Saline Solutions

Teacher Resource Pack

Middle Years and Senior Years

WATERWATCH
Murray
Communities Caring for Catchments

WATERWATCH Murray
Communities Caring for Catchments

River Murray Catchment Water Management Board

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Acknowledgements

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KESAB environmental solutions

Contents

Links to the S.A.C.S.A. Framework

Middle Years

Learning Area	Strand	Key Idea
Science	Life Systems	Students develop a shared understanding of the characteristics and behaviour of living things and how they are interrelated and interdependent. They appreciate and report on the place of humans in the earth's ecology; and develop their understanding of, explore future possibilities for, and act to contribute to, sustainable environments. **F In** KC1 KC2 KC3
	Earth and Space	Students investigate, through field work and research, the central importance of the earth's role in sustaining life and how changes impact on life; and understand the interaction of the atmosphere, the oceans and the earth's surface. **F In T** KC1 KC3
Society and Environment	Place, Space and Environment	Students access, investigate, interpret and represent information from fieldwork, electronic systems and other research, in order to explain local and global interactions and relationships between people and environments. **In T C** KC1 KC2
		Students discuss environmental, conservation or resource issues, and individually and/or in teams collaboratively develop strategies to bring about positive change in the local community. **F In T** KC2 KC4 KC6
	Time Continuity and Change	Students gather, research, analyse, evaluate and present information from a variety of sources to show understanding of particular times or events, from a range of perspectives. **T C** KC1 KC2
		Students investigate and analyse events, ideas, issues and lives of people in their local community, nation and the world, identifying patterns, changes, continuities and possible futures. **F Id C** KC1 KC5 KC6

Senior Years

Learning Area	Strand	Key Idea
Science	Earth and Space	Students learn that the earth is composed of materials that are altered by forces within it and on its surface, and that affect the way it sustains life. They report on this to various audiences. **F In T C** KC2
	Life Systems	Students use explanatory models to research the interrelationships within and between individual cells and whole organisms, and the environments which sustain and influence them. **In T** KC1
		Students critically explore the function of genetic and environmental influences of life processes. They consider the ethics and impacts of human intervention in manipulating these influences, and of taking responsible action. **Id In T** KC1
Society and Environment	Place, Space and Environment	Students examine social and natural environments, including Australian and international examples of uniques and fragile natural environments. They develop a critical understanding of past and present management and mismanagement of land systems. They analyse current practices, and suggest criteria of strategies to access and affect possible future practices.**F In** KC6

South Australian Curriculum, Standards and Accountability Framework (SACSA) 2001, Adelaide: Department of Education Training and Employment

How to Conduct the Lessons

Introductory Session

Students propose a scientific definition for water salinity. Write all suggestions on the board, circle key words and formulate an agreed definition.

Definition: Salinity is the concentration of salts. The salinity level of a river or water body is a measure of the salt load carried in the water.

1. Explain that table salt, Sodium Chloride (NaCl), is only one type of salt. Salinity refers to the total concentration of a range of dissolved salts, which can include Magnesium, Potassium, Bicarbonate, Calcium and Sulphates. Ask students where these salts might come from.
    - Groundwater collects salts from the local geology
    - Rising water tables due to land clearing and over-irrigation
    - Stormwater run-off collects salts from roads and other hard surfaces
    - Wind-blown top soil, salt lakes and sea spray
    - Salts may be present in fertiliser, herbicides and pesticides
    - Salt may be present in chemical treatments such as; sewage, swimming pools and manufacturing
2. Explain or demonstrate two techniques for measuring salinity.
    A. If you have access to a lab conduct an evaporation experiment. Evaporate a solution and weigh the salts remaining. The units used are milligrams per litre of solution (mg/L).
    B. Salinity meters measure electrical conductivity, which increases with the concentration of salt. The units used are microsiemens per centimetre (µS/cm). Use the Salinity meter in your water quality monitoring kit to measure the salinity of different solutions. See: Activities ‘How Saline is that Water?’

Saline Solutions

Part 1 The Causes and Effects of Salinity

- Find out what students already know about the causes of high salinity levels in the River Murray. These can be divided into natural factors (e.g. weather, geology) or human impacts (e.g. land clearing and irrigation). Make two lists on the board or ask students to write them down.
- Students work in groups to discuss the impacts of high salinity levels on river habitats, people and the wider community. Groups report their ideas back to the class.

See Fact Sheet 1 for more information.

Part 2 Groundwater and Rising Water Tables

- Groundwater movement is part of the natural water cycle so it is useful to review students’ understanding of the water cycle before exploring groundwater processes. (See Figure 1)
- Draw a cross section of a river and surrounding land. On one half show natural/deep-rooted vegetation and on the other show cleared/farming land. Use this diagram to help explain the impacts of land clearing on water tables, run-off and evaporation. (See Figure 2)
- Discuss high salinity levels in the River Murray and surrounding land in terms of these processes. (Use Key Terms page for useful definitions)
- Students complete the Activity Sheet.
- Students formulate a strategy for addressing the threat of rising salinity. Their strategy should include a description of the problem, the actions needed, people involved and possible outcomes.

See Fact Sheet 2 for more information.

Fact Sheet 1

Causes and Impacts of Salinity

The main causes of salinity problems are:

Geology
- Australia is a dry continent with naturally occurring salt deposits.
- The River Murray system was once part of an inland sea.
- Weathering and erosion of rocks.

Land Use
- Clearing of vegetation for farming and housing.
- Deep-rooted perennial species such as Mallee trees have been replaced with crops and pastures with shallower roots and different seasonal growth patterns.
- Irrigation practices which use water inefficiently (such as overhead irrigation, flood irrigation and irrigating for long periods infrequently), allows large quantities of water to seep into the groundwater. The water table rises bringing with it dissolved salts from the soil.
- Run-off, erosion and stormwater pollution can wash salts into the river system.

Some impacts of high salinity are:
- Water becomes unsuitable for irrigation as salty water stunts the growth of plants.
- River water becomes too salty to drink, affecting local & regional water supplies for humans and livestock.
- Trees and shrubs along the river die, compounding the problems of run-off, erosion and rising water tables.
- Loss of habitat for native fauna.
- Most freshwater flora and fauna are not adapted to live in salt water.
- Salt destroys concrete and bitumen, which can affect roads, buildings and bridges.
- Corrosion and blockage of pipelines.
- Water becomes harder, which is a problem for washing clothes as it wears them out faster and requires more detergent. (Detergent is less effective in salty water)

How Water Flows into the River Murray

The River Murray receives water in four ways.
PRECIPITATION - Rain falling into the waterway. **RUN-OFF -** Water that does not soak into the ground but runs across the ground, and other surfaces, into the waterway. Vegetation, surface type, barriers, slope and weather affect run-off. **THROUGH FLOW -** Water is absorbed into the topsoil and then moves downhill to the waterway, through the unsaturated zone (above the water table). **BASE FLOW -** Water soaks deep into the soil (recharge), reaching the ground water, then seeps into the waterway (discharge).

Fast Facts

- Experts estimate that 6,800,000 tonnes of salt will flow down the River Murray by the year 2020. That's enough to fill 340,000 semi trailers!
- Current salinity levels (μS/cm), increase along the length of the River Murray as follows, Murray source 10, Mildura 200, Renmark 300, Berri 430, Morgan 600, Murray Bridge 650 and Goolwa 800. Lake Bonney (near Berri) has an average salinity level is 5,000 μS/cm.
- Salinity in the lower Murray will increase by 50% by 2050, if nothing is done.
- Less than half of the salt in the River Murray is flushed out to sea. Most is deposited in the river or in irrigation areas and floodplain wetlands.
- During a wet year the River Murray provides 40% of South Australia's water. This increases to approximately 90% during a dry year, when metropolitan reservoirs are extremely low.

Fact Sheet 2

The Water Cycle

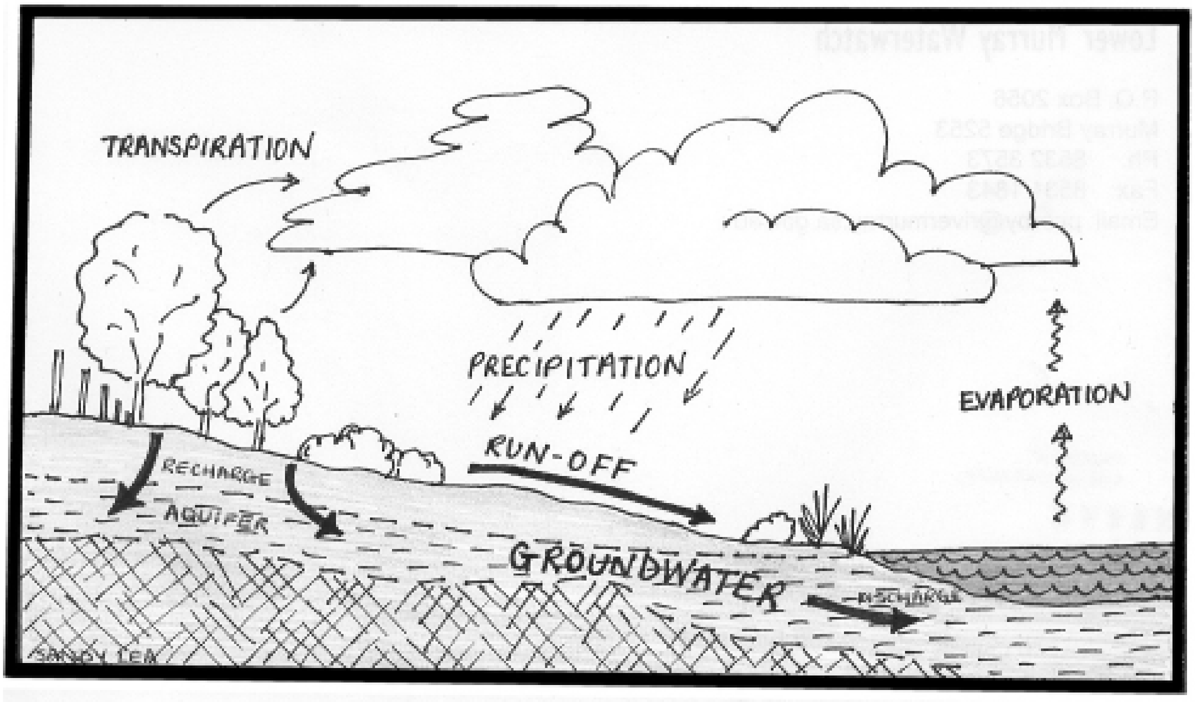


Figure 1

The Water Cycle is the movement of water from the atmosphere to the earth and back to the atmosphere through precipitation, run-off, infiltration, percolation, storage, evaporation and transpiration.

Groundwater Flow

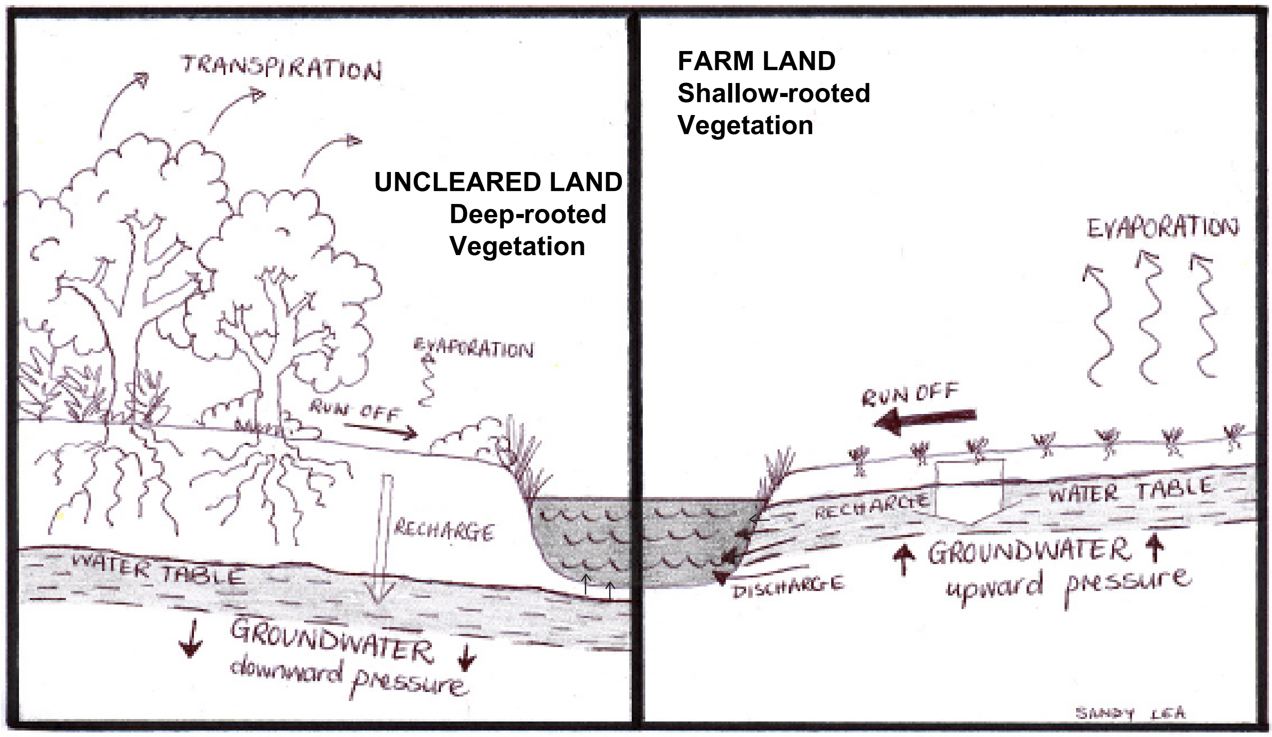


Figure 2

Rainwater can evaporate, be absorbed by vegetation, run-off hard surfaces or seep through soil, above the water table. The remaining rainwater is recharged into the groundwater aquifer. In areas of land clearing water tables rise, bringing groundwater and disolved salts closer the surface.

Key Terms

AQUIFER – any rock or soil layer capable of storing water and which allows water to pass through.

BASE FLOW – water that has sunk deep into the soil and met the groundwater, which seeps into waterways.

BASIN – area of land drained by a river and its tributaries.

BORE – a deep hole that reaches an underground water source and through which water rises due to hydrostatic pressure.

CULVERT – a covered channel or large pipe that diverts the natural flow of water.

DISCHARGE ZONE – an area where groundwater moves upward and escapes through natural springs, evaporation, transpiration and surface drainage.

EVAPORATION – the process by which water changes its physical state from a liquid to a gas.

GROUNDWATER – water that infiltrates into the earth and is stored in rock and soil below the earth's surface.

HYDROLOGY – applied science concerned with the water cycle, which includes precipitation, run-off or infiltration, storage and evaporation.

LEACHING – the process in which water percolating through the earth dissolves many substances and then carries them away in solution or suspension.

PERCOLATION – downward movement through the subsurface soil layers to groundwater.

PERMEABILITY – ease with which water flows through soil or rock.

RECHARGE ZONE – area of land where surface water from rain, irrigation or streams moves downward and infiltrates an aquifer.

RUN-OFF – portion of rainfall, melted snow or irrigation water, that flows across the land's surface instead of soaking into the ground. Run-off may pick up and carry a variety of pollutants.

SALINISATION – a process by which the concentration of salts in the root zone of the soil increases.
This is often caused by the capillary rise of saline moisture from a shallow water table.

SALINITY – concentration of salts, milligrams per litre (mg/L) or microsiemens per centimetre (µS/cm)

SALTS – compounds that separate in water to yield a positively charged ion and a negatively charged acid radical ion.

SEEPAGE – the process by which water percolates downwards and/or laterally through the soil, often emerging at ground level lower down a slope.

THROUGH FLOW – flow of water through the ground. Water, which has been absorbed into the topsoil, then moves downhill to a water body.

TRANSPIRATION – the process by which water taken up by plants from the soil, is evaporated from tiny pores on the leaf surfaces to the atmosphere.

WATER CYCLE – movement of water from the atmosphere to the earth and back to the atmosphere through precipitation, run-off, infiltration, percolation, storage, evaporation and transpiration.

WATER TABLE – upper surface of the zone of groundwater saturation.

Adapted from: *'Waterwatch Australia National Technical Manual'* Module 1, Canberra 2003

Water Quality Standards

Water Quality Standards Table

μs/cm	Use
0 – 800	• Good drinking water for humans (provided there is no organic pollution and not too much suspended clay material) • Generally good for irrigation, though above 300 μS/cm some care must be taken, particularly with overhead sprinklers which may cause leaf scorch on some salt-sensitive plants • Suitable for all livestock
800 – 2 500	• Can be consumed by humans, although most would prefer water in the lower half of this range if available • When used for irrigation, requires special management including suitable soils, good drainage and consideration of salt tolerance of plants • Suitable for all livestock
2 500 – 10 000	• Not recommended for human consumption, although water up to 3 000 μS/cm can be consumed • Not normally suitable for irrigation, although water up to 6 000 μS/cm can be used on very salt-tolerant crops with special management techniques. Over 6 000 μS/cm, occasional emergency irrigation may be possible with care • When used for drinking water by poultry and pigs, the salinity should be limited to about 6 000 μS/cm. Most other livestock can use water up to 10 000 μS/cm.
Over 10 000	• Not suitable for human consumption or irrigation • Not suitable for poultry, pigs or any lactating animals, but beef cattle can use water to 17 000 μS/cm and adult sheep on dry feed can tolerate 23 000 μS/cm. However, it is possible that waters below these levels could contain unacceptable concentrations of particular ions. Detailed chemical analysis should therefore be considered before using high salinity water for stock • Water up to 50 000 μS/cm (the salinity of the sea), can be used (i) to flush toilets provided corrosion in the cistern can be controlled and (ii) for making concrete, provided the reinforcement is well covered

Adapted from: *'SALTWATCH Involve me and I'll understand'* Dept. Primary Industries, Queensland, 1994

How Saline is that Water?

In this experiment students prepare 4 solutions, of different salinity levels, for comparison. Students learn the technique for measuring salinity and gain an appreciation of what concentration levels mean by tasting the solutions. This activity can be done in small groups or as a whole class demonstration.

EQUIPMENT

Salinity Meter
Distilled water or Rain Water
Instructions for measuring salinity
Table Salt
4 small, clean containers (plastic cups)
Teaspoons

SALINITY MEASUREMENT INSTRUCTIONS

Step 1 Remove cap and rinse end of probe in the water to be tested.

Step 2 Switch unit on (on/off button).

Step 3 Dip the end of the probe into the water to be tested. Gently swirl the probe, until the numbers stop changing on the screen.

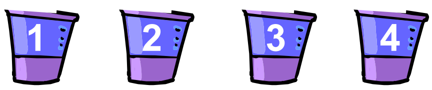
Step 4 Multiply your reading by 1000 (eg. 1.73 x 1000 = 1730 uS/cm).

Step 5 Record your result.

Step 6 Rinse the end of the probe with tap water and turn off.

PROCEDURE

1. Label the containers 1 – 4 and half fill them with water
2. Follow the instructions to measure the salinity level of the water in container one and record your results. (It should be less than 800 µs/cm)
3. Adding ¼ of a teaspoon at a time, add salt to container 2 until it measures approximately 1500 µs/cm. Record how much salt was added
4. Repeat Step 3 for container 3 until it measures approximately 7000 µs/cm
5. Repeat Step 3 for container 4 until it measures >10000 µs/cm
6. Taste each solution and record your response.



RESULTS

Container	Amount of Salt (tsp)	Salinity Level (µs/cm)	Taste
1			
2			
3			
4			

FOLLOW UP ACTIVITIES

- Students create a Procedural Writing Text to recount the experiment.
- Provide students with a copy of the Water Quality Standards and ask them to create an illustrated fact sheet.

Land Use and Groundwater Flows

1. Define the following terms.

SURFACE RUN-OFF ______________________________

GROUNDWATER RECHARGE ______________________________

GROUNDWATER DISCHARGE ______________________________

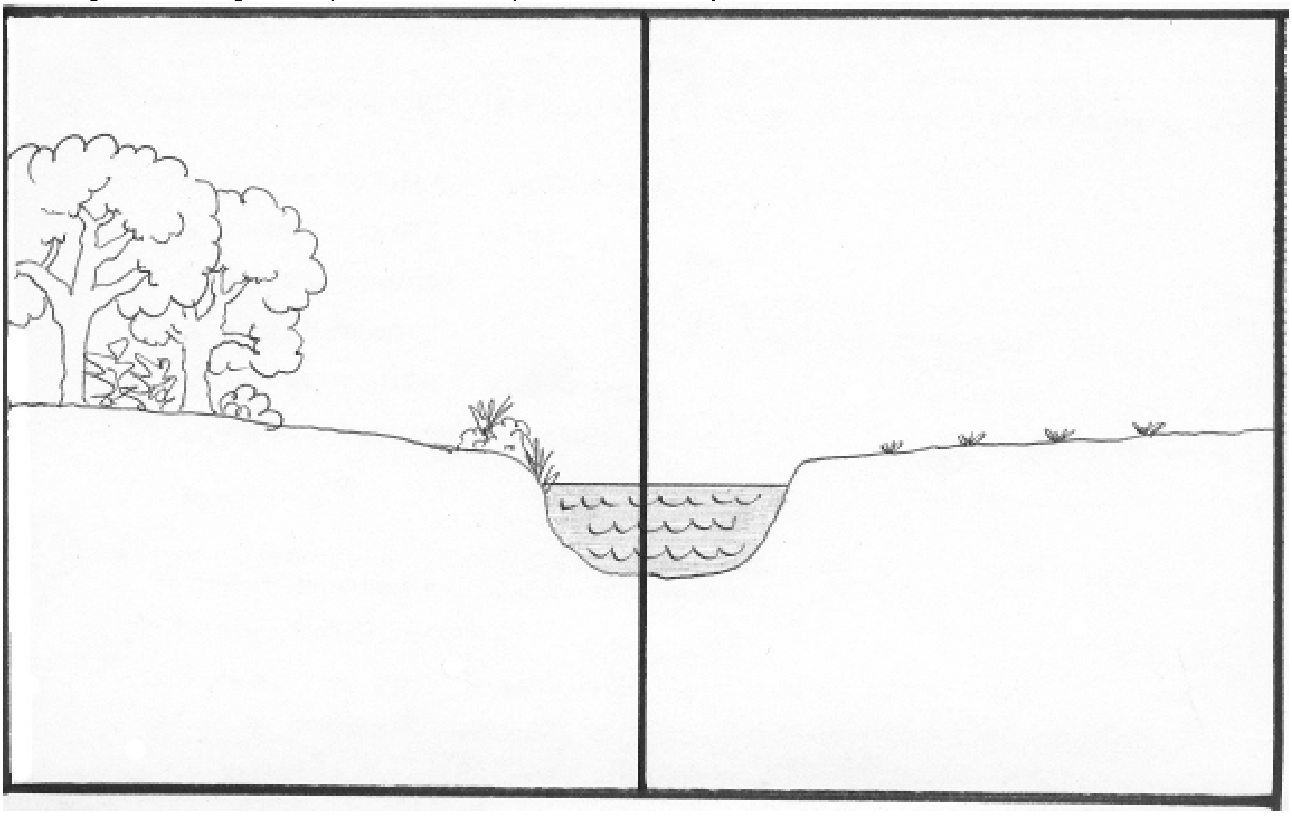
EVAPORATION ______________________________

TRANSPIRATION ______________________________

WATER TABLE LEVEL ______________________________

GROUNDWATER PRESSURE ______________________________

2. Complete the diagram using labels and arrows to compare; Surface run-off, Groundwater recharge, discharge and pressure, Evaporation, Transpiration and Water table levels.



3. Tick the correct box.

In areas of deep-rooted vegetation

	Increases	Decreases
Surface Run-off	☐	☐
Groundwater Recharge	☐	☐
Evaporation	☐	☐
Transpiration	☐	☐

In areas of shallow-rooted vegetation

	Increases	Decreases
Surface Run-off	☐	☐
Groundwater Recharge	☐	☐
Evaporation	☐	☐
Transpiration	☐	☐

4. Explain the relationship between these processes and salinity levels (in and around the River Murray). ______________________________

Other Learning Opportunities

Salinity Photos - Discussion Points

The salinity photos can be used for whole class discussions or group work. On the back of each photo is a brief description and points for discussion and/or research.

Salinity Management

Research salinity management practices and strategies. These may include:

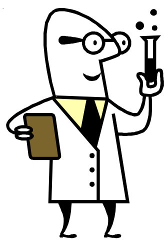
- Irrigation practices and drainage channels
- Changes to land use
- Caissons and Evaporation Basins
- Salt Interception Schemes
- Recovery and revegetation of salt-affected land
- Monitoring the quality of groundwater and water in the River Murray

Useful sources of information are:

River Murray Catchment Water Management Board www.rivermurray.sa.gov.au
Murray Darling Basin Commission www.mdbc.gov.au
National Dryland Salinity Program www.ndsp.gov.au
River Murray Urban Users Committee www.murrayusers.sa.gov.au
Save the River Murray Campaign www.SavetheMurray.com
CSIRO Land and Water www.clw.csiro.au

Salinity Audit and the Future of the River Murray

- Read:*SALINITY AUDIT Community Summary 1999*, Murray Darling Basin Commission
- Summarise one of the following sections; 'Key Findings', 'Rising Groundwater is the Problem' or 'The Financial Cost'. Present your summary as an information brochure or Power Point presentation.
- Include a Future Perspectives page, outlining positive solutions for salinity management.



Salinity Experiments

Design and conduct an experiment to investigate one of the following:

- The flow of water through different soil types
- Extracting salt from water
- The impact of salt on plant growth
- The relationship between salinity and evaporation rates

'The Silent Flood' © ABC 2003

The Silent Flood is a four part ABC documentary series, which examines salinity. Research and study activities have been developed for the four episodes and are available online: www.abc.net.au/learn/silentflood. The video is available from the ABC.

Salt Watch

The Waterwatch program conducts Saltwatch each year in May. If you would like to measure the salinity at your local waterway, or would like a copy of the Saltwatch data contact your Regional Coordinator.

WATERWATCH Murray
Communities Caring for Catchments

Salinity Photos

Farming Land A

Farming Land B

Farming Land A
Shallow-rooted annual crops, shown on this farming land use a little of the rain that falls on the ground. Excess water moves down into the soil to recharge the groundwater table.

- What are the long-term impacts of the groundwater table receiving increased recharge?
- When was land first cleared in your area?
- What percentage of land is used for pastures and crops? Compare this to the amount of land under native scrub.

Irrigated viticulture adjacent to remnant scrub, near Loxton North. Until 2001 water was pumped here through open channels, but these have now been converted to pipes.

- What are the advantages (for farmers and the environment), of using pipes instead of open channels?
- Why are farmers leaving more native vegetation around their crops?

Salinity Photos

Photos: R.Humphries

Noora Basin

Photo: R.Humphries

Noora Basin

Noora Basin
Samphire is a very salt tolerant plant, often found on floodplains and saltpans.

- Research how salt tolerant plants adapt to saline conditions.
- Explain the cracked soil surface.

Noora Basin
This is an evaporation basin where irrigation drainage is pumped. The land was originally used for dryland farming but, because it is a low lying area, the soil became very saline. It became an evaporation basin for Loxton irrigation drainage 30 years ago. There are plans to pump irrigation drainage from other areas around the Murray to this basin or the Stockyard Plains basin near Waikerie.

- Find the Noora and Stockyard Plains basin on a map and calculate their area.
- Contact the local council or interview an older relative to find out more about the history of Noora.

Salinity Photos

Thiele Flat

Rising Salt Damp

Dead trees on the Thiele Flat floodplain. There has been no water on the floodplain for approximately 10 years.

- Explain why these trees have died.
- Research the changes to water flow in the River Murray over the last 100 years.

Rising Salt Damp
This property is in a low lying area between irrigated properties.

- Walk through your local town and record and evidence of rising salt on buildings, roads and vegetation.

Salinity Photos

Caisson - Puddletown

Sump - Puddletown

Puddletown Caisson
Irrigation drainage is pumped here from neighbouring properties. From here it is pumped to an Evaporation Basin away from the River, where the water evaporates and leaves the salt behind.

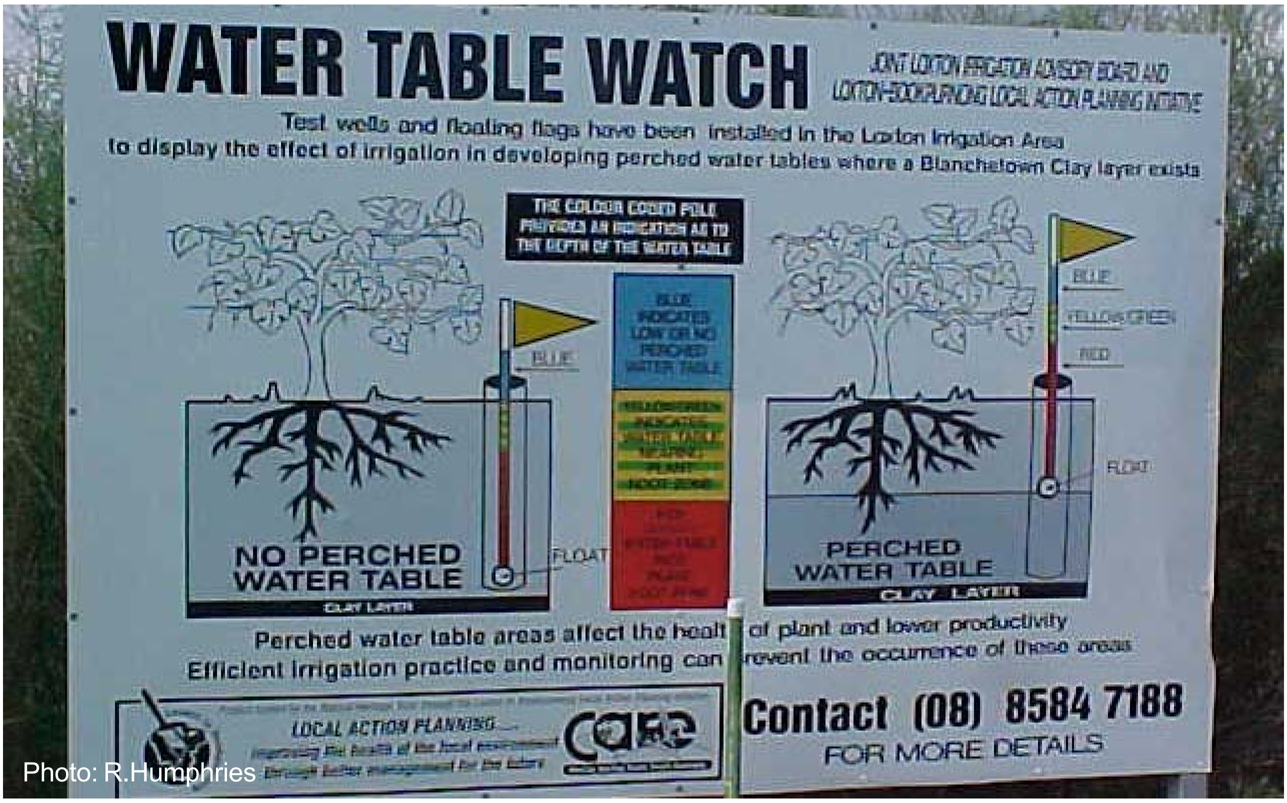
- Why do you think the volume of drainage is steadily decreasing?
- What kind of problems do you think might be associated with these drainage outfalls?

Puddletown Sump
Irrigation drainage from the Barmera area is pumped to the caisson at Puddletown.

- Explain the salt crusting on the ground around the sump.
- Explore your local area and locate sumps and drainage outfalls.

Salinity Photos

Irrigation Drainage



Water Table Watch

Irrigation drainage
Water from the caisson seeps into the ponds, as they are low lying. There are many reeds and sedges growing around the ponds.

- Find out what a caisson is and what they are used for.
- Explore topographical maps of the local area and identify creeks, swamps and salt plains.

Water Table Watch

- Explain how the floating flags work.
- Locate floating flags in your area.
- Ring your Local Action Planning group for more information about the Water Table Watch program.