only pretreatment is filtration to remove solids greater than 5 microns.There is no pretreatment using chemical additives to adjust pH or control scaling.The system is solar powered,operating continuously during sunshine hours.The groundwater is pumped using solar power to a tank with a reservoir level to ensure that there is always a feed supply to the ro unit. The ro unit is solar powered so that it operates for about 6 hours per day every day automatically. There is no concentrate to be disposed of, because the concentrate from the ro module is returned to the feed tank. This does not affect the concentration of the feed supply significantly for the following reasons;

1. The permeate is only 10% of the feed supply. This means that the concentrate salinity is only increased by 10%.

2. The feed tank supplies water to the community of about 40 people for purposes other than drinking water. Drinking water usage is generally less than 10% total water usage.

The maximum increase in salinity by returning the concentrate to the feed tank is approximately 5%.

For this low permeate yield there is the benefit of having the membranes operating at lower than normal pressure for ro units. The unit requires a larger membrane area for the required supply rate than conventional ro units. At lower pressures the membrane will last longer and the likelihood of inorganic fouling is reduced. Organic fouling is reduced by using water that is pumped from groundwater into a covered tank where water is being continuously used.

From this review there is an increase in maintenance as the proportion of permeate to feedwater increases. There is addittional pretreatment to protect tthe membranes in a more efficient system in relation to water consumption and energy use.

Mulga Bore is the only unit that does not require a daily check on its operation while it is in use. There is no pre treatment with chemicals and the salinity is already low.Its water supply is guaranteed,its power source is also guaranteed. Membranes operate under low pressure that minimises the deposition of inorganic salts in or on the membrane.

Recommendation

To make a reverse osmosis unit appropriate for a remote location it should:
1. operate on its own power supply; or have a guaranteed no fluctuation supply
2. require no daily record of operation,and be able to operate constantly between monthly maintenance checks;
3. It would be preferable that the waste water is able to be used for some purpose,or kept to a minimum if this is not possible;
4. The permeate should be about 5-10% of the feedwater supply so that operating pressures are low and the chance of fouling the membrane is also reduced;
5. Additional safeguards should be included that will protect the membranes, particularly if suspended matter/particles are likely to infiltrate the water supply.