Planning water supplies for the farm.

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PIRSA

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"*Adoption of innovative practices to improve on-farm water security leading to increased sustainability and NRM outcomes in the Northern Mt Lofty and Barossa Ranges"* project,

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Water sources for farm use

Rainfall and runoff

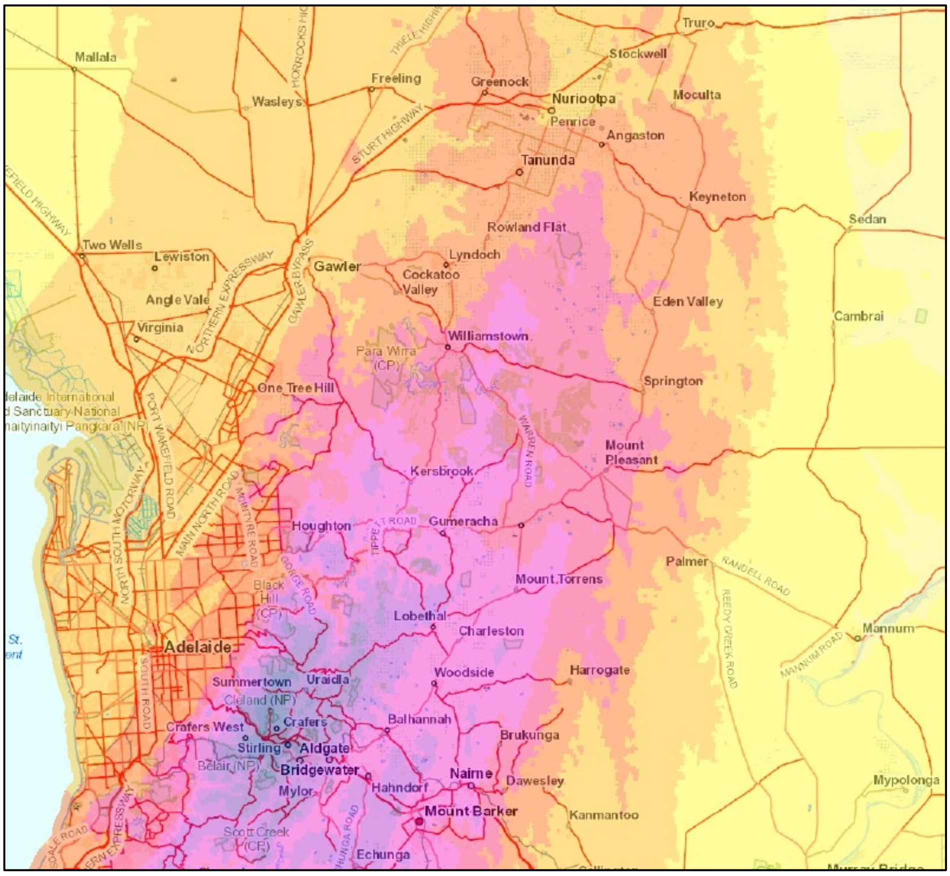
Annual average rainfall in the Mount Lofty Ranges varies from 400 mm on the eastern flanks to over 900 mm around Mount Lofty (Figure 1). Data for selected locations is shown in Table 1.

Table 1: Annual average rainfall (mm) for selected stations in Barossa Ranges

Angaston	556	Birdwood	716
Williamstown	677	Sedan	304
Keyneton	528	Cambrai (Kongolia)	294
Mount Pleasant	668	Palmer	413

Source: Bureau of Meteorology Climate Data Online

Figure 1: Average annual rainfall Mount Lofty Ranges



Source: NatureMaps

Most of this rainfall is infiltrates the soil or runs off. Run off occurs when the soil is saturated and unable to absorb any more water or when rainfall intensity exceeds infiltration rate (such as in very fine-textured soils). Shallow soils with a restrictive layer (such as rock or dense clay) will become saturated more quickly than deep, well drained soils. In the Barossa Ranges, natural runoff increases substantially when annual rainfall exceeds 500 mm.

Runoff is therefore determined by the permeability of the surface onto which rain falls. Impermeable surfaces are ones such as iron roofs and plastic sheeting, slightly more permeable surfaces are concrete and asphalt. Compacted, bare earth has less impermeability and coarse-grained or well-structured or soils with vigorous plant growth have the highest permeability.

While rainfall is of very good quality, run off can be contaminated by materials on the surface onto which it falls (e.g. dung, contaminant-laden dust).

Underground water

Rainfall that drains through the soil profile collects in layers of rock, sand or gravel. It accumulates minerals and salts from the soil and rock it drains through and into. Much of the salt in South Australia's underground water is from sediments formed under sea water or blown inland from the sea and leached through the soil.

Springs and seeps occur when the groundwater layer intercepts the ground surface (usually in close proximity to a rock bar).

Bores and wells are used to access ground water – bores are cased and set up to draw water from a particular layer whereas wells are open holes in which groundwater from different depths can mix. There is no definitive "map" of underground water resources as numerous layers hold varying amounts of water at wide ranging quality. Another factor in assessing bores is their yield, that is, how quickly water can be drained from the rock strata. Most of the underground water in the Barossa Ranges is contained in fractured rock aquifers so accurate predictions of quality and yield are nearly impossible.

Drill holes in South Australia are logged and mapped. NatureMaps, hosted by the Department for Environment and Water, has a drill hole data layer set (Figure 2) and querying an individual drill hole will provide data from WaterConnect that usually includes a salinity measurement and often a yield measurement (Figure 3).

Checking drill hole data in an area is the most practical way to assess the quality and yield of underground water resources in an area.

Important water resources in South Australia are protected and managed by being 'prescribed' under the Landscape South Australia Act 2019. Prescription enables sustainable management of the water resource to provide security for all water users, including the environment. Once a water resource is prescribed, all people who take water from that prescribed resource need a licence or approval from the Minister to do so. The main exception is that taking water for stock (not including intensive stock keeping such as feedlots, piggeries, chicken farms etc) and water for domestic use can be exempted from licensing requirements. Taking water for fire fighting and road making are currently exempt from licensing.

Some of the prescribed water resources areas are:

- Barossa
- Marne River and Saunders Creek
- Western Mount Lofty Ranges
- Eastern Mount Lofty Ranges.

Further information on management of a region's water resources can be obtained from the local Landscape Board.

Figure 2: Screenshot of NatureMaps drill hole data layer

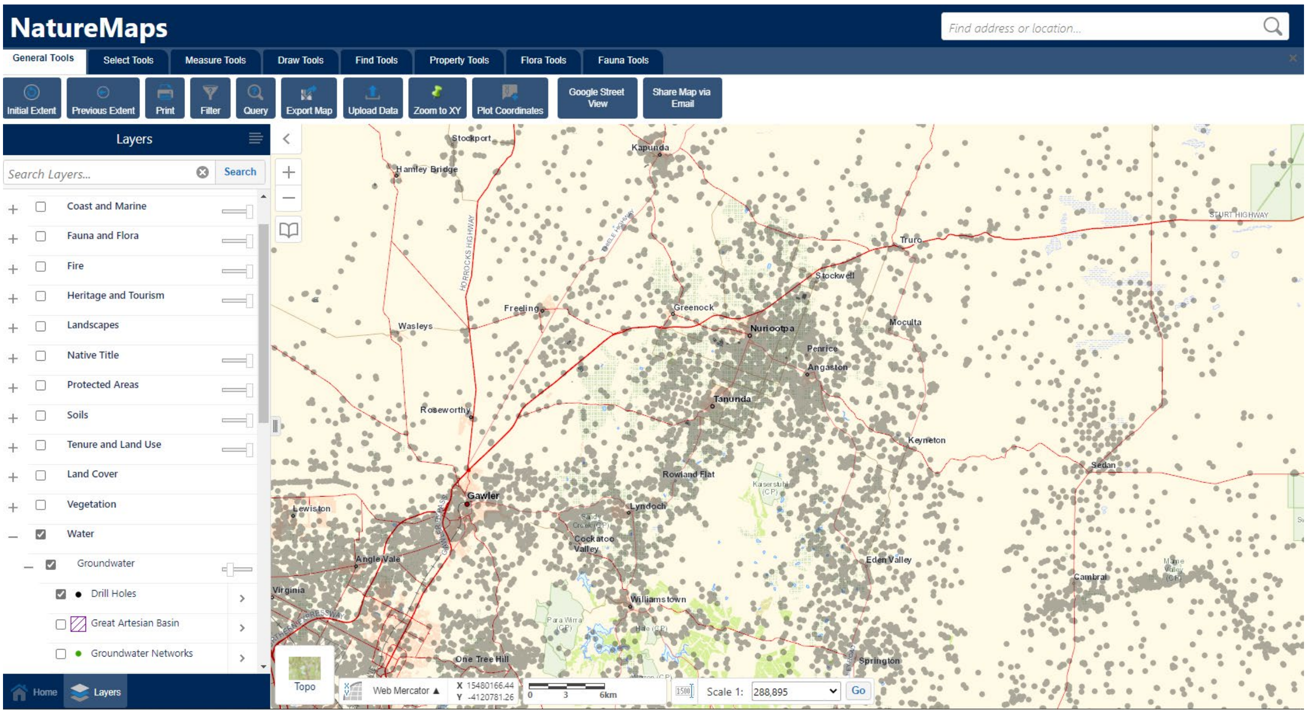
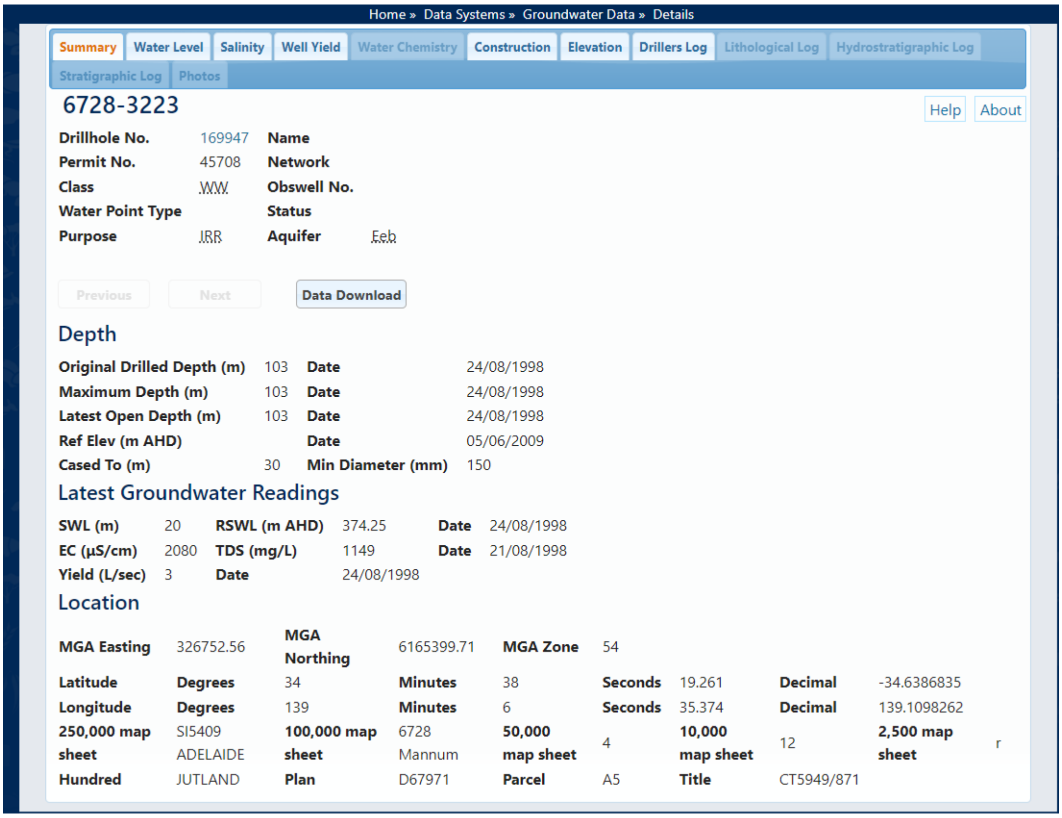


Figure 3: Screenshot of WaterConnect Groundwater Data for Drillhole No. 169947


Home » Data Systems » Groundwater Data » Details

Summary | Water Level | Salinity | Well Yield | Water Chemistry | Construction | Elevation | Drillers Log | Lithological Log | Hydrostratigraphic Log | Stratigraphic Log | Photos

6728-3223

Help | About

Drillhole No.	169947	Name	
Permit No.	45708	Network	
Class	WW	Obswell No.	
Water Point Type		Status	
Purpose	IRR	Aquifer	Feb

Previous | Next | Data Download

Depth

Original Drilled Depth (m)	103	Date	24/08/1998
Maximum Depth (m)	103	Date	24/08/1998
Latest Open Depth (m)	103	Date	24/08/1998
Ref Elev (m AHD)		Date	05/06/2009
Cased To (m)	30	Min Diameter (mm)	150

Latest Groundwater Readings

SWL (m)	20	RSWL (m AHD)	374.25	Date	24/08/1998
EC (µS/cm)	2080	TDS (mg/L)	1149	Date	21/08/1998
Yield (L/sec)	3	Date	24/08/1998		

Location

MGA Easting	326752.56	MGA Northing	6165399.71	MGA Zone	54				
Latitude	Degrees	34	Minutes	38	Seconds	19.261	Decimal	-34.6386835	
Longitude	Degrees	139	Minutes	6	Seconds	35.374	Decimal	139.1098262	
250,000 map sheet	SI5409 ADELAIDE	100,000 map sheet	6728 Mannum	50,000 map sheet	4	10,000 map sheet	12	2,500 map sheet	r
Hundred	JUTLAND	Plan	D67971	Parcel	A5	Title	CT5949/871		

Imported water

Two sources of supply from outside the Mount Lofty Ranges are wastewater from the SA Water Treatment plant at Bolivar on the Adelaide Plains, and water pumped and distributed from the River Murray.

The Northern Adelaide Irrigation Scheme is proposing to extend access to treated wastewater to the Barossa Valley and possibly Eden Valley, primarily for irrigation. The New Water Infrastructure to the Barossa Project (Barossa New Water) aims to deliver new, secure, climate-independent and affordable water to complement other water sources, to underpin productivity growth in the broader region and economic benefits to the State. The project is investigating the viability of delivering new water supply to Barossa and Eden Valleys by leveraging supply and infrastructure of the Northern Adelaide Irrigation Scheme, and other existing infrastructure, and address industry demand from the wine, livestock, and horticulture sectors for new water sources to provide security from declining rainfall, surface water and underground water availability.

The Swan Reach to Paskeville pipeline supplies water from the River Murray to the Barossa Valley, Lower North and Yorke Peninsula areas, serving townships and farmland along its route. The water is treated at Swan Reach as it is pumped into the pipeline (Figure 5). Salinity of water at Morgan during high flows is around 280 EC units (188 mg/L)

The 87 kilometre Mannum to Adelaide Pipeline was the first major pipeline built from the River Murray to serve the needs of Adelaide. The pipeline supplies water to the metropolitan network through a water treatment plant at Anstey Hill. It directly supplies residents in the Torrens Valley and north eastern foothills suburbs and can also deliver water to six reservoirs (figure 6). Salinity of the Murray River at Mannum during high flows is about 300 EC units (200 mg/L).

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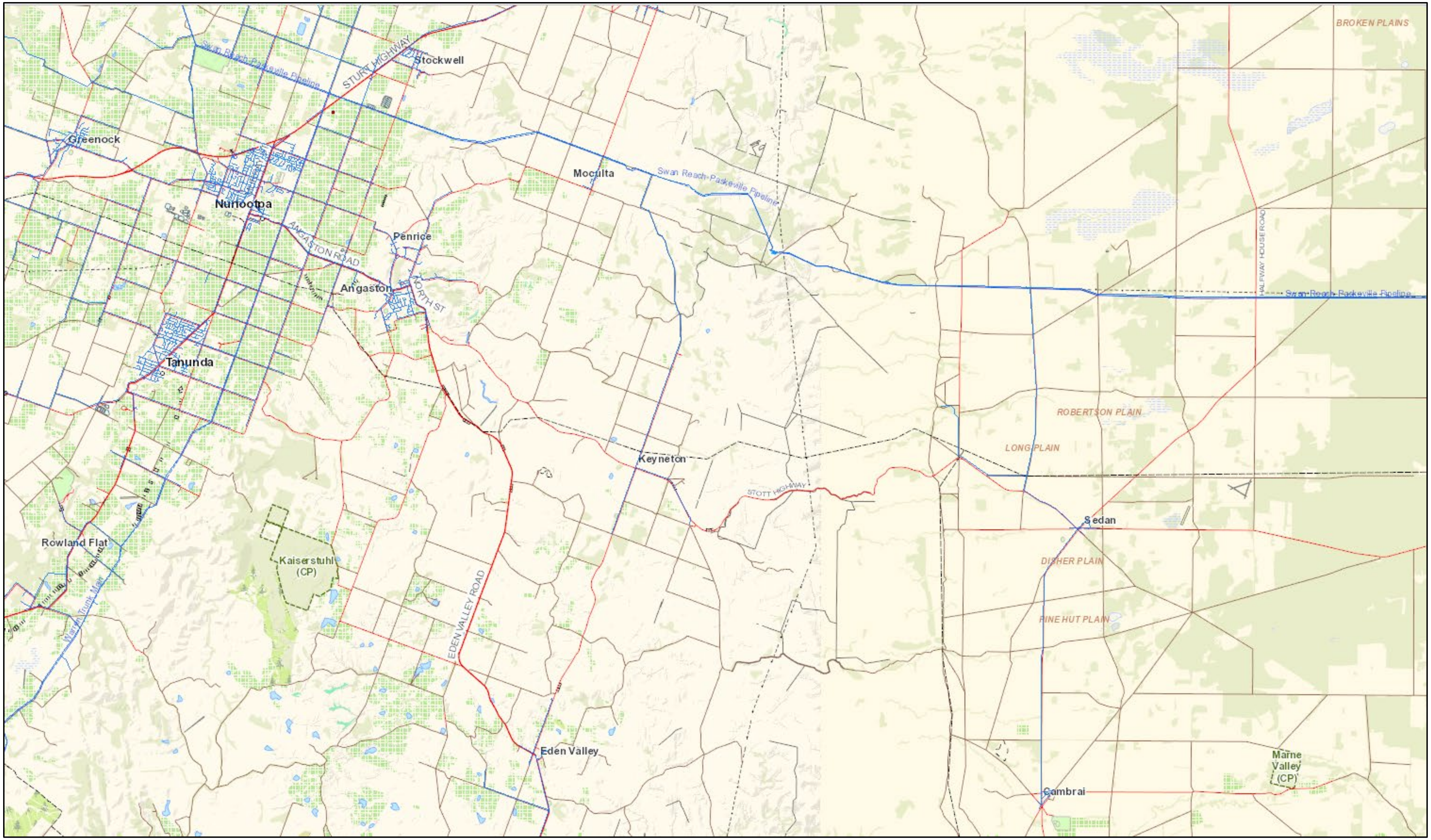
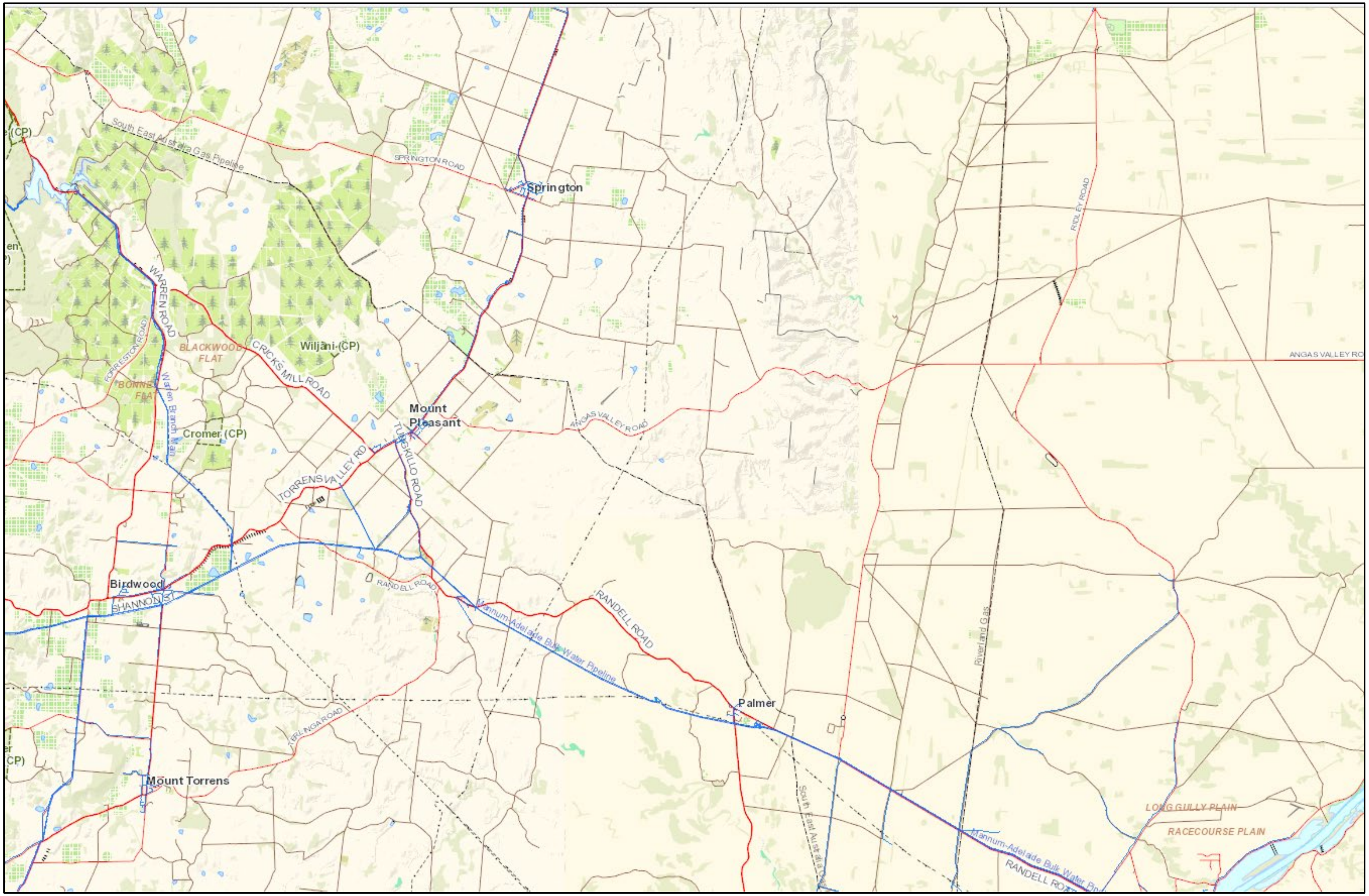
Figure 5: Swan Reach (River Murray) to Paskeville pipeline



Source: https://map.sarig.sa.gov.au

Figure 6: Mannum (River Murray) to Adelaide pipeline



Source: https://map.sarig.sa.gov.au

Capturing or accessing water on-farm.

Harvesting run-off

Historically, most run-off has been collected from whole watersheds and held in dams placed in watercourses (on-stream storage). Dams filled when soil were saturated and/or rainfall intensity exceeded soil infiltration rates. Users downstream (including the environment) did not receive water until dams filled and overflowed. Newer dams now are sited off-stream and with low-flow devices to maintain flows in watercourses.

Rainfall collected from roofs of houses and sheds has been used for chemical spraying, domestic supplies and some stock watering.

These are somewhat “natural” or “opportunistic” catchments, using existing land forms and infrastructure to collect run-off.

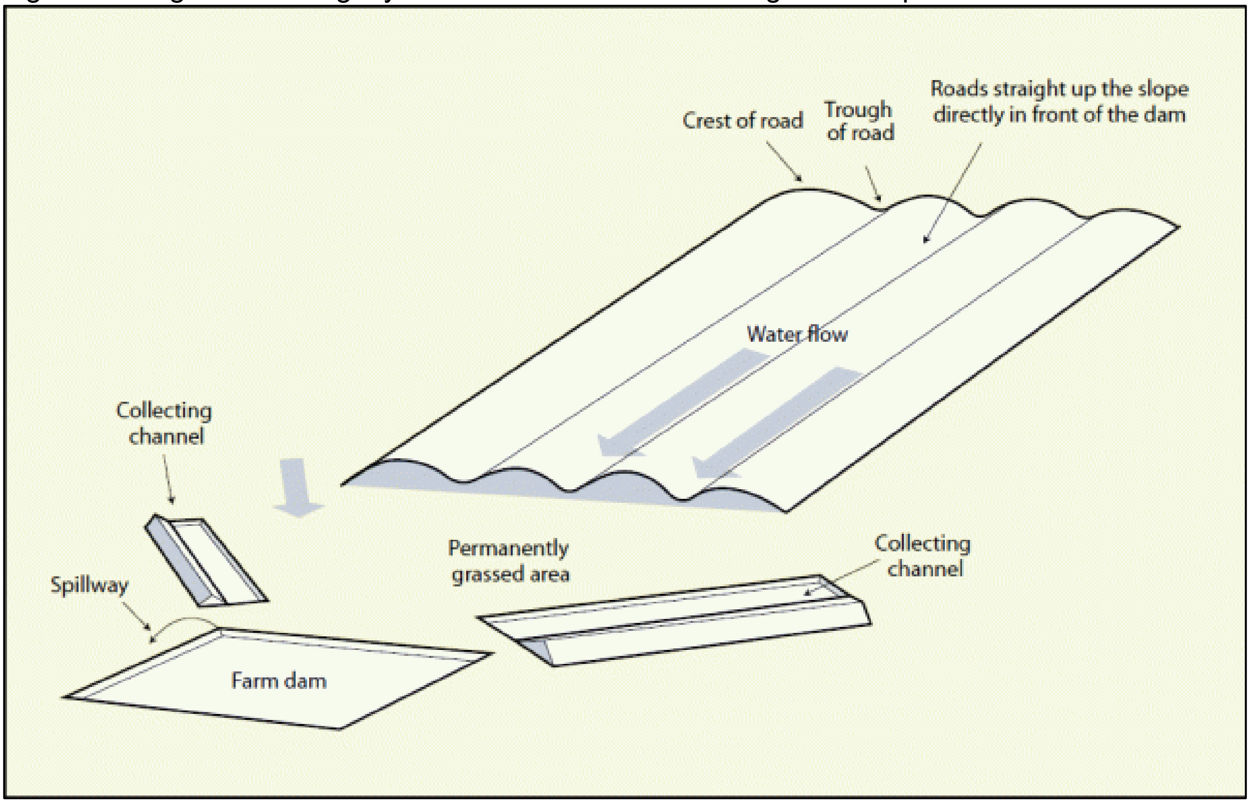
Designed and engineered catchments, such as roaded and sheeted catchments are specifically designed to capture run-off from a dedicated area. Roaded catchments (Figures 8, 9 & 10) are usually constructed with a patrol grader where earth banks and channels are built to collect, concentrate and generate flows. Sheeted catchments have soil surfaces covered by an impervious material, such as plastic used to line dams. Both roaded and sheeted catchments are usually built on sites with some slope so that water runs off.

Roaded catchments:

- Requires soil type that can be compacted to reduce permeability (usually a proportion of clay)
- Requires a design that enables water to run off at velocities that do not erode the soil (i.e. surveying is required to ensure fall of banks and channels is not too steep)
- Requires a structure at its base to intercept silt and direct run-off into a storage facility (dam or tank).
- Requires regular maintenance to ensure that banks and channels remain sound and have not eroded or filled in; and there is no plant growth on them.
- Preferably are fenced off to stop stock walking or camping on them.
- Costs are mostly in earthworks.
- South Australian case studies have shown that runoff from roaded catchments captures about 20 to 25% of rainfall, with a higher proportion in wetter seasons.

Figure 7: Small roaded catchment at Nuriootpa Research Centre 1988

Figure 8: Diagram showing layout of roaded catchment for ground slope of less than 1.25%



Source: WA Department of Primary Industries and Regional Development

Figure 9: Roaded catchment in WA with dam filled with water.

Source: WA Department of Primary Industries and Regional Development

Sheeted catchments:

- Will shed at least 95% of any rainfall
- Requires material that will last for long period of time, exposed to sunlight and weather
- Requires to be laid on even surface without any underlying sticks, stones or gravel that can puncture or abrade sheeting
- Requires structure at foot of catchment to collect and direct run-off into dam or tank.
- Requires fencing to keep domestic and wildlife off sheet and tearing or puncturing it
- Requires weighting to keep sheet flat on ground and minimise movement and abrasion of sheet.
- Costs: Plastic sheeting, laying of sheeting, earthworks (bed levelling and construction of sump)

Figure 10 show a sheeted catchment at Wharminda, and farmers' practical experiences of installing sheeted catchments are provided on pages 12 to 14.

The volume of water that can be generated from an impermeable surface is far greater than a semi-permeable surface, particularly during low intensity rainfall.

Table 1 shows the run-off from an area of 60 x 60 m^2 (3600 m^2) for various annual average rainfall scenarios and the imperviousness of the catchment surface. Earthen surfaces imperviousness could be around 20 to 25% whereas plastic sheeted catchments are expected to be at least 95%.

Figure 10: Sheeted catchment at Wharminda

Source: Eyre Peninsula Natural Resources Management Board

Table 1: Calculated run-off from area

Calculating run-off yield from an area

Area (m^2)

Width (m)	Length (m) 40	60	80	100	120
40	1600	2400	3200	4000	4800
60	2400	3600	4800	6000	7200
80	3200	4800	6400	8000	9600
100	4000	6000	8000	10000	12000
120	4800	7200	9600	12000	14400

Calculate yield: area (m^2) x annual rainfall average (mm / yr) x proportion runoff %

e.g. Area: 1000 m^2

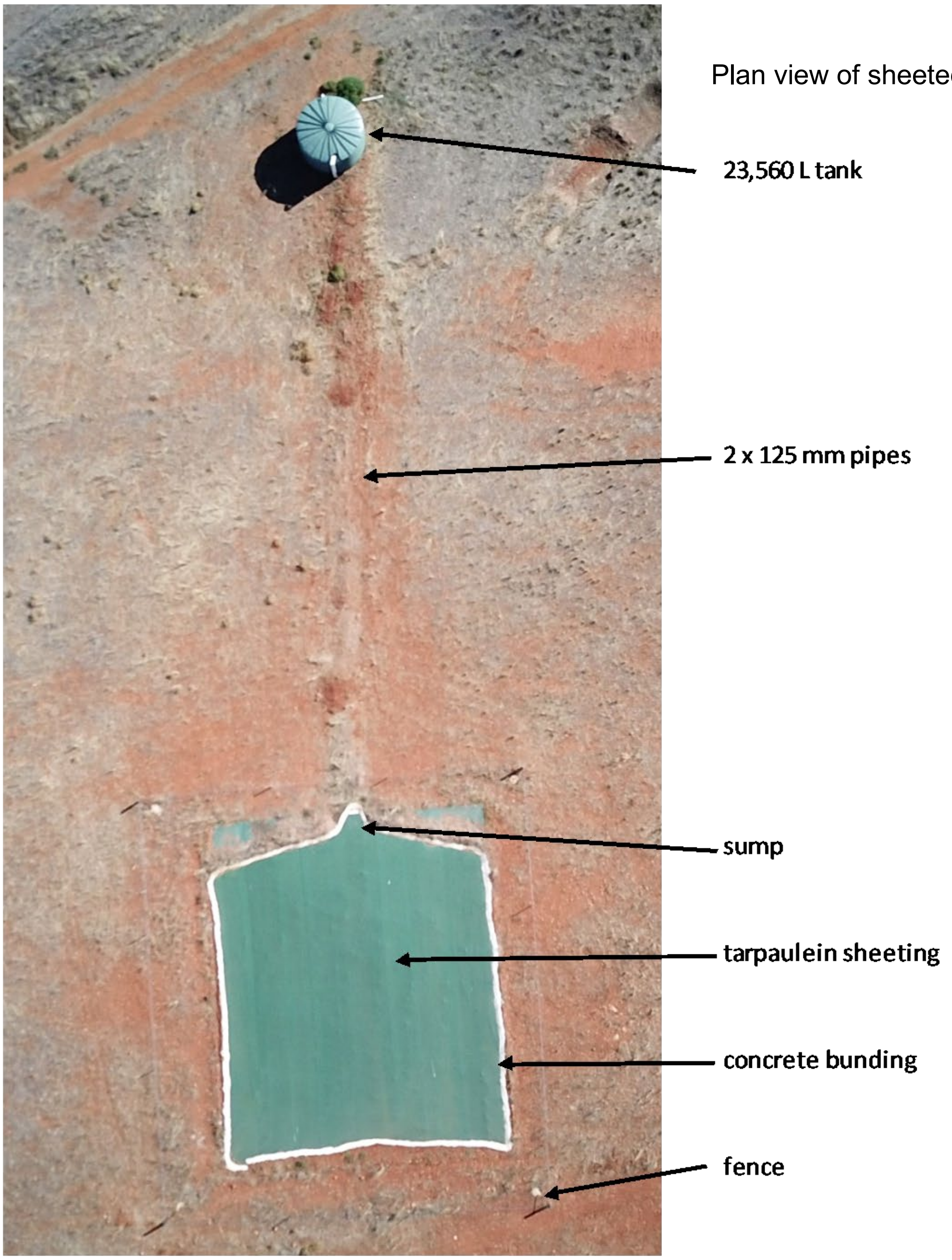
Yield (Litres)

Annual rainfall (mm / yr)	% runoff / surface imperviousness 20	40	60	80	90	100
178	35600	71200	106800	142400	160200	178000
200	40000	80000	120000	160000	180000	200000
250	50000	100000	150000	200000	225000	250000
275	55000	110000	165000	220000	247500	275000
300	60000	120000	180000	240000	270000	300000
325	65000	130000	195000	260000	292500	325000
350	70000	140000	210000	280000	315000	350000
375	75000	150000	225000	300000	337500	375000
400	80000	160000	240000	320000	360000	400000
425	85000	170000	255000	340000	382500	425000
450	90000	180000	270000	360000	405000	450000
475	95000	190000	285000	380000	427500	475000
500	100000	200000	300000	400000	450000	500000
525	105000	210000	315000	420000	472500	525000
550	110000	220000	330000	440000	495000	550000
575	115000	230000	345000	460000	517500	575000
600	120000	240000	360000	480000	540000	600000
625	125000	250000	375000	500000	562500	625000
650	130000	260000	390000	520000	585000	650000
675	135000	270000	405000	540000	607500	675000
700	140000	280000	420000	560000	630000	700000
725	145000	290000	435000	580000	652500	725000
750	150000	300000	450000	600000	675000	750000
775	155000	310000	465000	620000	697500	775000
800	160000	320000	480000	640000	720000	800000

In this example, a 1000 m^2 area of roaded (earthen) catchment in a 400 mm rainfall area would be expected to yield 80,000 to 100,000 litres of runoff over a year.

Practical Experience: Sheeted catchment providing spray water supply

In 2021, Philip Combe laid a custom-made tarpaulin on an area of 0.03 ha to capture rainwater for crop spraying. The bore water available on the property near Laura was too saline to use. A hill slope on uncultivated land of approximately15% slope was selected for the collection site and a 15 m x 20 m area levelled. Average annual rainfall for the district is approximately 450 mm.



Plan view of sheeted catchment

The tarpaulin was made to order from a manufacturer and cost approximately $800. After the tarpaulin was pegged around the edges, a concrete bund of approximately 30 cm high was built on the edge of the sheeting.

The catchment of 300 m^2 in a 450 mm average annual rainfall area has the potential to generate 128,250 litres per year of run-off (assuming a 95% efficiency).

Installing the sump

Sump

Practical Experience: Sheeted catchment increasing runoff into existing dam

Dale Button of Robertstown farms 3000 ha in an area of 250 mm average annual rainfall and runs a Merino stud, wool and lamb production, and cropping enterprises. In recent years there has been little runoff into dams.

Dale established a sheeted catchment on an area above an existing dam which “holds like a bottle”.

Earthworks were initially conducted to flatten and level the catchment area and clean out the dam.

Eight-metre-wide poly liner was laid over the area of 30 m x 40 m, secured by truck tyres, and welded together.

A cement drain pit was installed at the catchment’s lowest point to feed into storm water pipes which discharged into the dam’s existing cement inlet.

A 1.2 m high cyclone fence was erected around the catchment to keep stock and wildlife out.

Costs:

- Earthworks $2,500
- Poly liner (8 m x 200 m x 1.8 mm) + welding $8,300
- Fencing and piping $1,000

Total cost $11,800

Lined catchment immediately above dam

Storm water pipes carry runoff from liner to concrete inlet of dam.

Source: BIGG 2021 “Harvesting rainwater proves invaluable during dry times” 2021

Underground water

The quality and yield of bores in the Mount Lofty Ranges varies widely, even when bores are close to one another. Unfortunately, there is no means of determining the quality and yield of an underground water source until a drill hole is bored.

A random selection of drill holes in the region and their data from WaterConnect demonstrates this variability (Table 2).

Table 2: Water salinity and yield of various drill holes.

Drillhole No.	Location (Hundred)	Total Dissolved Solids (mg/L)	Yield		Date latest TDS reading
			(L/s)	(L/hr)	
169947	Jutland	1,149	3.0	10,800	21/08/1998
74402	Jutland	365	2.0	7,200	28/11/1973
75905	Jellicoe	2,143	0.1	360	06/04/1977
74143	Jellicoe	3,252	0.3	900	25/07/1977
182485	Moorooroo	1,861	2.3	8,100	13/10/2000
59180	Para Wirra	547	1.9	6,732	02/02/1983
49199	Barossa	1,998	2.3	8,172	17/11/1959
75529	Tungkillo	3,147	3.0	10,800	22/09/1988

Water salinity is a critical component of water quality. Table 3 shows general classes of salinity based on its electrical conductivity (EC) measurement.

Table 3: General salinity classification for water

EC (mS/cm, dS/m)	EC (mS/m)	Approximate total dissolved solids (mg/L or ppm)	Status
0–0.80	0–80	0–456	Low salinity
0.80–2.50	80–250	456–1425	Moderately salty
2.50–5.00	250–500	1425–2850	Salty
>5.00	>500	>2850	Very salty

Source: WA Department of Primary Industries and Regional Development "Water salinity and plant irrigation"

Livestock tolerances of saline water for animals on different feed types are shown in Table 4.

Table 5 shows pasture and crop tolerance to saline water on a loamy soil. Soil type and drainage can strongly influence salinity tolerances of plants hence more thorough investigation of water's suitability for irrigation should be undertaken if it is being considered.

Table 4: Approximate tolerances of livestock to salinity in drinking water (TDS in mg/L).

Key:

A: No adverse effects on animals expected

B: Animals may have initial reluctance to drink or there might be some scouring but stock should adapt without loss of production

C: Loss of production and decline in animal condition can be expected. Livestock might tolerate these levels for short periods if introduced gradually.

Livestock	**A salinity (mg/L)**	**B salinity (mg/L)**	**C salinity (mg/L)**
Beef cattle (mature, dry on pasture)	0–4000	4000–5000	5000–10 000
Beef cattle (feedlots)	0–4000		>4000[b]
Dairy cattle (mature, dry)	0–2400	2400–4000	4000–7000
Dairy cattle (milking)			3500
Sheep (mature, dry on pasture)	0–4000	4000–10 000	10 000–13 000[a]
Sheep (mature, dry, feedlots)	0–4000		>7000[b]
Sheep (mature, dry, confinement Feeding)	0–4000		>7000[c]
Sheep (weaners, lactating and pregnant on pasture)	0–4000		6600
Sheep (lambs, intensive feeding)	0–4000		>4000[b]
Horses	0–4000	4000–6000	6000–7000
Poultry	0–2000	2000–3000	3000–4000
Pigs	0-4000	4000-6000	6000-8000

[a] sheep on lush green feed may tolerate up to 13 000 mg/L TDS without loss of condition or production.
[b] intensive feeding for growth
[c] confinement feeding for maintenance
Source: WA Department of Primary Industries and Regional Development “Water Quality for Livestock”

Table 5: Pasture and fodder crop tolerance to irrigation with saline water on loamy soil

Crop	0% yield loss		10% yield loss		25% yield loss	
	EC (mS/m)	mg/L	EC (mS/m)	mg/L	EC (mS/m)	mg/L
Birdsfoot trefoil	330	1881	400	2280	500	2850
Cocksfoot	100	570	210	1197	370	2109
Couch	270–635	1539-3620	No data available		No data available	
Kikuyu grass	270–635	1539-3620	No data available		No data available	
Lovegrass	130	741	210	1197	330	1881
Paspalum dilatatum	270–635	1539-3620	No data available		No data available	
Perennial ryegrass	370	2109	460	2622	590	3363
Phalaris	310	1767	380	2166	530	3021
Puccinellia	635–2365	3620-13481	No data available		No data available	
Red clover	100	100	160	912	240	1368
Rhodes grass	270–635	1539-3620	No data available		No data available	
Saltwater couch	635–2365	3620-2365	No data available		No data available	
Strawberry clover	100	570	160	912	240	1368
Sub clover	100	570	110	627	240	1368
Sudan grass	190	1083	340	1938	570	3249
Tall fescue	260	1482	390	2223	570	3249
Tall wheat grass	500	2850	660	3762	900	5130
White clover	90	513	No data available		No data available	
Barley (hay)	400	2280	490	2793	630	3591
Lucerne	130	741	220	1254	360	2052
Maize	110	627	170	969	250	1425
Sorghum	450	2565	500	2850	560	3192

Source: WA Department of Primary Industries and Regional Development "Water salinity and plant irrigation"

Practical Experience: Bore Sinking

Michael Evans engaged drillers to sink a bore on his property at Flaxman Valley in 2021.

The bore is 105 m deep, yields 2,000 L/hr and has a salinity of 2,000 mg/L.

The cost of drilling, steel casing, PVC casing and surface casing was $16,878 (~ $161/m).

Additional costs:

Solar Pump from Diener Solar at Kapunda - $10,184

Trenching using Vemeer Trencher from Barossa Valley Hire - $300/day

Pipe and fittings - $500

Source: Michael Evans

Reducing salinity of underground water

Desalination

Reducing the proportion of salts in solution will improve water quality and improve its suitability for a number of purposes. However, the process is expensive in terms of energy requirements (and possibly greenhouse emissions) and equipment.

The most common process used for desalination is reverse osmosis where a semi-permeable membrane separates salt from water. Very high pressures are required to force water through the membrane. The energy required for reverse osmosis increases with water salinity and decreases using warmer water.

A pre-treatment step such as coagulation, filtration or microfiltration of water is often required to ensure water quality and reduce the chance of membrane failure. Water samples should be tested before installing a desalination plant to assess salt and mineral contents and to assist selection of appropriate equipment.

Desalination plants do not last as long as traditional water treatment equipment and require regular maintenance and operation to prevent corrosion and blockages.

Very saline waste is generated as part of the process and appropriate disposal of this material is required.

Practical Experience: Desalination

Peter and Margie Whittlesea of Mount Eba station near Glendambo, have installed a small-scale desalination plant to improve household and stock water on their property.

The property has several bores, ranging in salinity from 3,500 to 12,000 mg/L. Two bores near the homestead (3,500 and 6,500 mg/L) supply three houses and stock water at shearing and other stock handling times. High concentrations of iron and salt in the water damage household appliances and place added stress on livestock.

A Puredrop 4 membrane desalination plant was purchased for $8,500 in 2016.

Puredrop 4 membrane desalination plant on Mt Eba

The plant:

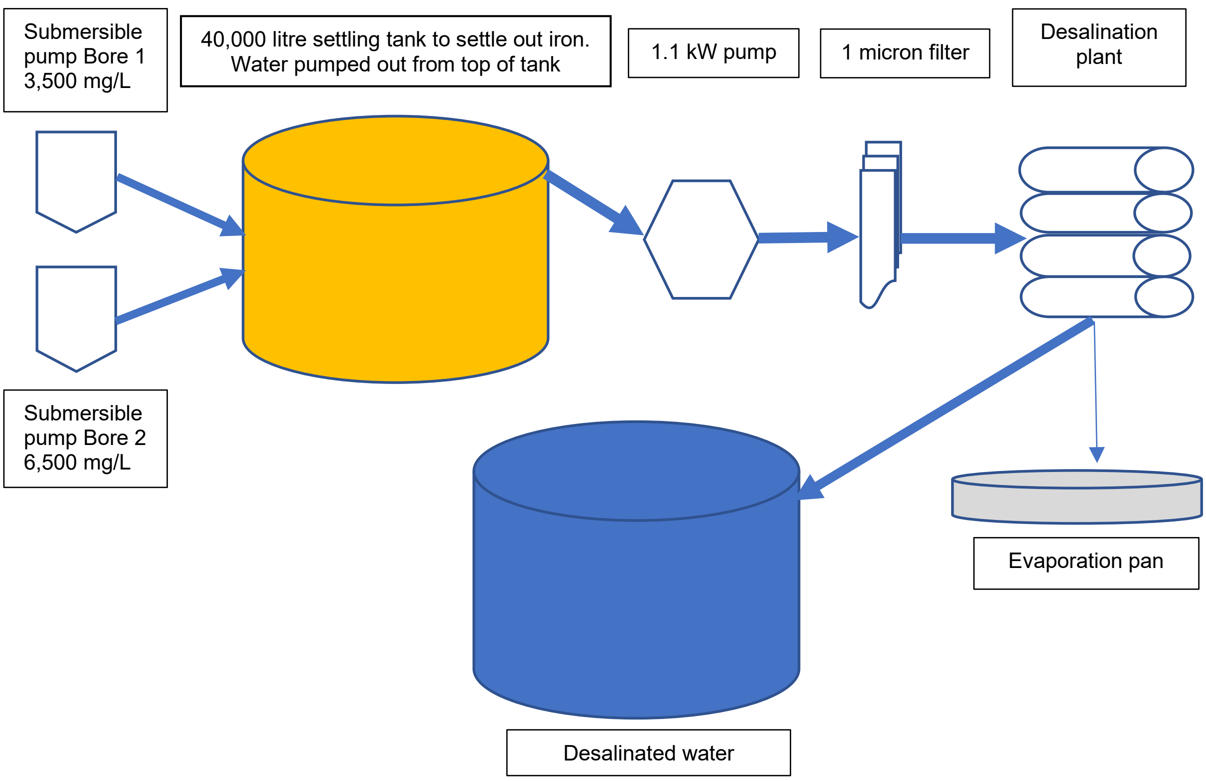
- has a 1.1 kW pump, pressurising the unit to 1,380 kPa.
- produces 12-15 litres per minute of good quality water.
- runs 2 to 3 hours per day while the station's diesel generator is operating.

A one micron particle filter to remove fine sediment (iron and sand) filters water entering the membranes.

The plant is set up in a small shed with concrete floor.

Membranes require cleaning every 2 to 3 years, more frequently for bore water with high contaminant content. System should last at least 10 years if maintained well. Filter requires replacement every 6 weeks at a cost of $35 per filter.

The unit was custom built using quality stainless steel and pumps and built to suit the water quality at the site. Clients are required to have water samples analysed at a qualified laboratory when ordering equipment.



Source: SheepConnect Case Study "Desalination"

Shandying

Shandying or blending water is mixing better quality water with poorer quality water to obtain a blend that is suitable for purposes that do not require very good quality water. Most sheep and cattle can drink water of up to 4,000 mg/L salinity with no adverse effect so providing them with potable water of less than 500 mg/L can be unnecessary and expensive.

Calculating volumes and salinities of various sources is required to determine the quality of the blended product.

To calculate the salinity of a blend of 2 water sources a and b (each of a known volume):

$$\frac{\text{(volume a (L) x salinity a (mg/L)) + (volume b (L) x salinity b (mg/L)}}{\text{Volume a (L) + volume b (L)}} = \text{salinity a + b (mg/L)}$$

Example: water source a :- 1 L mains water 250 mg/L TDS
water source b :- 1 L bore water 5,100 mg/L TDS

Salinity of blended water = (250 + 5,100) / (1+1) = 5,350 / 2 = 2,675 mg/L

To achieve a desired salinity concentration from a combination of 2 water sources, calculate the volume (y) of the poorer quality source (b) required to blend with 1 L of the better quality source (a).

$$\text{Desired salinity (mg/L)} = \frac{\text{(1 (L) x salinity a (mg/L)) + (y (L) x salinity b (mg/L))}}{\text{1 (L) + y (L)}}$$

$$\text{Where y} = \frac{\text{(desired salinity (mg/L) – salinity a (mg/L))}}{\text{(salinity b (mg/L) – desired salinity (mg/L))}}$$

Example: Desired / target salinity of 3,500 mg/L sought from blend of water a 300 mg/L and water b 5,100 mg/L.

$$\text{Required volume y of b water} = \frac{(3{,}500-300)}{(5{,}100 - 3{,}500)} = \frac{3{,}200}{1{,}600} = 2\text{ L}$$

To check:
(1 L x 300 mg/L) + (2 L x 5,100 mg/L) / (1 L + 2 L) = 10,500 mg/L / 3 L = 3,500 mg/L

Shandy ratio 1:2 litres of a:b will achieve water quality suitable for livestock drinking water.

The simplest way to shandy water is to add a known quantity and quality of water to another known quantity and quantity of water and mix. While water quality of sources is going to remain relatively constant, the accurate measurement of volumes is critical for maintaining the quality of the blended water. Stirring water regularly after blending is important as saline water is heavier than fresher water.

Water blending technology is available to automate the process however pressure and flow rates of water sources must be known before an appropriate system can be designed. Reliable radio telemetry and cellular networks are required to efficiently operate and maintain an automated system.

Experience from the Coorong district of South Australia has shown that installation of an automated system for blending water (approximately $15,000) is cost effective where primary producers are paying between $50,000 to $100,000 per year for mains water supplied by SA Water for watering livestock (See "Coorong Water Security Innovations Applied – Technical Note *Automated shandying, water blending technology (groundwater / mains water")*.

The steps required to assess if water shandying is cost effective:

- Determine yield (L/hour) and salinity of available water sources.
- Determine a desirable salinity and volume of water required to serve purpose e.g. livestock drinking water 3000 mg/L to water 50 adult cattle a day (@100 L per head) – 5000 L per day.
- Determine if volumes and flow rates from sources will be sufficient for purpose.
- Calculate cost of pumping water from sources to shandying tank and cost of establishing shandying tank capable of holding at least 3 days supply e.g. 15,000 litres.
- Calculate cost of automation (if required).
- Compare with cost of current water source in use (including costs of lost production if it is of poor quality).

Importing water

The Barossa New Water project is in the phase of business case development where industry demand for water including water volumes, quality and price, that is economically and financially viable to supply and deliver, is being determined.

The business case developer's key activities are to:

- understand industry demand for water including quantity, quality, uses and willingness to pay
- understand gaps between current and forecast demand
- analyse and model the economic benefits, uplift factors and costs of the scheme at a regional state and national level
- explore business model and funding requirements including potentially feasible commercial models and options
- identify and consider relevant regulatory and legal considerations
- prepare route options and developing full scheme design and costings for capital and operating expenditure for a preferred route, once identified.
- develop an implementation strategy that may include preferred procurement or delivery model, packaging and market engagement.

Once the business case has been developed, an indication of the costs of accessing this water can be made.

Storing water on-farm

Dams

Historically, earthen dams were constructed in watercourses to capture run-off. Over time, as more and more were built, problems began to arise with human and environmental riparian rights as downstream flows were restricted. In most catchments now, dam construction requires approval from Landscape Boards.

Off-stream dams are constructed outside of watercourses and rely on sources of water such as diversions from watercourses, artificial catchments i.e. roaded or sheeted, or imported water.

Earthen dams require clay to form banks and seal – older, leached clays are preferable as they form a solid bank. Cracking clays should be avoided as they swell on wetting and shrink on drying, creating holes in banks. Soil should be free of rocks and debris such as tree roots, as these can weaken a bank’s strength.

Lining a dam with plastic sheeting protects dam walls from “blowing out” and seepage losses in the base. Placing a plastic “blanket” on top of the water significantly reduces evaporation losses, which can be 50% or more in an open dam. These are significant cost savings for a producer buying imported water. The cost of liner materials in earlier constructions was around \$10 to \$15 / m^2 but current online prices appear to be in the range of \$25 to \$30 per square meter. It is best to speak directly to reputable, experienced suppliers and installers to get more accurate prices.

A well designed and constructed earthen dam will generally have a longer life span than concrete, polyethylene or steel tanks and less likely to be destroyed by fire.

Darren Noonan from FABTECH was asked to provide some indicative costs of dam liner and cover materials for a dam 40 m x 30 m and average depth of 1 m, with a batter of 45^0.

Two products were quoted for do-it-yourself installation:

Flexible polypropylene which is more flexible and conforms to dam slope better;

Reinforced polyethylene which is not as flexible but provides better puncture and chemical resistance.

The cost of self-installation (or DIY) liners (as of April 2022) is provided in the table below:

DIY Liner				
Material	**Length (m)**	**Width (m)**	**Price Inc GST**	**\$ / m^2**
0.50 mm flexible polypropylene	45	35	\$9,615.38	5.55
0.75 mm flexible polypropylene	45	35	\$12,907.13	7.45
1.00 mm flexible polypropylene	45	35	\$14,639.63	8.45
0.41 mm reinforced polyethylene	45	35	\$7,189.88	4.15
0.75 mm reinforced polyethylene	45	35	\$10,568.25	6.10
1.00 mm reinforced polyethylene	45	35	\$12,214.13	7.05

The cost of supplying and installing high density polyethylene will depend on a wide range of factors such as the scope and complexity of the job, exchange rate, location of and access to site, number of crew required etc.

As a guide the costs of supplying and installing high density polyethylene (as of April 2022):

1.0 mm HDPE \$7.00 - \$12.00 m^2 + GST + variable costs
1.5 mm HDPE \$8.50 - \$14.00 m^2 + GST + variable costs
2.0 mm HDPE \$10.00 - \$16.00 m^2 + GST + variable costs

Source: Darren Noonan FABTECH fabtech.com.au

Tanks

Tanks provide more options than dams in terms of size, siting and distribution. They can store water for every paddock on a property or for a particular purpose e.g. fire fighting. Polyethylene tanks can be relocated to other sites. However, they can be more easily damaged or destroyed by fire, storm, or accidents. Steel tanks are relatively cheaper than poly tanks at large volumes as they are constructed on site whereas larger poly tanks become restricted by transportation limitations (e.g. size of load).

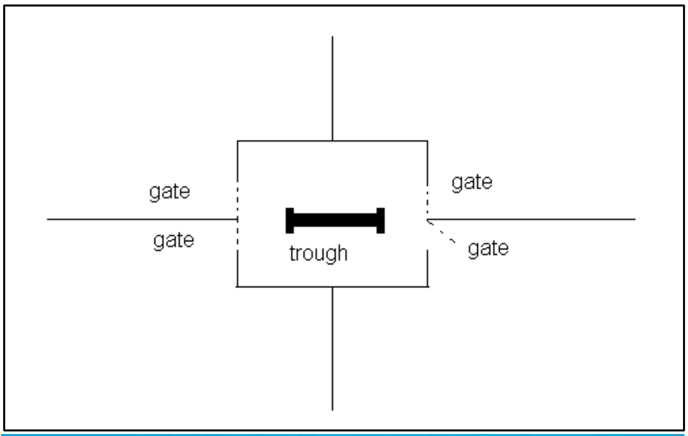
Scanning of tank makers' web sites show the range of products available and listed prices (Table 6).

Table 6: Range of type, capacity and price of tanks available from various suppliers (April 2022)

Concrete			**Poly**			**Steel**			**Fibreglass**		
L	**Cost**	**$/L**	**L**	**Cost**	**$/L**	**L**	**Cost**	**$/L**	**L**	**Cost**	**$/L**
5,000	$2,279	0.46	1,000	$1,250	1.25	5,300	$2,200	0.42	5,300	$1,400	0.26
5,300	$3,000	0.57	5,000	$2,000	0.40	10,500	$3,600	0.34	10,500	$1,400	0.13
10,500	$4,000	0.38	5,300	$1,350	0.25	22,500	$5,000	0.22	22,500	$3,200	0.14
11,075	$5,961	0.54	10,000	$3,500	0.35	25,000	$6,250	0.25			
22,150	$7,030	0.32	10,500	$1,350	0.13	55,000	$7,750	0.14			
22,500	$7,000	0.31	22,500	$2,800	0.12	110,000	$10,000	0.09			
33,250	$12,089	0.36	22,700	$3,200	0.14	160,000	$14,000	0.09			
			23,650	$3,250	0.14	220,000	$18,250	0.08			
			30,000	$4,445	0.15	250,000	$19,500	0.08			
			45,400	$6,355	0.14	285,000	$22,500	0.08			
						375,000	$28,000	0.07			

Sources: heritagetanks.com.au, agriculture.coerco.com.au, tankworld.com.au, tanket.com.au

Practical Experience: Using tanks and troughs to manage grazing



Neil and Antoinette Sleep's property Willangi, of over 2,036 ha, is located 15 km north of Peterborough in 312 annual average rainfall country.

They have established a cell grazing system where small paddocks are intensively grazed successively by a large mob of sheep over a few days.

Watering points have been set up so that most troughs water four paddocks. The watering points are the main means of moving sheep from one paddock to another by opening and closing gates at the watering point.

Each trough is supplied by a tank; tanks are supplied mainly from one bore. Collectively, the tanks store 409,500 litres on the property.

Sheep tend to go to the trough in small numbers throughout the day rather than in one big mob in the morning and evening, enabling the trough to maintain an adequate supply of water.

Source: M-A Young (2007) "Time controlled grazing on a low rainfall farm - a case study"

Water distribution around the farm

(*This section is drawn from Caris, Rob 2005 "On Farm Water Reticulation Guide" published by GWMWater.)*

Understanding hydraulic flows

Reticulating water around a property requires an understanding of pressures, flow rates, pressure drop and head loss.

Pressure is required to deliver water through a pipe, either from a pump or elevated tank (gravity). Most of the pressure available in a system is required to overcome friction between flowing pipe and inside of pipes, fittings and any differences in elevation from a tank to the pipes end point. Pipe friction is related to pipe diameter, length, fittings used and speed of flow and any build up of foreign materials within pipes. The higher the pressure, the greater the flow but water leaves pipes at atmospheric pressure.

For every metre of depth in fresh water, pressure increases by approximately 10 kPa. This pressure is often referred to as "head" and "metres of head".

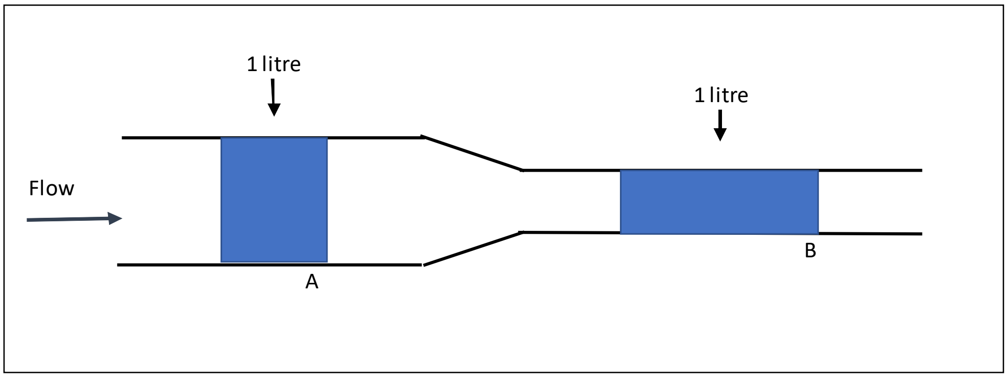
1 m water = 10kPa = 1.4 Psi (kPa = kilo Pascals; Psi = pounds per square inch)

Flow rate is the volume of water passing a given point in a given time. While its standard unit of measurement is cubic metres / second, calculating farm water requirements typically uses units such as Litres / second (L/s), Litres / minute (L/min) or Mega Litres / day (ML/day).

Flow rate in a pipe is constant. In Figure 11, it takes the same time for 1 litre to pass point A as it does to take to pass point B. The velocity is greater in the smaller diameter section than in the larger diameter pipe.

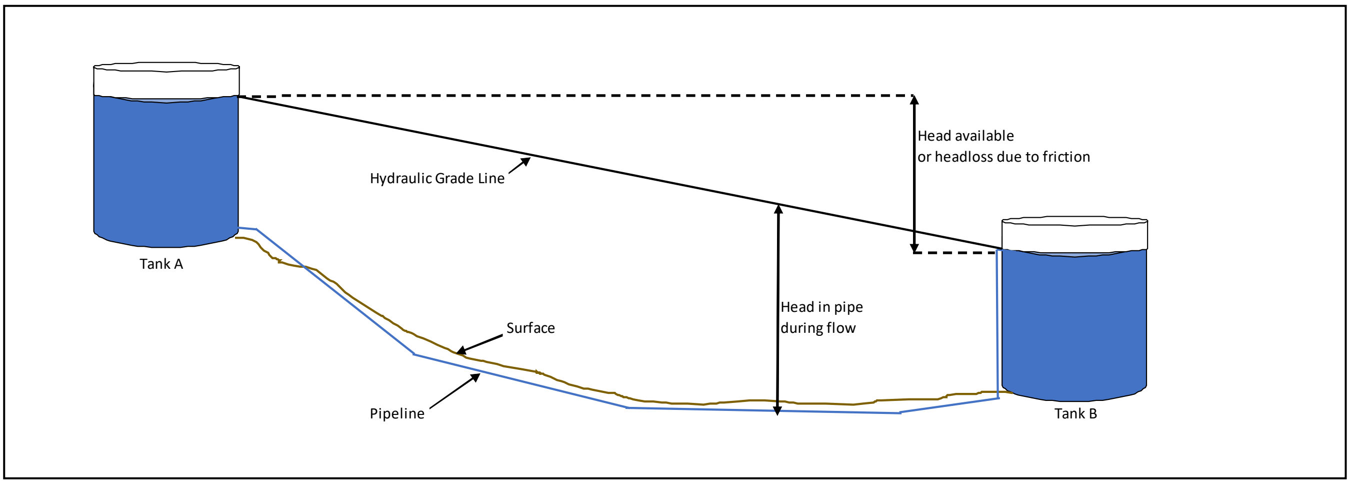
For a given flow rate, the smaller the cross sectional area, the higher the velocity and therefore the higher the friction loss.

Figure 11 Unchanged flow rate in a pipe



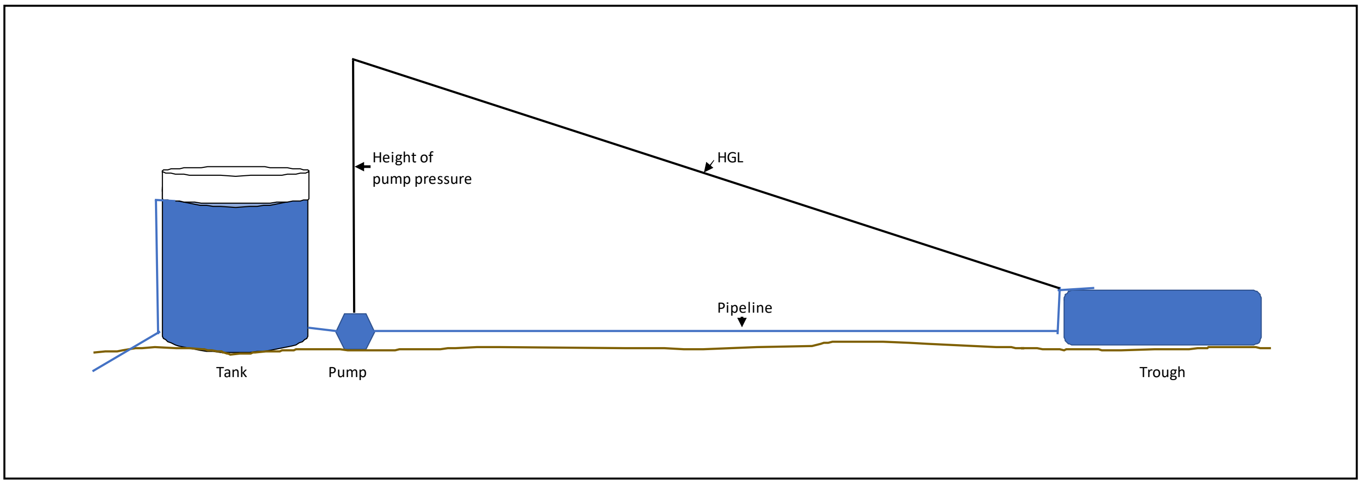
Hydraulic Grade Line (HGL) or Hydraulic Gradient links point of atmospheric pressure. It represents pressure, expressed in metres of water (or head) at any point in a pipe and the metres of head lost in overcoming friction up to that point. Pressure is given by the distance from the pipe up to the HGL, loss is the distance from the water level down to the HGL (Figure 12).

Figure 12 Pressure and friction losses in a pipeline



On flatter country, a pump produces a head and raises the HGL in a similar way to placing a tank on a hill (Figure 13).

Figure 13: Raising the Hydraulic Grade Line on flatter country



Pipe friction A rough surfaces on the inside of a pipe causes turbulence in water flows, slowing velocity of flows close to the pipe wall. This friction slows flows and causes a greater pressure drop along the length of the pipe.

A smooth surface on the inside of the pipe creates less turbulence so water velocity close to the surface will be less impeded.

A cross sectional “slice” or area of water across a pipe will have water flowing at different velocities – slower along the sides of the pipe and fastest in the middle. A build up of materials on the inside of pipes causes roughness that increases friction and reduces the cross-sectional area of the pipe, slowing flows. Similarly, changes in pipe diameter and fittings causes turbulence and additional friction.

Water flow from a pipe depends on available pressure, pipe diameter, pipe length roughness of the inner part of the pipe. As pipes are mostly cylindrical, doubling a pipe’s diameter increases its cross-sectional area four times.

Pressure Rating (PN) represents the safe working pressure of a pipe and is expressed as PN. The PN number times 10 gives the safe working pressure in metres of water at 20^0C therefore a PN10 pipe has a safe working pressure of 100 m or 1000 kPa. “Rural” pipe has a maximum operating pressure of 60 m or 600 kPa at 20⁰C. Suppliers of pipe can provide data on the maximum working pressure for pipes of various PN when the pipe is subjected to temperatures greater than 20⁰C.

Table 7 Selection of appropriate PN rating for temperatures > 20⁰C

Maximum working pressure (kPa) at various temperatures					
PE 100	**50 years**				
Nominal pressure rating	**20⁰C**	**25⁰C**	**30⁰C**	**35⁰C**	**40⁰C**
PN4	400	370	340	320	290
PN6.3	630	590	55	500	460
PN8	800	740	690	630	580
PN10	1000	940	870	800	730
PN12.5	1250	1180	1100	1010	920
PN16	1600	1490	1380	1270	1160
PN20	2000	1880	1740	1607	1460
PN25	2500	2370	2200	2020	1840

Source: polypipe.com.au

Example calculation – selection of appropriate PN in temperatures > 20⁰C

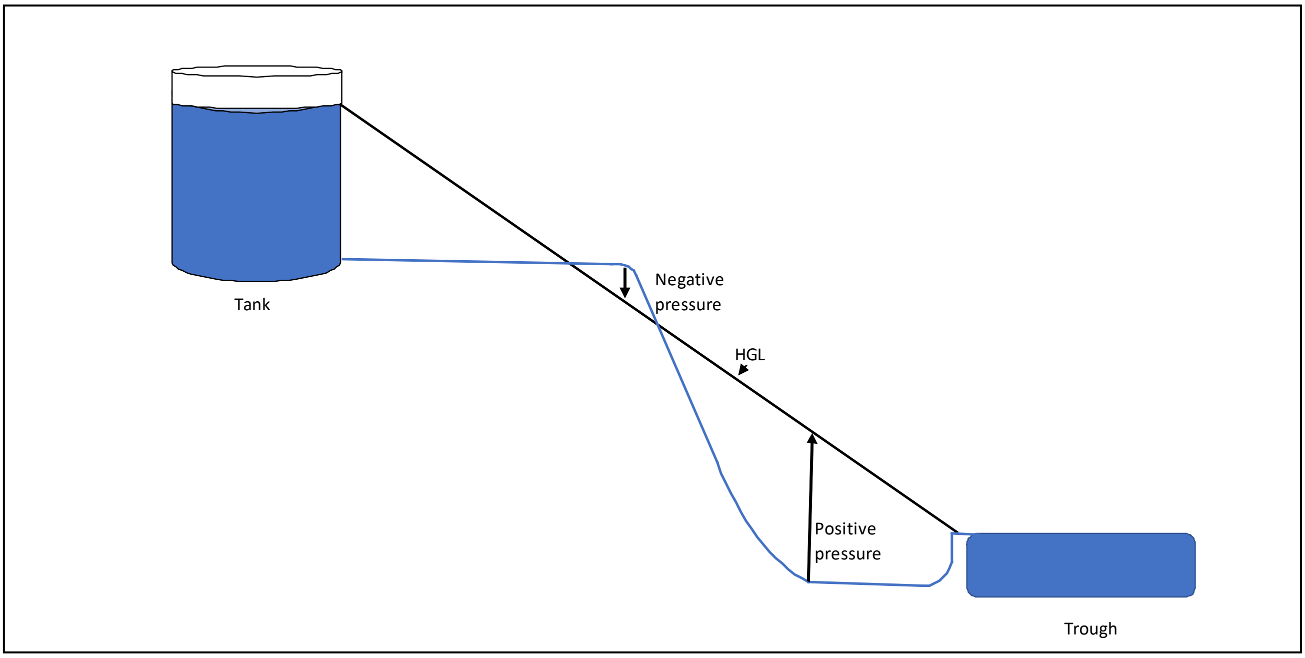
- PE100 pipe is to be used above ground where the water supply and pipe can reach temperatures of 40°C.
- The maximum pressure in the system is 900kPa.
- Table x indicates that PN10 has a maximum pressure rating of 730kPa at 40°C and therefore is not sufficient.
- After factoring in a 10% safety margin (990kPa), PN16 is recommended for this system.
- At this temperature the pipe has a design life in excess of 50 years

Low pressures in pipelines Pressure less than atmospheric pressure is commonly called negative pressure or negative head. Negative pressures can develop in reticulation systems under certain circumstances and will generally occur in suction pipes.

Most pressure gauges give a gauge reading of zero when disconnected and open to the atmosphere, even when they are under atmospheric pressure. A total vacuum has zero pressure. Absolute pressure is displayed on gauges registering zero at total vacuum. Gauge pressure shows on gauges registering zero at atmospheric pressure. The average atmospheric pressure at sea level is 100 kPa therefore absolute pressure readings are approximately 100 kPa higher than gauge pressure readings.

Negative pressures in farm supply systems occur when the Hydraulic Gradient Line falls below the pipeline. The distance from the HGL up to the pipeline represents the amount of negative pressure (Figure 14). While on paper it is possible to plot a negative head of more than 10 m, this is impossible in practice as a negative head of 10 m is equal to a total vacuum.

Figure 14: Development of negative pressure in a pipeline system



Negative heads of more than 3 m in pipelines should be avoided as they can cause pulsating flows, damage pumps and might stop flows.

Pipe sizing and pipe friction Charts 1 and 2 have been developed by engineers, showing the relationship between pipe length, diameter, flow rate and head loss for different types of pipe. In the displayed charts, friction losses for two different types of polyethylene pipe are shown.

The horizontal axis gives flow rate (Q) in litres per second, the vertical axis shows the head loss due to friction (Hf) in metres of water per 1000 m of pipe.

Chart 1

Metric Flow Chart for Polyethylene Pipe

PE80B complying to AS4130

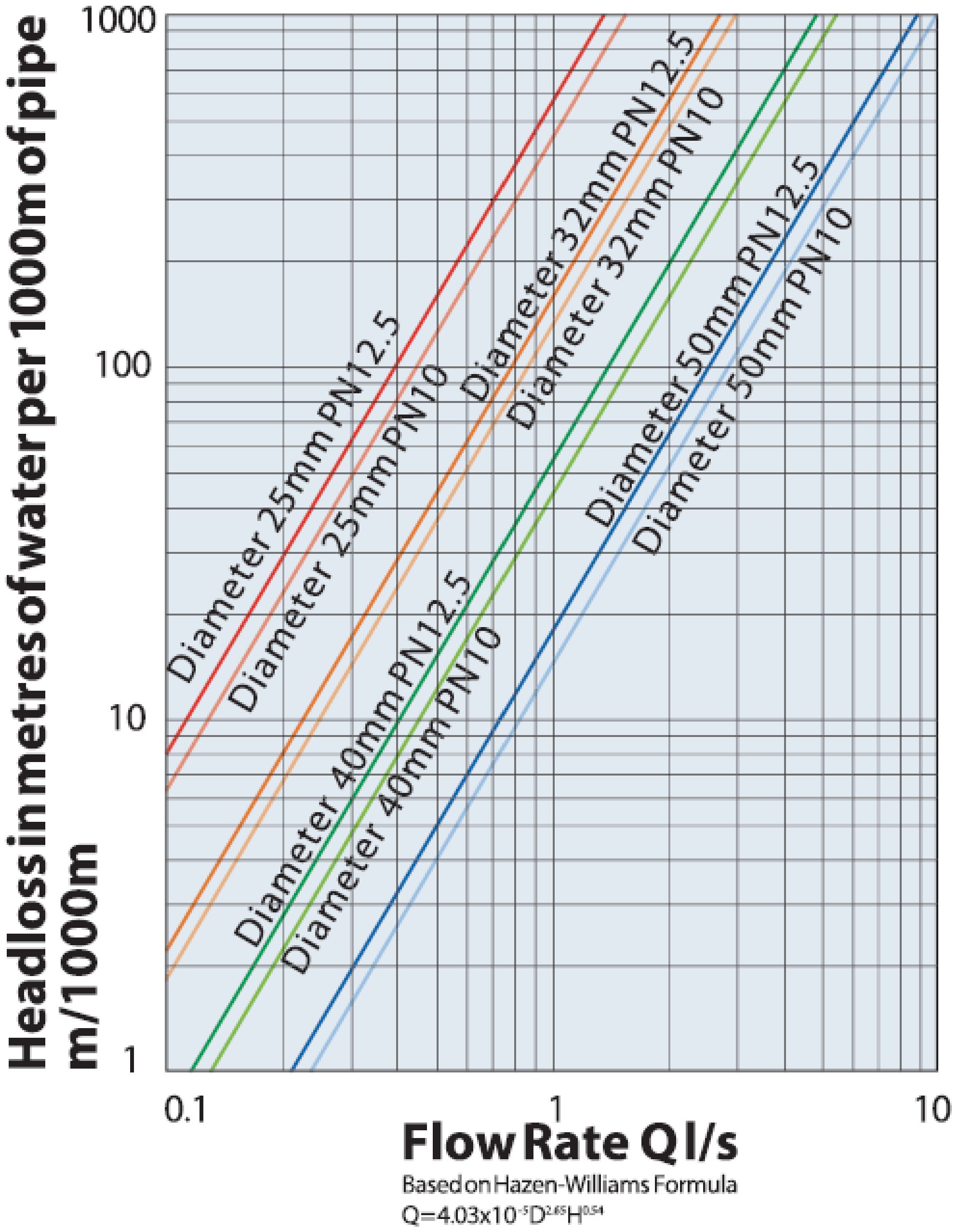
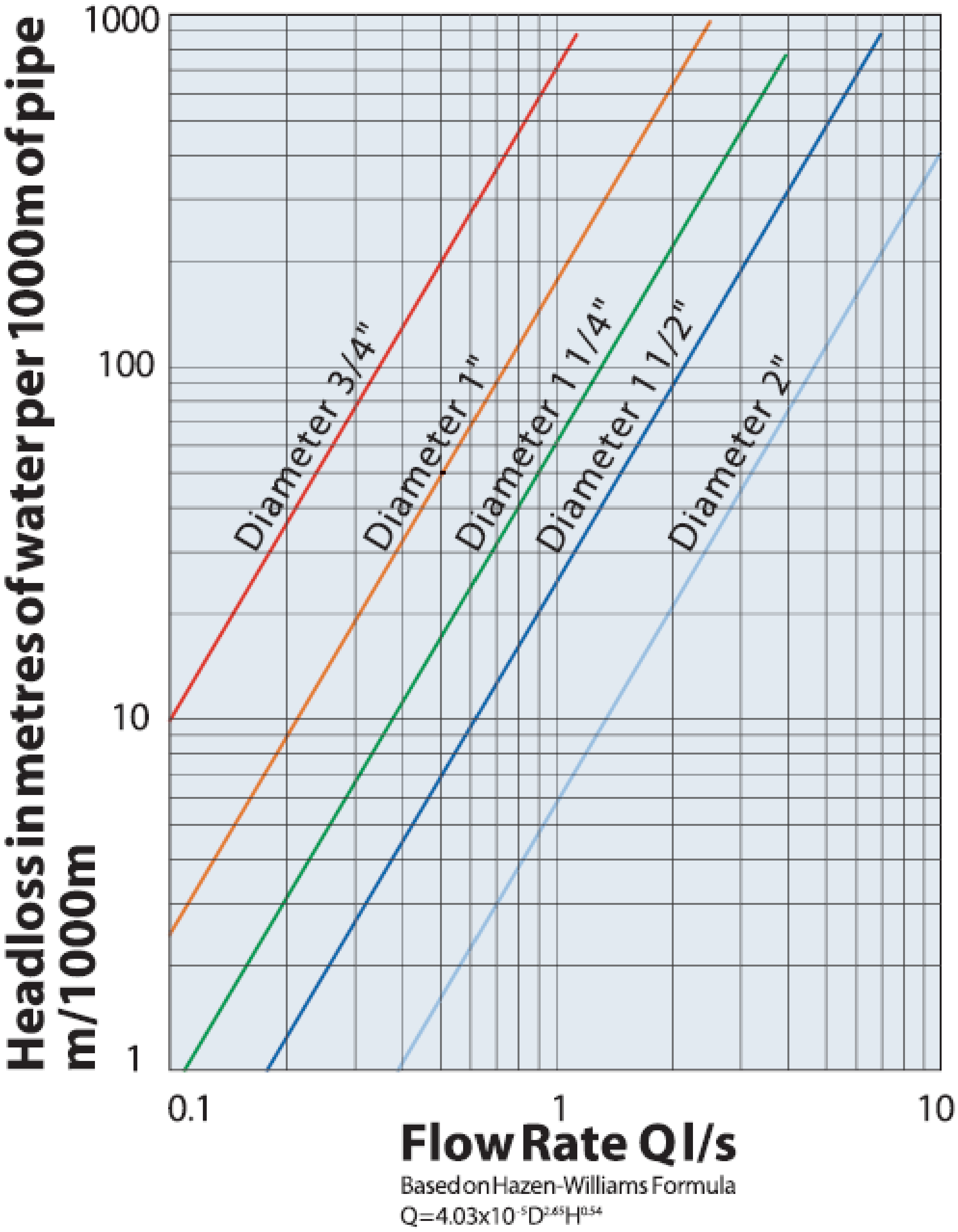


Chart 2

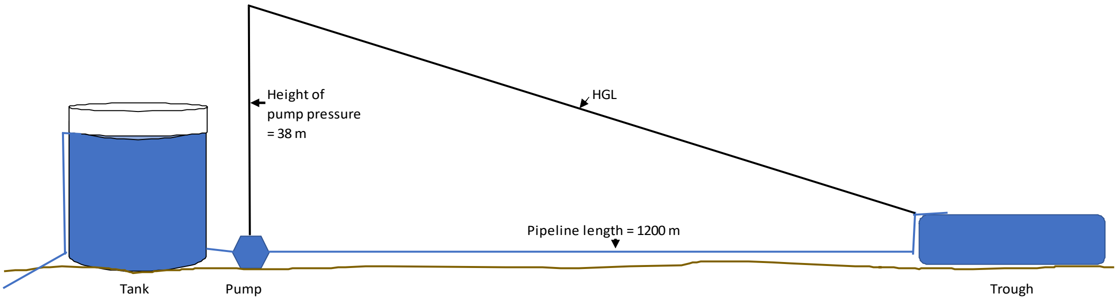
Imperial Flow Chart for Polyethylene Pipe

PE80B complying to AS4130



These charts help determine the size and PN rating of pipe required to deliver a specified flow rate over a known distance and pressure.

Example calculation – selection of pipe size and PN to deliver 0.8 L/s through a 1,200 m long pipeline, given an available head of 38 m.



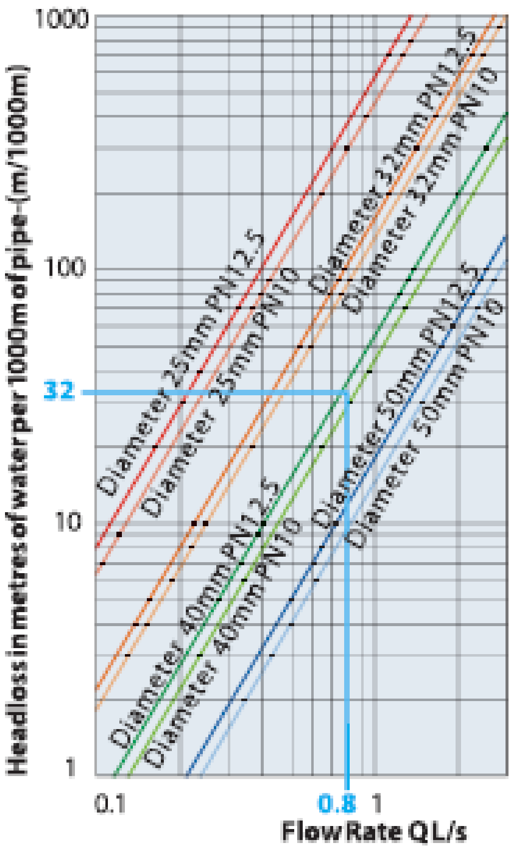
Head loss = 38 m / 1200 m

Equivalent head loss over 1000 m = $\dfrac{38 / (1200/1000)}{1{,}200 / (1200/1000)} \approx 32 / 1000$

Therefore approximately 32 m of head loss over 1000 m.

Maximum head is 38 m so pipe in range of PN4 to PN10 suitable (but dependent on availability from suppliers).

Using Chart 1, a 40 mm diameter PN10 pipe will deliver a flow rate of close to 0.8 L/s



Remote monitoring of water reticulation systems' components

Factors in a water reticulation system that can be monitored include water levels in tanks, dams and troughs; water pressures; flows; salinities and leaks. Sensors, monitors, meters and cameras are powered by solar, mains or battery power, and data transmitted via radio, mobile phone or satellite signals.

Their most valuable use is in ensuring stock or irrigation water supplies do not run out, leaving thirsty animals and wilting plants. Detection of leaks or overflowing troughs can save costs of bought water and conserve a valuable resource. Use of remote equipment saves labour and travel costs, particularly if water supplies are distributed over a large area.

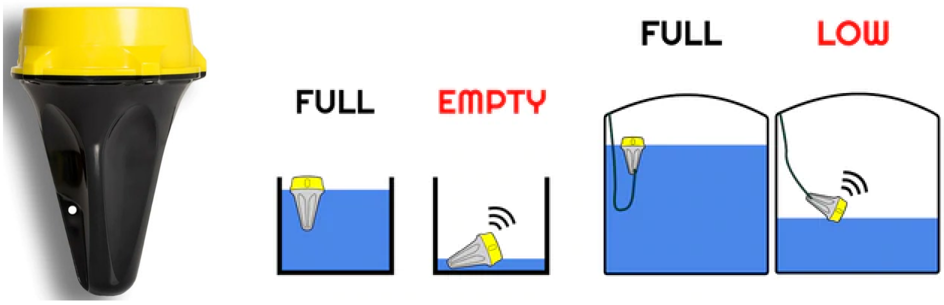
Commonly used equipment includes:

Water level sensors – detects amount of water in a tank or trough, can send regular signals and / or alerts when water levels are low.

Tank monitoring kit:

- Solar powered with replaceable battery packs
- Connects vis Telstra 3G mobile
- Uses industrial grade level sensors
- Capable of reading multiple sensors e.g. pressure, flow meters, cameras
- Measures and reports on water levels each hour
- Sends alerts if water levels low or high

Source: farmmonitoringsolutions.com.au



Floating water sensor:

- Floats on water surface
- Tilts when water level becomes low
- Has tilt sensor, GPS and mobile phone chip to send data built in
- Not permanently fixed so can be moved from place to place.

Source: www.farmo.com.au

Water pressure and flow meters – checks that desired pressures and flows are maintained, particularly if blending water and to identify leakages in systems. Leak detectors (e.g. water flow meters) detect abnormal water usage patterns such as at night time when stock do not drink.

Water flow sensor:

- Reports L/min flow rates
- Provides aggregate flow data
- Users can receive alerts based on custom triggers

Source: farmbot.com.au

Practical Experience: Monitoring water flows to detect leaks

Julian and Adam Desmazures in the Coorong / Tatiara District run a 1400 ha property. They have 2000 ewes, 800 wethers in a feedlot, 300 hectares of dryland lucerne, more than 100 hectares of established pastures and 40 cows.

All water used on the property, including domestic, is from SA Water mains via one meter. Water usage is quite variable over a year because of the diversity of farming enterprises and seasonal conditions.

A Sentek MULTI flow monitoring system was installed that logs and transmits data. The system measures and records flows from the water meter every 15 minutes and provides daily water alerts and meter readings via SMS and email. The Desmazures receive a daily SMS with meter readings. Graphs of daily, monthly and yearly water usage can be viewed online anytime on the system's supplier's website.

The system enables the monitoring of daily water usage and identification of excessive flows that might occur due to a leak.

Source: www.coorong.sa.gov.au/council-services/coorong-tatiara-local-action-plan/water-security/water-leak-detection

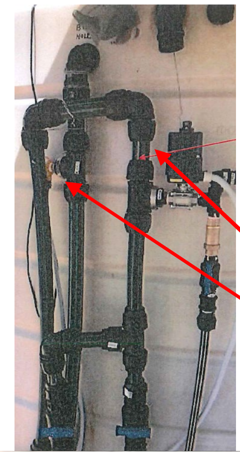
Cameras – visual monitoring of water levels, animal behaviour (including domestic, feral and native animals) and weather.

Remote camera:

- Transmits images to mobile phone, email or file transfer protocol site for web viewing
- Transmits photos, videos or both
- Movement or time lapse settings
- Uses mobile phone digital network
- Solar panels recharge battery storage
- Able to send instant alerts

Source: outdoorcameras.com.au

Salinity meters – check quality of water



Electrical conductivity meter:

- Submersible or inline
- Fitted with electrodes required for specific range e.g. 100 to 200,000 EC units

Source: gfps.com

Blending unit – 3 water sources
Blending valve
EC meter
Source: Coorong Water Security Innovations Applied Technical Note

Determining property water requirements

Working out water requirements for a property requires consideration of all present and future uses.

Consider what water is currently used for on the property:

House:

SA Water estimates that the average residential premises in SA uses 493 L / day.

A typical residence's water use comprises:

Garden & outdoor	40%
Bath & shower	20%
Laundry	16%
Kitchen	11%
Toilet	11%
Other	2%

Therefore, excluding garden and outdoor consumption, a household on average uses 296 L / day.

In 1991, estimates of water use of households with septic systems in the Wimmera area of Victoria were:

No. of household residents	1	2	3	4	6
Litres per day (household)	180	250	320	340	380
Evaporative air conditioner uses up to 40 L / hr or 960 L / day					

Source: State Electricity Commission of Victoria-Rural Stock and Water Domestic Supplies, June 1991 in Caris (2005)

Note that this data would not include savings from development of water efficient systems and practices after 1991.

Surrounds:

The surrounds of the house will vary in water consumption, depending on their nature and purpose such as, lawn, ornamental garden, native gardens, fruits and vegetables, and amenity plantings (shade and shelter). An irrigation system might be installed as a bushfire protection measure.

Sheds and Workshops:

Water in and around sheds and workshops is used for cleaning and washing equipment and areas, workers' hygiene, and storage for fire fighting

Cropping:

In dryland cropping, most water is used for spraying of herbicides, insecticides, fungicides and liquid fertilisers. Approximately 40 – 200 L/ha is required for each chemical application.

Livestock drinking:
Livestock water requirements vary enormously over a year according to an animal's age, feed supply, and sex (i.e. pregnant / lactating) and environmental conditions. Tables 15 and 16 show the volumes of water required for sheep and cattle taking these variables into account.

Table 15: Calculating sheep water requirements

Water requirements for sheep over summer (litres/day)

		Range	
Dry feed	1.8	to	3.7
Saltbush		up to	14.0
Lucerne Hay			9.0
High protein stubbles	2.7		5.6

Autumn / winter / spring

Green feed	1

Calculate no. of days x DSE x litres/day according to feed type

Example		Volume of water required for mob for year		
No. sheep (ewes pregnant single 60 kg)	400			
DSE rating	1.4	Demand	Low	High
Days on dry feed	120		120,960	248,640
Days on saltbush	0		-	-
Days on high protein hay	30		-	151,200
Days on high protein stubble	60		90,720	302,400
Days on autumn / winter / spring feed	155		86,800	86,800
Total for year	365	Litres	**298,480**	**789,040**
		kiloLitres	**299**	**789**

DSE ratings

Mature ewes

Liveweight		Pregnant		Lactating	
kg	Dry	Single	Twin	Single	Twin
50	1.0	1.3	1.5	2.5	3.4
60	1.2	1.4	1.6	2.9	4.1

Growing lambs

Liveweight	Growth (g/day)		
kg	50	100	150
20	0.6	0.8	1
40	1	1.3	1.5

Sources: "Feeding and Managing Sheep in dry times", PROGRAZE

In this calculation, the amount of water required over a high demand year for a mob of 400 ewes is nearly 800,000 litres.

Table 16: Calculating cattle water requirements

Water consumption for cattle over summer (litres/day) (SMR)		
Lactating	up to	160
Dry adult	up to	100
Dry adult on saltbush	up to	140
Weaner	up to	50

Long term average consumption (litres/day) (AVE)	
Lactating	80
Dry adult	50
Dry adult on saltbush	70
Weaner	25

Calculate: (no. cattle type x no. days SMR consumption rate)
+ (no. cattle type x no. days long term average AVE consumption rate)

No. head		No. days SMR	No. Days AVE	
Lactating	100	90	275	
Dry adult	200	90	275	
Dry adult on saltbush	0	90	275	
Weaner	100	90	275	
Water requirement		Total litres SMR	Total Litres AVE	Total Litres YEAR
Lactating		1,440,000	2,200,000	3,640,000
Dry adult		1,800,000	2,750,000	4,550,000
Dry adult on saltbush		-	-	-
Weaner		450,000	1,375,000	1,825,000
				10,015,000

WA DPIRD Livestock water requirements and water budgeting for south-west Western Australia – calculating and mapping requirements

In this example, a mob of 400 head could require up to 10 megaLitres of water over a year.

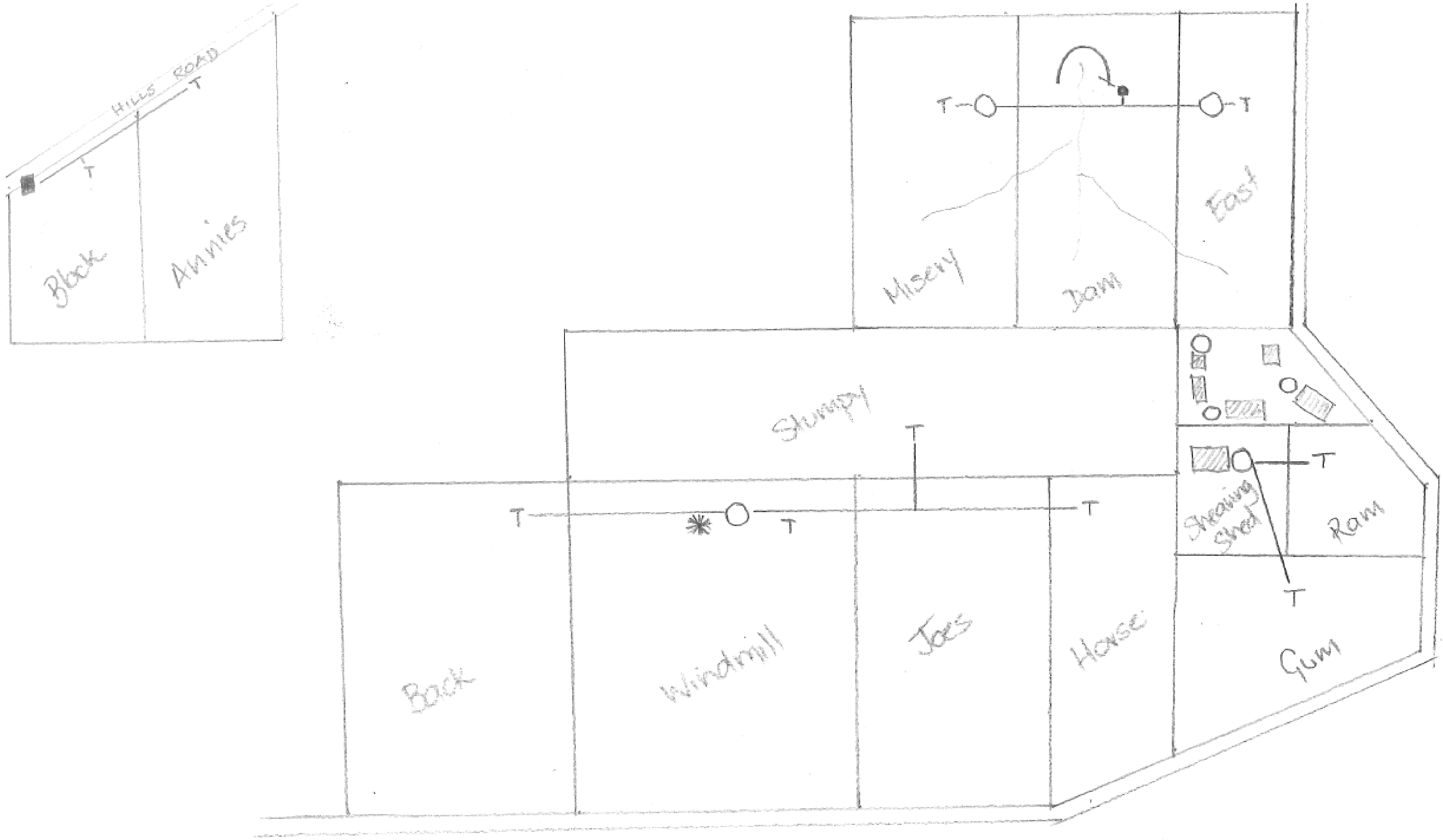
Property's current water requirements and use:

Undertaking an audit of water use will enable consideration of how and how much water is used on the property. (Tables 15 and 16 can be used to calculate livestock water requirements)

		Estimated L / day	Salinity approx mg / L	Source rainwater, Mains, dam, groundwater
House				
bath & shower		53	5	rainwater
laundry		43	5	rainwater
kitchen		29	5	rainwater
toilet		29	3000	groundwater
drinking water, sundries		5	5	rainwater
Surrounds				
garden		100	5	rainwater
birdbaths		5	5	rainwater
seedlings		5	5	rainwater
Sheds and workshops				
Washdown		20	3000	groundwater
Shearing shed & workshop	handwashing and toilet	2	5	rainwater
Firefighting storage		41	3000	groundwater
Cropping				
crop spraying	268 ha sprayed 3 times per year @ 100 L / ha	220	3000	groundwater
crop spraying	32 ha sprayed 3 times per year @ 100 L / ha	110	5	rainwater
Livestock				
400 ewes				
- pregnant	DSE 1.4 62 days dry feed, 90 days high protein stubbles 582,000 L			
- lactating	DSE 2.9 90 days green feed 104,400 L			
- dry	DSE 1.2 93 days green feed, 30 dry feed 97,920 L			
	Total for year 784,320 L	2150	3000	groundwater
100 wethers	DSE 1 180 days dry feed, 185 days green feed 85,100 L	233	3000	groundwater
400 lambs	DSE 1 120 days green feed, 60 days dry feed 136,800 L	375	3000	groundwater
5 rams	DSE 1.2 180 days green feed, 30 days hay, 155 days dry feed 6,150 L	17	3000	groundwater
10 steers	227,500 L for year	623	3000	groundwater
Subtotals		352		rainwater
		3708		groundwater
TOTAL	per day	**4060**		water
	year	**1,481,900**		water

Property's existing water infrastructure:

The audit also includes mapping the property's water sources, storage and reticulation networks.



From the map, an infrastructure inventory is developed:

Water source	Bore			Dam			Mains			Rainwater		
Location	Windmill paddock			Dam paddock			Meter on Hills road			Shed and house roofs		
Pumping equip	windmill			1 x pressure pump						1 x pressure pump		
Water quality	2500 mg / L			300 mg / L			200 mg / L			5 mg / L		
Pressure / head	30 m			280 kPa			200 kPa discharge from meter			350 kPa pump; shearing shed tank 10 m head		
Comments	windmill to be replaced by solar panels and submersible pump			Capacity 600,000 L but rarely full.			considering tank to store water + leak detection unit			Shearing shed tank firefighting water.		
Paddock Name	Tanks No. & volume	Pipes type & diameter	Troughs number & length	Tanks No. & volume	Pipes type & diameter	Troughs number & length	Tanks No. & volume	Pipes type & diameter	Troughs number & length	Tanks No. & volume	Pipes type & diameter	Troughs number & length
Stumpy		250 m x 50 mm PN10	1 x 2.5 m									
Back		250 m x 50 mm PN!0	1 x 2.5 m									
Joes		500 m x 50 mm PN10	1 x 2.5 m									
Horse		50 m x 50 mm PN10										
Windmill	1 x 31,700 L poly	700 m x 50 mm PN10	1 x 2.5 m									
East				1 x 22,500 L poly	100 m x Imperial $1^{1/2}$ inch	1 x 2.5 m						
Misery				1 x 22,500 L poly	200 m x Imperial $1^{1/2}$ inch	1 x 2.5 m						
Dam					500 m x Imperial 1 ½ inch							
Block								500 m x 50 mm PN10	1 x 2.5 m			

Annies								250 m x 50 mm PN10	1 x 2.5 m			
Gum											10 m x 50 mm PN10	1 x 2.5 m
Ram											10 m x 50 mm PN10	1 x 2.5 m
Shearing shed										1 x 50,000 L steel	250 m x 50 mm PN10	1 x 2.5 m
Farmyard										1 x 27,000 L poly 1 x 31,700 L poly		

As the map is drawn and schedule drawn up, the water requirements of the property, current and future can be considered and assessment made of the capacity of the infrastructure to meet those requirements.

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