



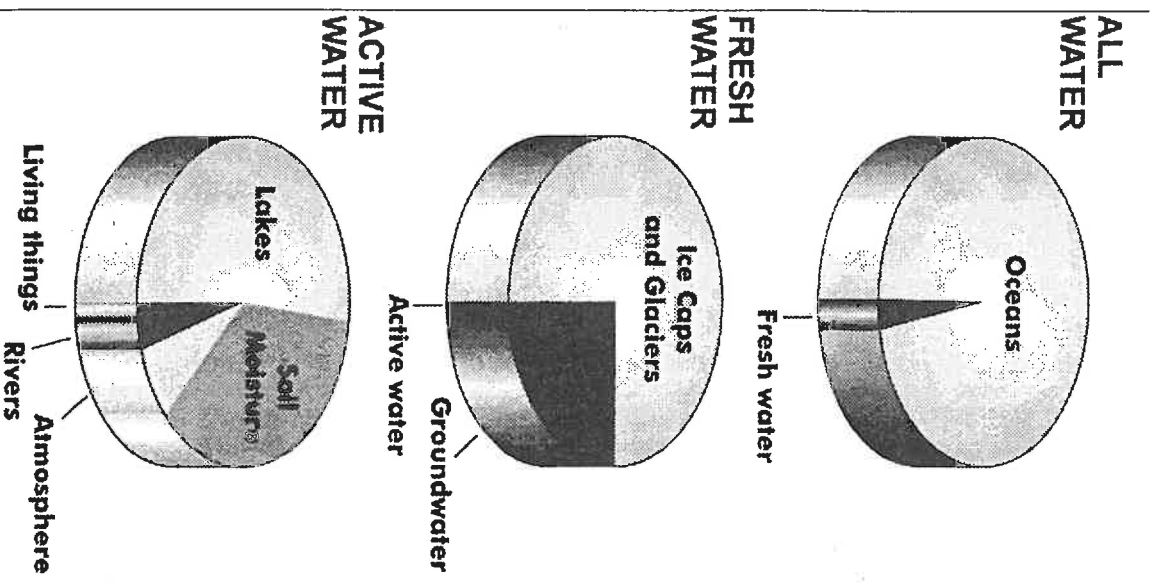
Dolphin Sands Groundwater Forum

Miladin Latinovic

Mineral Resources Tasmania

May 2001

Surface Groundwater Water Relationship

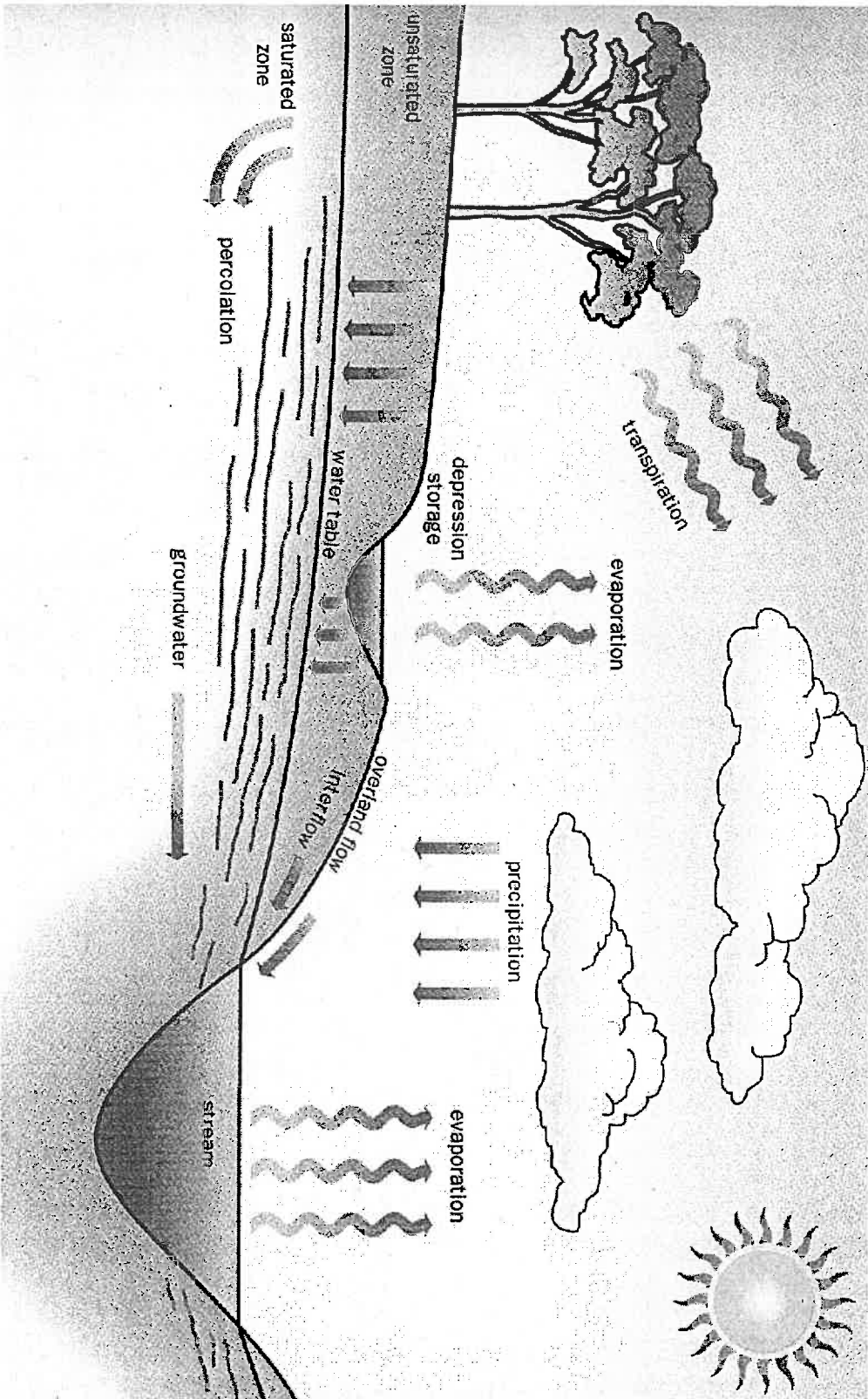


Surface and rain water usually regarded as primarily source of fresh water in Tasmania (Dolphin Sands is an exemption).

River base flow is a component made up of groundwater.

It is estimated that 40-50% of the total water flow in Australian rivers is directly related to groundwater.

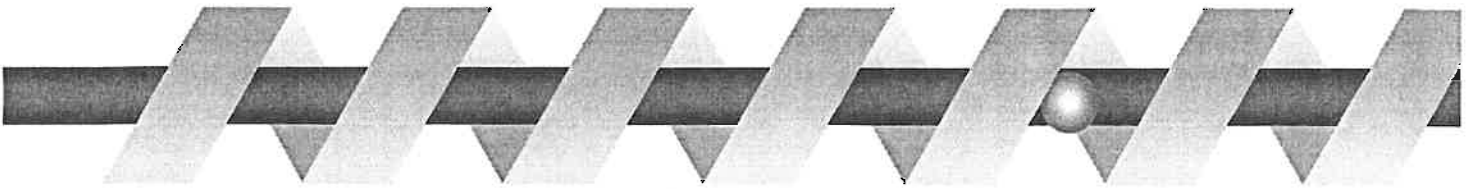
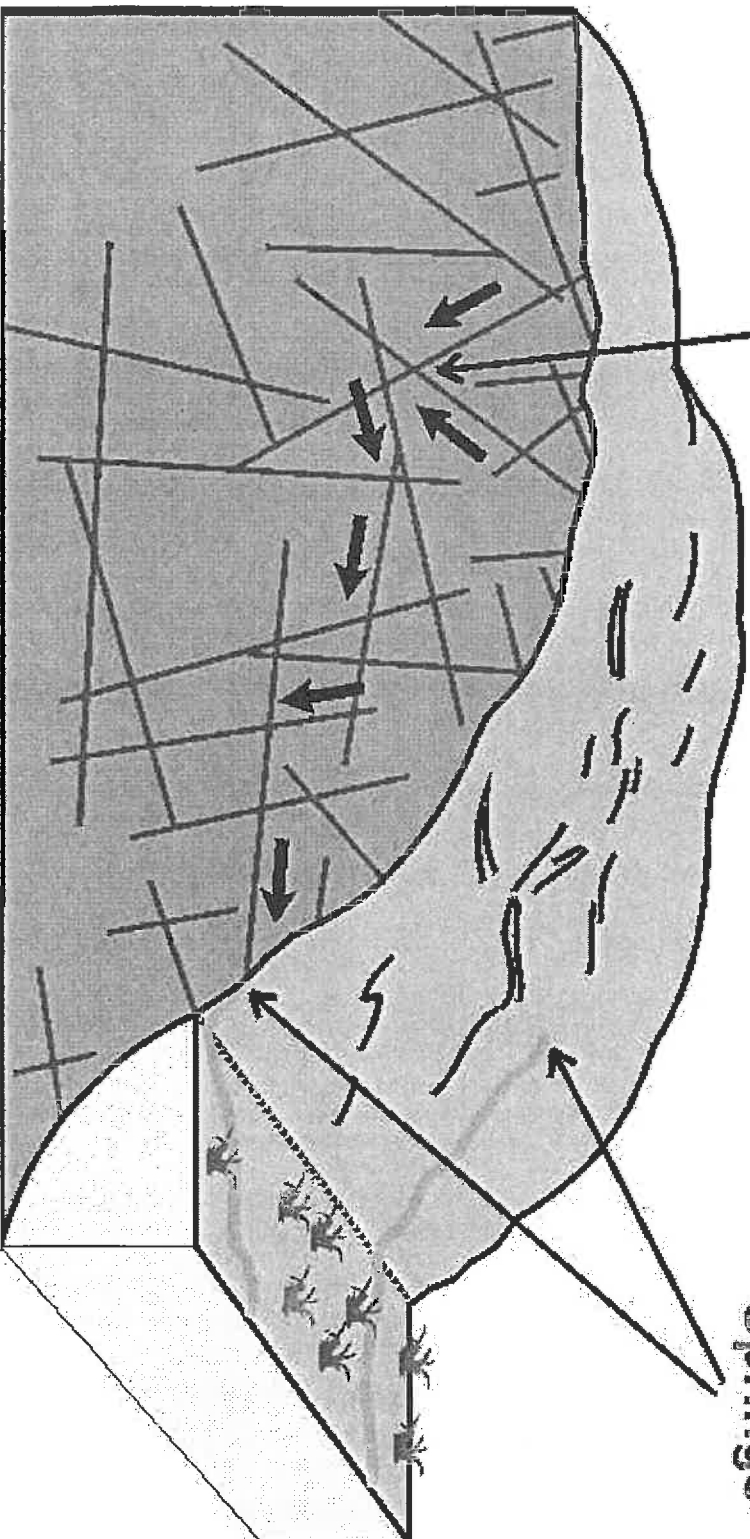
Water Cycle



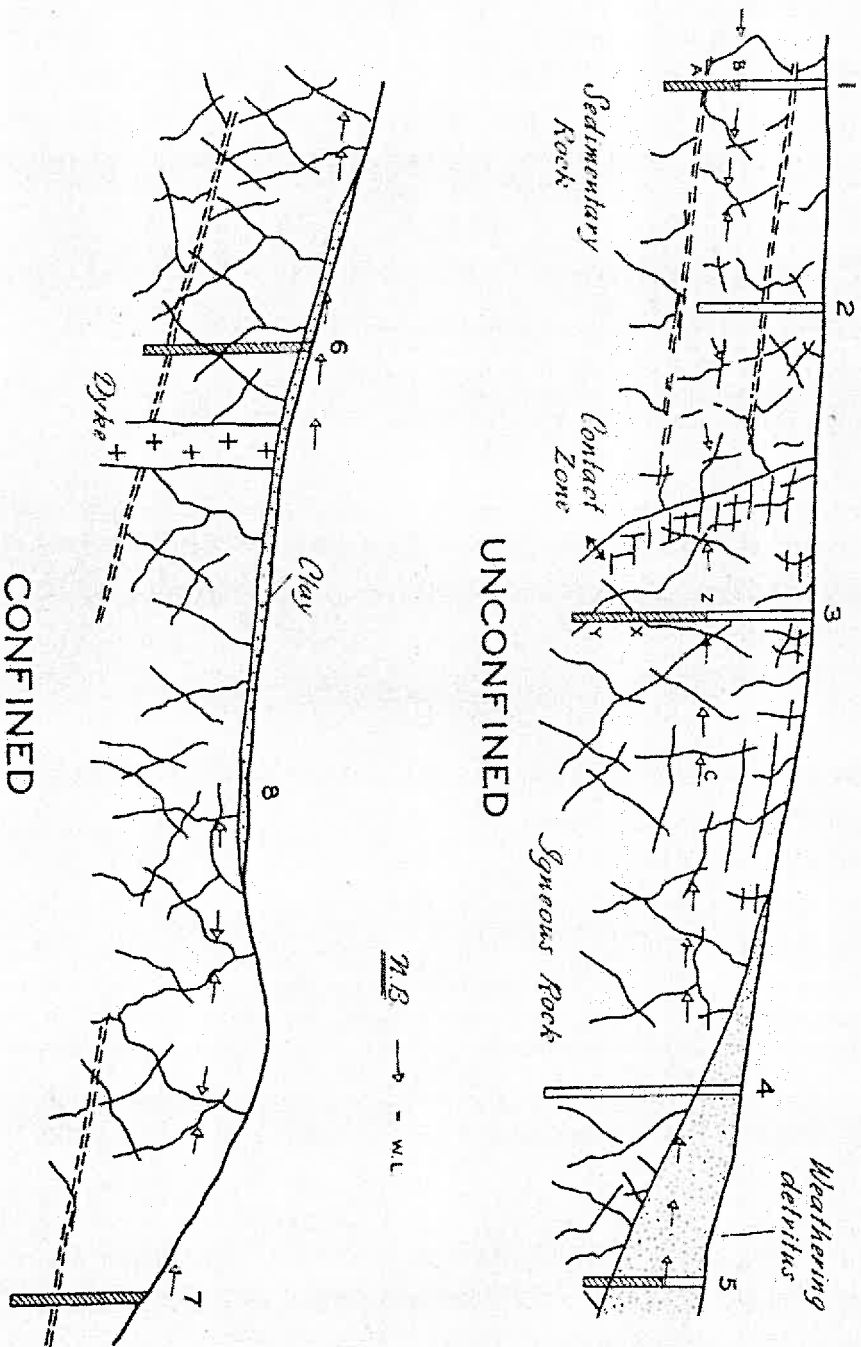
Groundwater - Spring water relationships

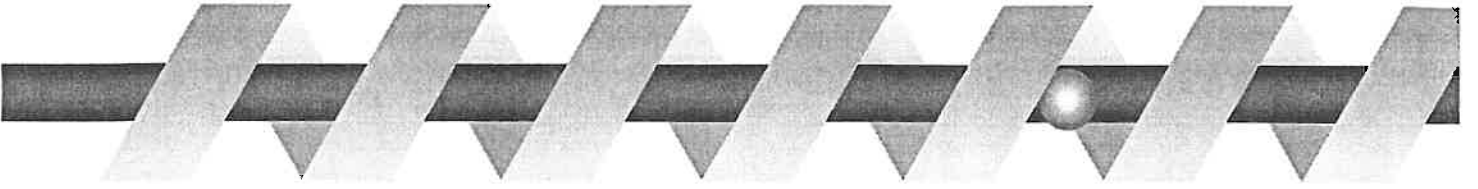
Water-bearing
fracture system

Springs

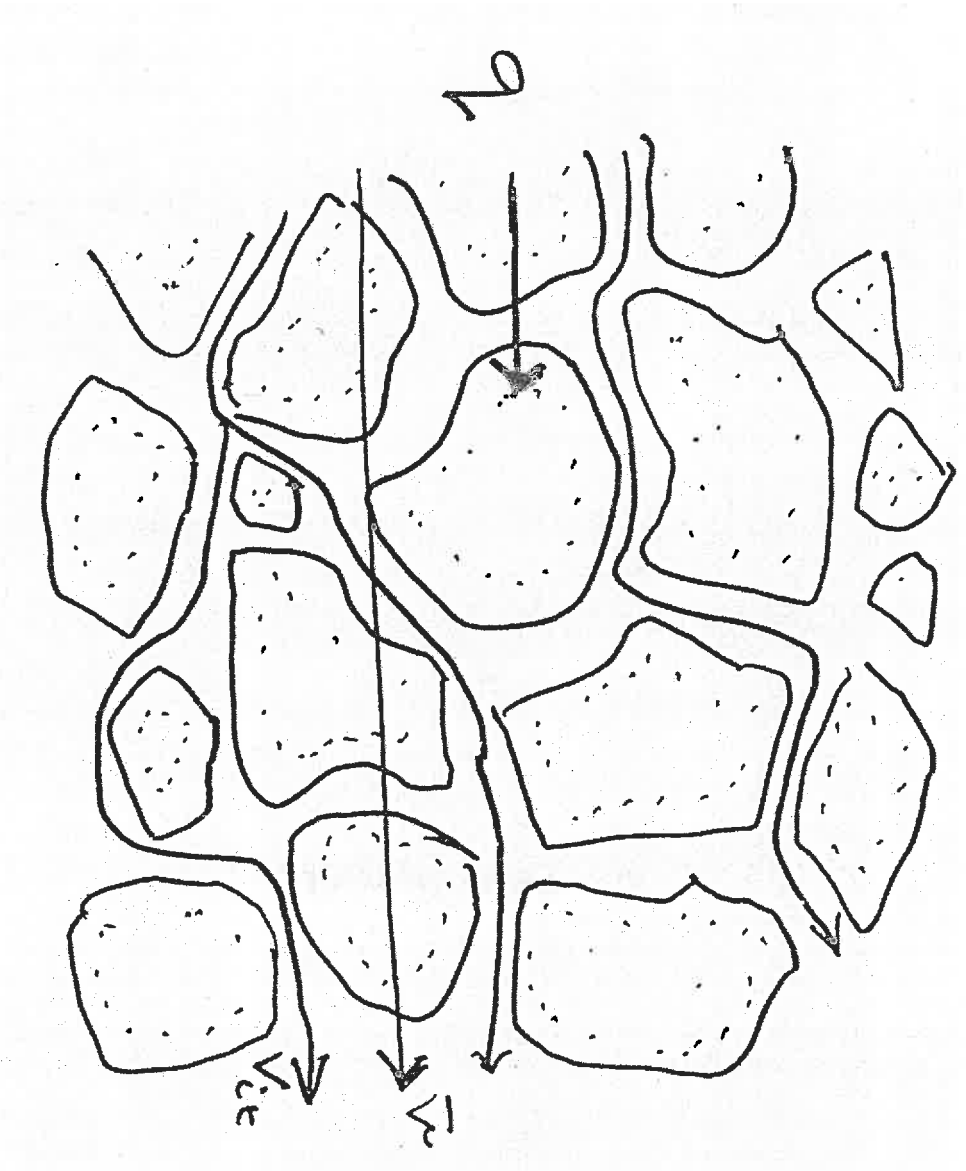


Confined and Unconfined Aquifers

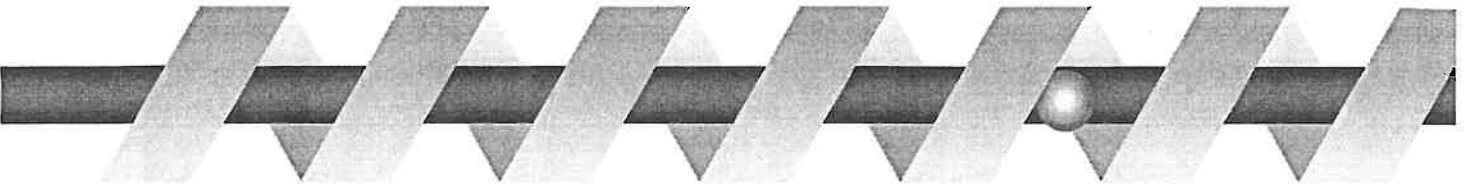
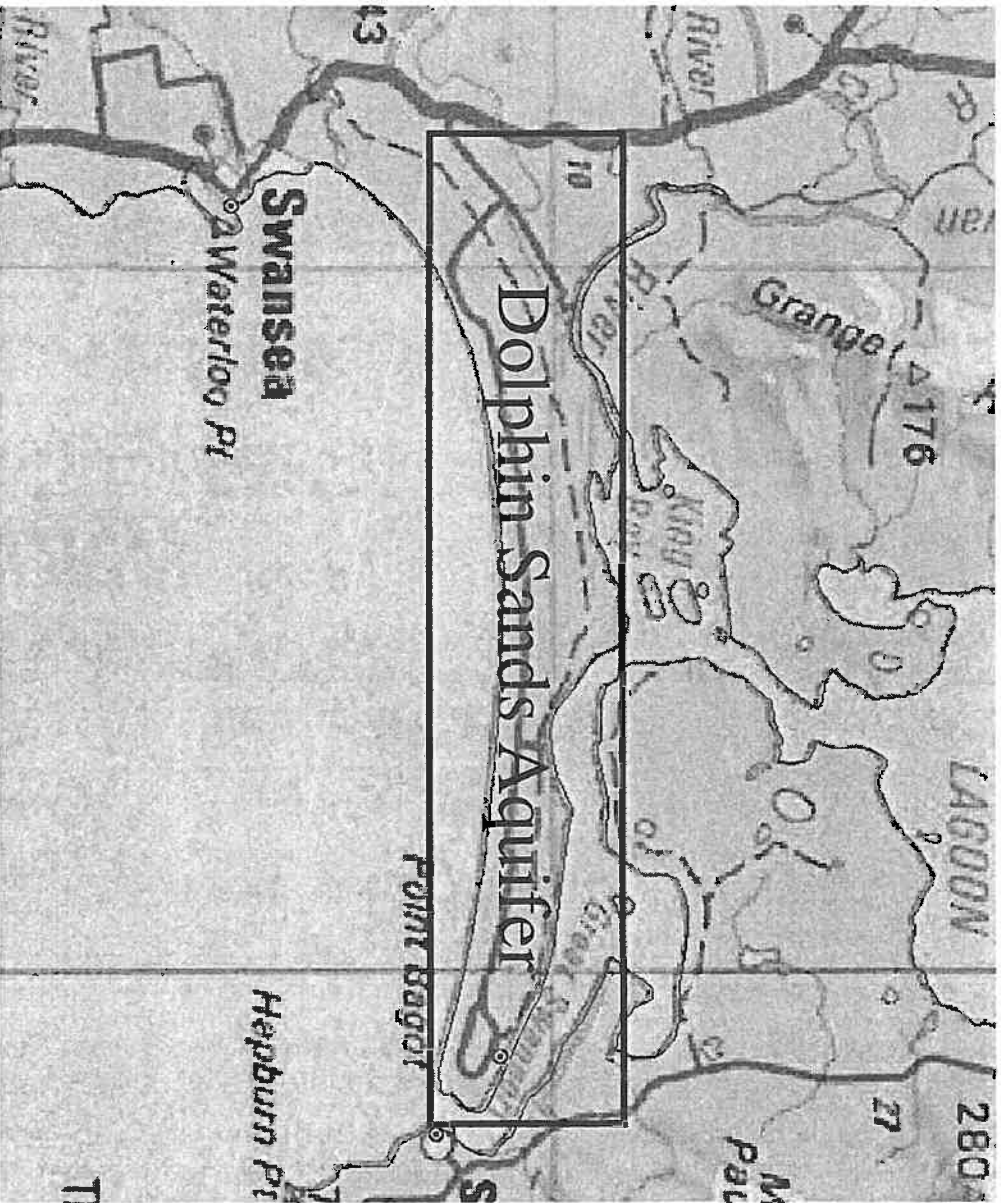




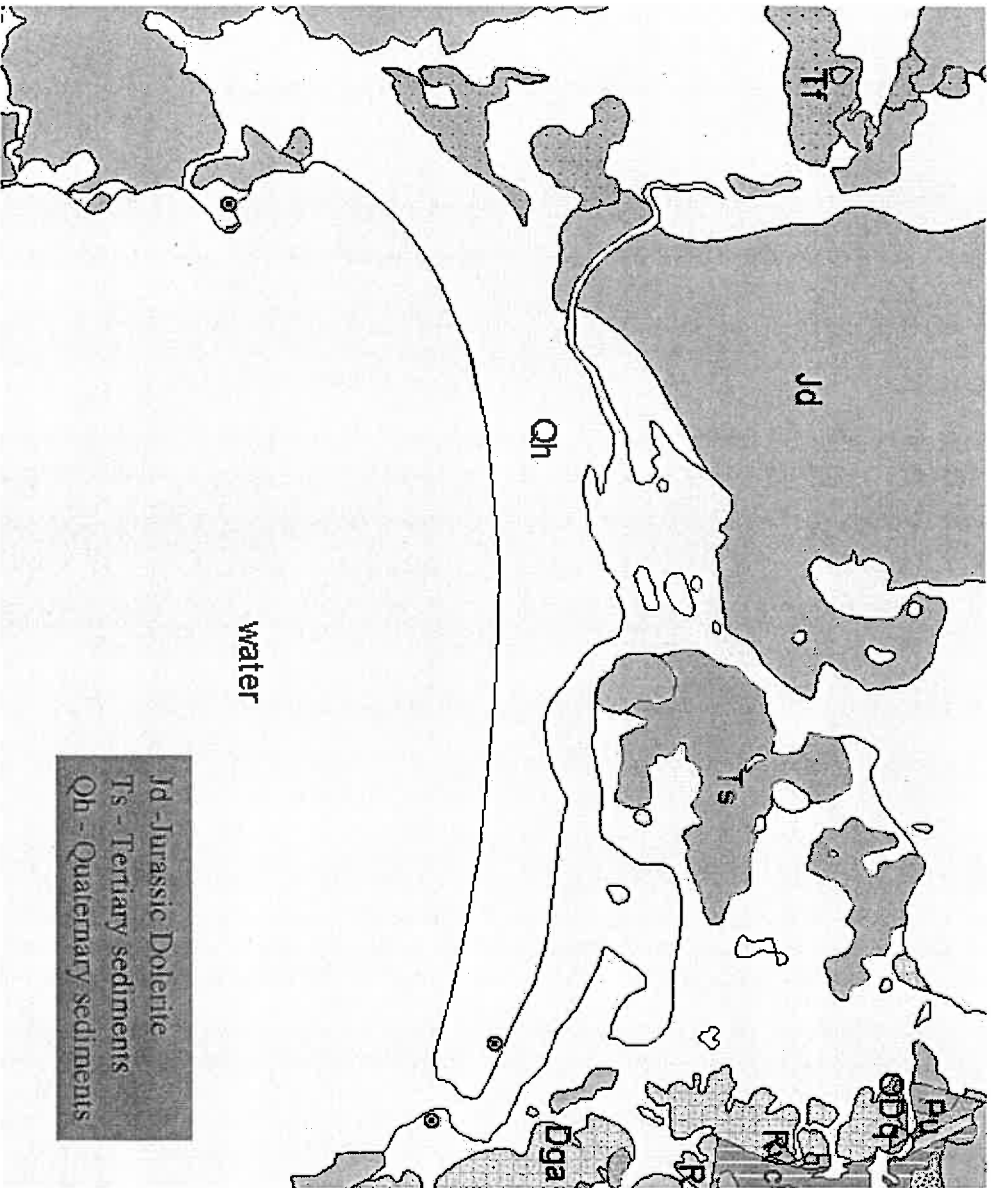
Intergranular (Porous) Aquifer



Swansea Aquifer Location



Swansea Geology 1:250000





Previous Groundwater Investigations

Mines Department Investigation in 1968 (P. Stevenson)

- 30 boreholes drilled, 4 m deep at 800m interval
- Depth of water struck varied from 0.6 - 4m
- Total Dissolved Solids values varies from 200 mg/l at the centre of the spit and 2000 mg/l at the eastern end.
- Average TDS value of 800 mg/l was suggested across the aquifer

Mines Department Caravan Park Investigation (before 1980)

- 15m deep bore revealed sand thickness greater than 15m
- Depth to water table 3m with fresh water present up to 15m
- vertical water quality variation from 350 - 560 mg/l
- Spear array proposed with suggested yields of 20-30 l/min, with 10m spacing between spears

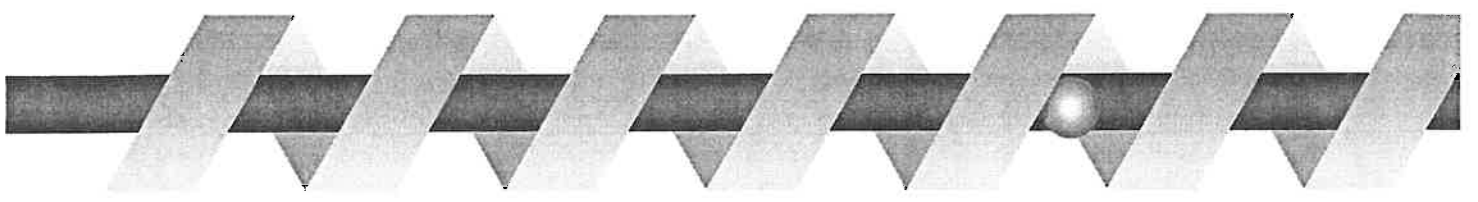
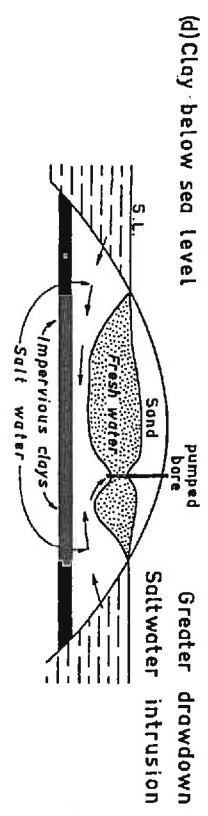
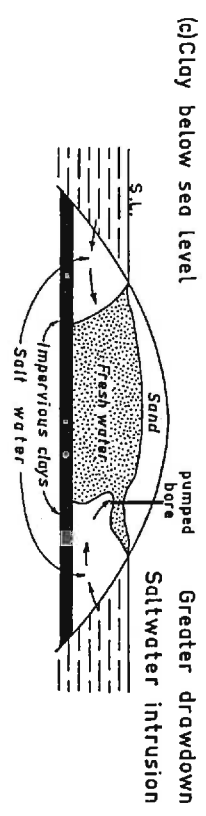
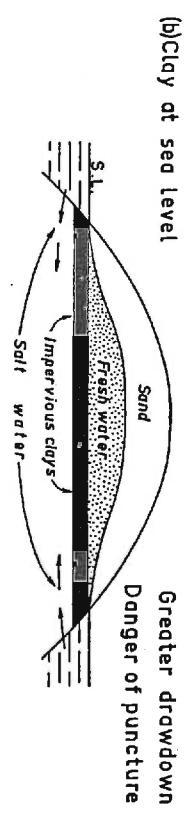
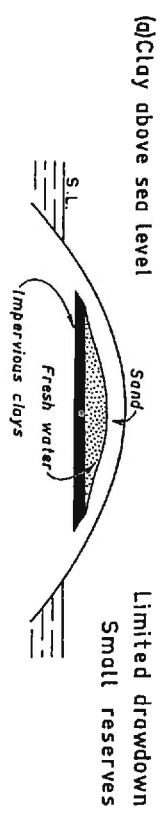


Previous Groundwater Investigations

Mines Department Department Investigation for Supplement to the water supply for Swansea in 1980 (WGC)

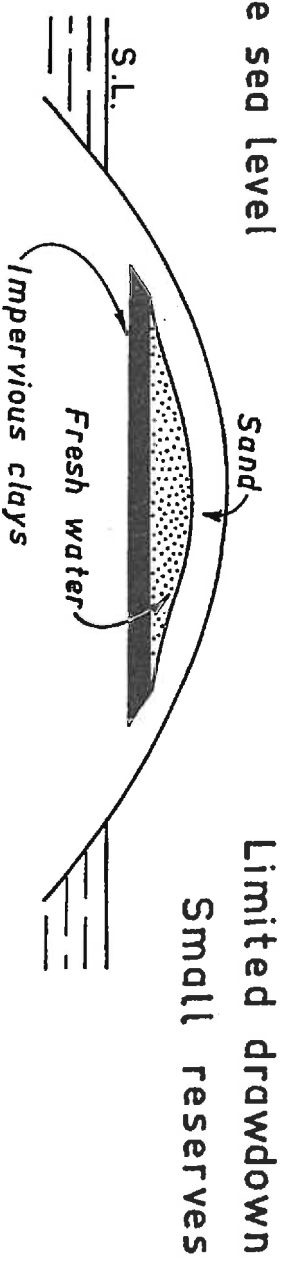
- **System of spears pumped 21 days at 570 mg/l (~17ML extracted)**
- **Average TDS value of 570 mg/l obtained**
- **Bacterial contamination detected with concentrations of coliform bacteria up to 25/100ml**

Possible Water Conditions in Coastal Areas



Case I - perched water table; clay above sea level

(a) Clay above sea level

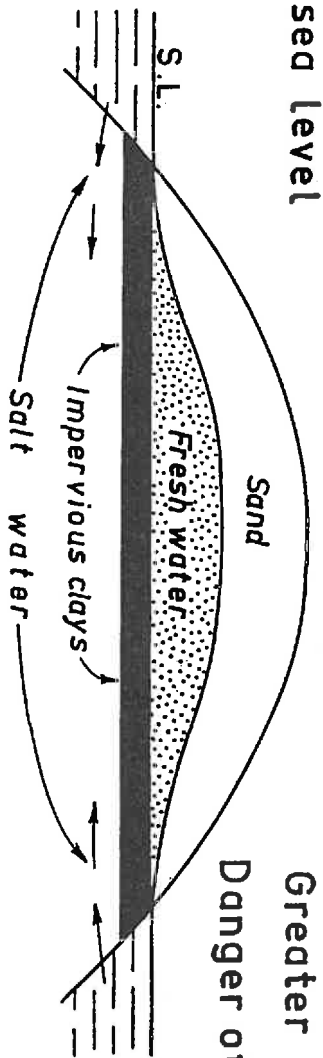


Spear in this situation would have limited success

Larger diameter excavations required (wells and trenches)

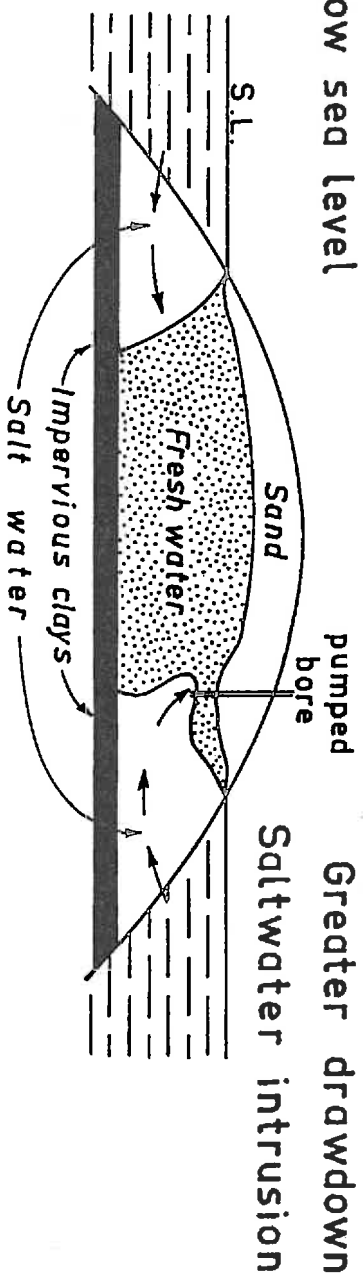
Case II - clay at sea level

(b) Clay at sea level



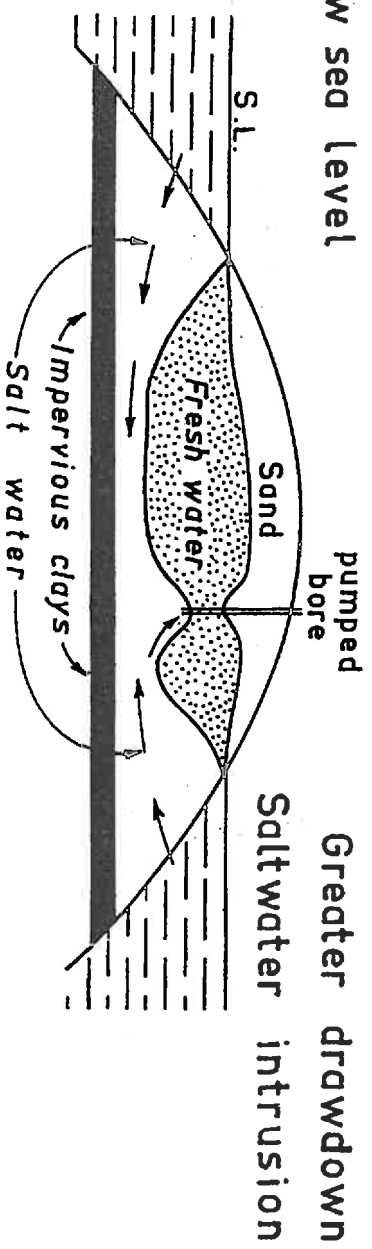
Case III - clay below sea level

(c) Clay below sea level



Case IV - clay below sea level

(d) Clay below sea level



Dolphins Beach/7Mile Beach aquifer analogy

Aquifer Name	7 MILE BEACH	DOLPHIN BEACH
Aquifer Area	10km ²	18km ²
Aquifer Type	Intergranular (porous) Unconfined	Intergranular (porous) Unconfined
Average Thickness	10m	About 7m
Average Annual Rainfall	550mm	600mm
Estimated Safe Yield	1650 ML	720 ML (based on aquifer recharge of 40mm/year)
Vulnerability to pollution	High	High
Nitrate Pollution	Confirmed in 1997/98	Some evidence in 1999
Bacteria Pollution	-	Confirmed in 1980
Risk of intrusion of sea water or salty groundwater from surrounding aquifers	Evidence of lateral movement of salty Tertiary groundwater and mixing with fresh groundwater from Quaternary Aquifer due to over pumping.	Currently there is no data to support salty water intrusion. Low-Moderate risk and only if excessive extraction in the coastal area occurs. Deep boreholes into underlying tertiary clays should be avoided as they may lead to establishment of hydraulic connection between two aquifers (lower tertiary aquifer probably has poor water quality).



Monitoring - of existing and monitoring wells

Groundwater Quantity:

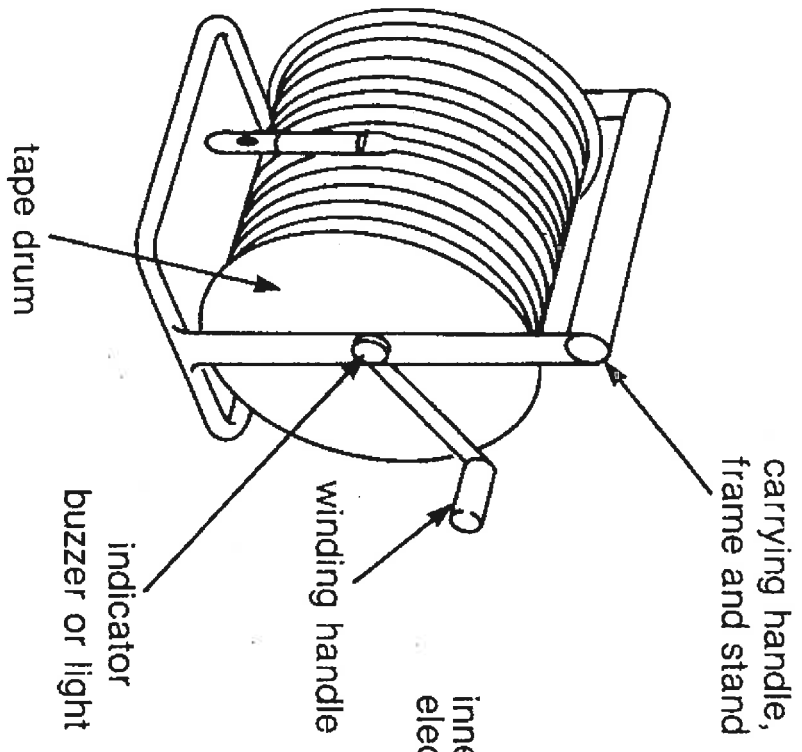
- Systematic recording of existing and new borehole in the area
- Standing water levels observations (monitoring and production wells/spars)
- Recording of extraction volumes of groundwater
- Aquifer pump testing and sampling

Groundwater Quality:

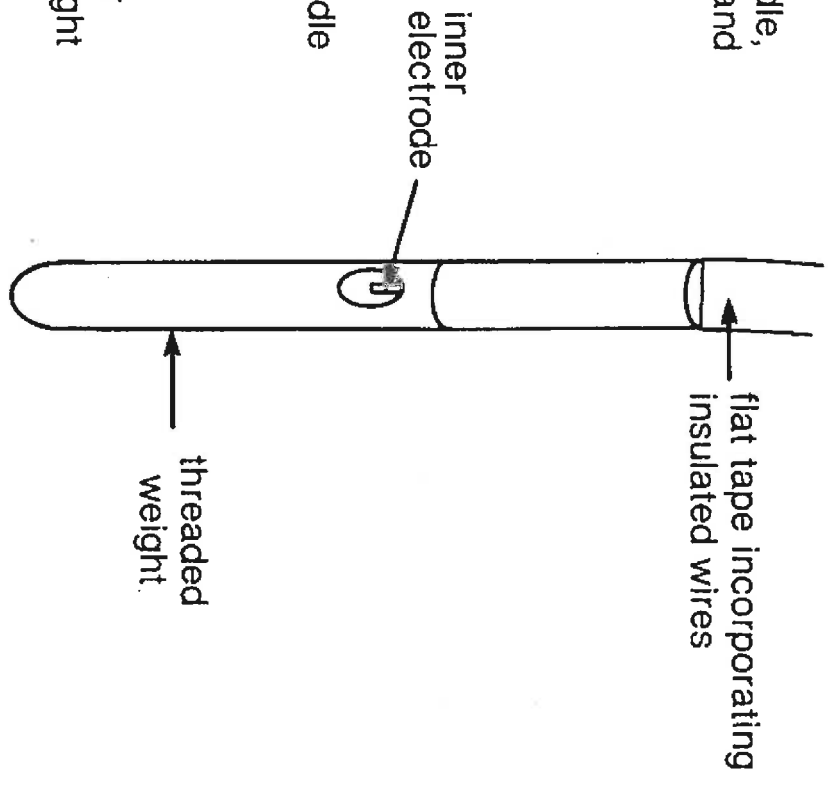
- Electrical Conductivity (water Salinity) - using conductivity meters (\$150 +GST)
- pH - analytical strips or pH meters (expensive)
- Nitrate - nitrate test strips (a pack of 100 strips cost ~\$50)
- Bacterial analysis if elevated Nitrate concentration detected

Standing Water Level Monitoring Device

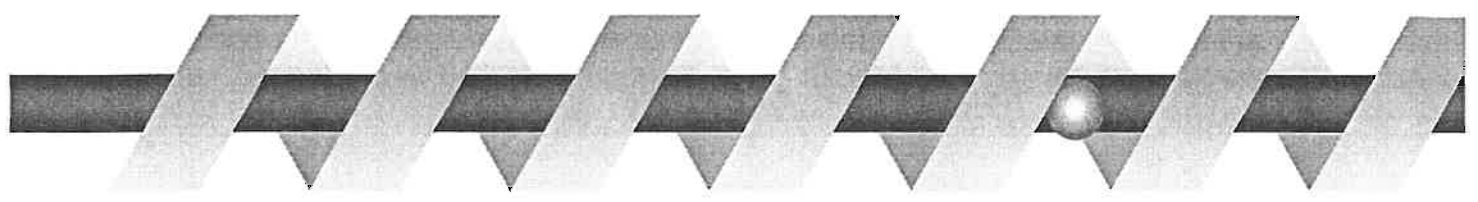
(a) general assembly

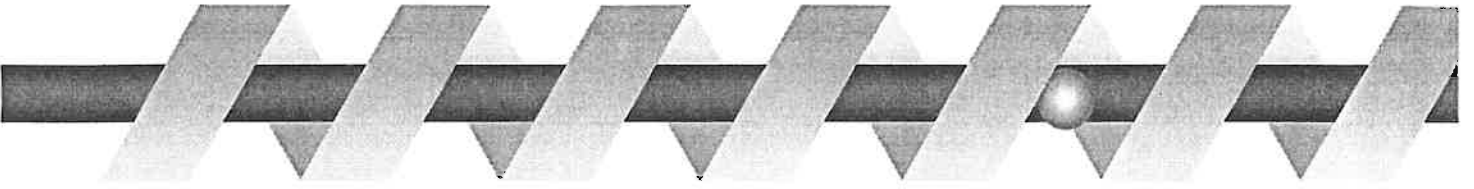


(b) detail of probe



C) home made devices





Sampling Devices

- Open Bailer
- Point Source Bailer
- Syringe Sampler

- Bladder Pump
- Helical Pump
- Piston Pump
- Centrifugal Pump

- Gas Lift

Groundwater Sampling Guide by J.M.C.Weaver

Table 2.1 Sampling tree

	FIELD MEASUREMENT ¹	DETERMINANDS TO BE MEASURED IN THE LABORATORY
WATER QUALITY FOR CONSUMPTION	HOUSEHOLD CONSUMPTION	pH (Alkalinity)
	LIVESTOCK DRINKING	pH & EC
	IRRIGATION	pH (Alkalinity)
INDUSTRIAL USAGE		pH Eh ALKALINITY
		CAT/AN, encrustation/corrosion, Fe/Mn.
HYDROCHEMISTRY FOR GROUNDWATER SURVEYS	MAJOR HYDROCHEMISTRY	CAT/AN plus what project needs.
	TRACE ELEMENTS	CAT/AN plus trace elements as project needs.
	RADIO-ISOTOPES	Determined by project.
GROUNDWATER POLLUTION MONITORING	ARTIFICIAL RECHARGE	K, NO ₃ plus what project indicates is needed.
	CLASS 1 WASTE DISPOSAL	CAT/AN, DOC ⁴ , DOX ⁵ plus toxic substances of interest.
	CLASS 2 WASTE DISPOSAL	CAT/AN, DOC, DOX plus toxic substances of interest.
	CLASS 3 WASTE DISPOSAL	CAT/AN, DOC plus toxic substances of interest, if any.
	PESTICIDE CONTAMINATION	Identified target pesticides, nitrate and potassium.
	ACID MINE DRAINAGE (AMD)	CAT/AN, identified heavy metals.
	SEWAGE DISPOSAL	CAT/AN, DOC microbiology.
ARTIFICIAL RECHARGE	CAT/AN, DOC microbiology, phenols and DOX.	
UNDERGROUND STORAGE TANKS (UST)	DOC, Identified substances plus degradation products.	
GENERAL SUSPECTED POLLUTION	pH Eh ALKALINITY	CAT/AN, DOC, DOX.

1. Temperature is measured as a matter of course when measuring pH.
2. CAT/AN - Full analysis of major cations and anions.
3. Microbiology - Includes the standard determinands for drinking-water quality.
4. DOC - Dissolved organic carbon
5. DOX - Dissolved organic halogens

Groundwater Sampling Guide by J.M.C. Weaver

This chart outlines some of the general types of groundwater sampling devices available for bedrock water investigations. Most of the devices outlined are designed for use in existing monitoring wells installed in unconsolidated deposits. Special conditions such as fractured rocks or multilevel aquifers may call for in situ sampling devices as outlined in general. Suitability stated on currently available literature and is subject to change.

IN SITU SAMPLING DEVICES	GROUND WATER PARAMETERS																			
	Device	Approximate Minimum Sample Depth	Minimum Well Diameter	Sample Delivery Rate of Volume	EC	pH	Redox	Major Ion Temp	INORGANIC				ORGANIC			RADIOACTIVE		BOL		
									Nitrate	Ammonia	Disolved	Free	Volatils	TOC	TOX	Radium	Group alpha & beta		Coliform bacteria	
Open bucket	no limit	12 mm	variable	variable	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Peristaltic pump	no limit	12 mm	variable	variable	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Syringe sampler	no limit	26 mm	0.04 - 0.75 L	0.04 - 0.75 L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Gas-lift	200 ft	50 mm	0 - 2 Liters	0 - 2 Liters	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Bladder pump	400 ft	26 mm	0 - 7.5 L/min	0 - 7.5 L/min	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Hydraulic ram	400 ft	50 mm	0 - 4.5 L/min	0 - 4.5 L/min	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Plunger pump (Gas-lift)	200 ft	26 mm	0 - 2 Liters	0 - 2 Liters	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Centrifugal	Variable	75 mm	variable	variable	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Peristaltic	26 ft	12 mm	0.04 - 1.1 L/min	0.04 - 1.1 L/min	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Gas-lift	variable	25 mm	variable	variable	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Gas-lift	150 ft	25 mm	0.75 Liters	0.75 Liters	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Peristaltic	no limit	no limit	applicable	0.04 - 0.5 L	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Sampling devices on this chart are divided into two categories: (1) portable devices for sampling existing monitoring wells, and (2) in situ monitoring devices (often multilevel) that are permanently installed. Sampling device construction materials (including tubing, seal liners, etc.) should be evaluated for suitability in sampling specific groundwater parameters. It is assumed on this chart that existing monitoring wells are properly installed and dominated of materials suitable for detection of the parameters of interest. See reference for additional information.

Sample delivery rates and volumes are average ranges based on typical field conditions. Actual delivery rates are a function of diameter of monitoring installation, size and capacity of sampling device, hydrogeologic conditions, and depth to sampling point. For all devices rate should be carefully controlled to prevent attraction or degassing of the sample.

Indicators shown is generally suitable for applications (sampling device is cleaned and operated properly and is constructed of suitable materials).

Groundwater Sampling Guide by J.M.G.Weaver

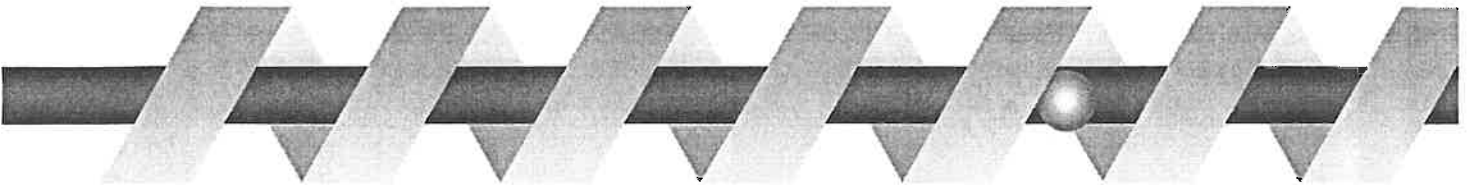
Table 2.3 Sample size, preservation and holding time

Measurement	Volume required (mL)	Container or glass	Preservation	Maximum holding time	APHA Standard Method Number
Acidity	100	P,G	Cool, 4°C	24 hrs	2310 - Acidity
Alkalinity	100	P,G	Cool, 4°C	24 hrs	2320 - Alkalinity
Aluminium	50	P,G	Filter on site	6 months	3111
Asenic	100	P,G	HNO ₃ to pH <2	6 months	3114 - metals by Hydride generation/AAS
Bromide	100	P,G	Cool, 4°C	24 hrs	4500 - Br ⁻
COD	50	P,G	H ₂ SO ₄ to pH <2	7 days	5220 - COD
Chloride	50	P,G	None	7 days	4500 - Cl ⁻
Colour	50	P,G	Cool, 4°C	24 hrs	2120 - Colour
Chromium	100	P,G	Filter on site	6 months	3500
Cyanides	500	P,G	Cool, 4°C	24 hrs	4500 - CN ⁻
Dissolved oxygen					
Probe	300	G only	Det. on site	None	4500 - O Oxygen (dissolved)
Winkler	300	G only	Fix. on site	None	4500 - O Oxygen (dissolved)
DOC	100	P,G	Cool, 4°C	14 days	5310
DOX	50	G-T-cap	Cool, 4°C	14 days	5320
Fluoride	300	P,G	HNO ₃ to pH <2	7 days	4500 - F ⁻ Fluoride
Hardness	100	P,G	Cool, 4°C	7 days	2940 - Hardness
Iodine	100	P,G	Cool, 4°C	24 hrs	4500 - I Iodine
Iron	50	P,G	Filter on site	6 months	3500-Fe
Manganese	50	P,G	HNO ₃ to pH <2	6 months	3500-Mn
Metals					
Dissolved	200	P,G	Filter on site	6 months	3010 - 3500
Mercury	100	P,G	Filter HNO ₃ to pH <2	38 days (glass)	3112
Dissolved	100	P,G	Filter HNO ₃ to pH <2	13 days (plastic)	

Always mark on the sample bottle the preservative used.

Groundwater Sampling Guide by J.M.C. Weaver

Measurement	Volume required (mL)	Container or glass	Preservation	Maximum holding time	APHA Standard Method Number
Nitrogen					
Ammonia	400	P, G	Cool, 4°C	24 hrs	4500 - N
			H ₂ SO ₄ to pH < 2		4500 - NH ₃
Kjeldahl	500	P, G	Cool, 4°C	24 hrs	4500 - Norg
			H ₂ SO ₄ to pH < 2		
Nitrate	100	P, G	Cool, 4°C	24 hrs	4500 ⁻ NO ₃ ⁻
			H ₂ SO ₄ to pH < 2		
Nitrite	50		Cool, 4°C	24 hrs	4500 ⁻ NO ₂ ⁻
			Cool, 4°C		
Oil & grease	1 000	G only	Cool, 4°C	24 hrs	5520 Oil and grease
			H ₂ SO ₄ to pH < 2		
Pesticides	1000	G, T-cap	Cool, 4°C	14 days	6000 - 6640
			Cool, 4°C		4500 - H ⁺
pH			Det. on site		
Phenols	1000	G, T-cap	Cool, 4°C	28 days	5530 Phenols
			H ₂ SO ₄ pH < 2		
Phosphorus					
Ortho-phosphate, dissolved	50	P, G	Filter on site	24 hrs	4500 - P
			Cool, 4°C		
Hydrolyzable	50	P, G	Cool, 4°C	24 hrs	
			H ₂ SO ₄ to pH < 2		4500 - P
Total, dissolved	50	P, G	Filter on site	24 hrs	4500 - P
			Cool, 4°C		
Radioactivity	5000	P	Filter on site	48 hrs	
			5 mL HNO ₃ per 1 L		
Radon					
Radon	100	G, T-cap	Cool, 4°C	24 hrs	3114
Selenium	50	P, G	HNO ₃ to pH < 2	6 months	4 500 - SI
Sulfate	50	P only	Cool, 4°C	7 days	4500 - SO ₄ ²⁻
Sulfide	50	P, G	Cool, 4°C	7 days	4500 - S ²⁻
			2 ml zinc acetate	24 hrs	
Sulfite	50	P, G	Cool, 4°C	24 hrs	4500 - SO ₃ ²⁻
Tribalometanes					
Tribalometanes	2 x 25	G, T-cap	a) Cool, 4°C	14 days	6232
			b) Cool, 4°C		
Chlorine					
VOC	2 x 50	G, T-cap	Cool, 4°C	14 days	6210





Groundwater Standards, Guidelines and State Policy on Water Quality (DPIWE) and Groundwater Database (MRT)

AS/NZS Standards:

- Aquifer pump testing
- Water Quality Sampling AS/NZS 5667

Guidelines:

- Australian and New Zealand Guidelines for Fresh and Marine Water
- Australian Drinking Water Guidelines (1996)

Tasmanian References:

- State Policy on Water Quality Management 1997 (DPIWE)
- State Groundwater Database “BORIS” maintained by Mineral Resources Tasmania:

- 8000 borehole records
- information available on demand, Internet delivery planned
- data collected in Dolphin sand area will be include into database