Resources for Unit:

8.2 WATER FOR LIVING.

Stage 6 Senior Science,

Preliminary Course.

(#)\* - refers to lesson number in unit plan outline. The following are either worksheets/notes to be directly printed for students or are pages with notes and resources for suggested teacher use.

Being an electronic resources enables addition of information where-ever one may find something relevant to add. Feel free to adjust the file as you see fit to meet the needs of your particular students.

(21) Algal Blooms

Most algae are safe and are a natural part of aquatic ecosystems. However, some algae can produce toxins that can be damaging to humans, domestic animals and livestock that drink or come in contact with the water, as well as to organisms living in water. These **algae can be found in freshwater as well as brackish and marine waters.**

Blue-green algae (also known as cyanobacteria) are the only group of algae to be toxic in freshwaters. Though microscopic, when **the algae form colonies and accumulate together (Bloom)** they can become visible to the naked eye. Blue–green algae **can produce potent liver and neurotoxins as well as skin irritants**. However, not all blue–green algae are toxic, and even toxic species do not always produce toxins.

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| **A range of different conditions can lead to freshwater or marine algal blooms**.**Freshwater algal blooms-**Freshwater algal blooms occur when there is a combination of suitable environmental conditions including: * **Nutrients-**eutrophication (nutrient enrichment, mostly N and P) encourages growth.

 -Runoff and erosion from fertilised agricultural areas and sewage  Effluent - -blooms can occur at low nutrient levels but not as commonly* **Temperature-**around 25° C optimal

 * **Light-**optimal growth when intermittently exposed to high light intensities.

 -ability to adapt to variable light conditions gives blue–green algae a competitive advantage over other algal species. * **Turbidity-**Turbidity, or muddiness of water, is caused by the presence of suspended sediments and organic matter in the water column. When turbidity is low, more light can penetrate through the water column, creating optimal growth conditions.
* **Stable Conditions-**prefer stable water conditions with low flows, long retention times, light winds and minimal turbulence.

**Marine algal blooms** Marine algal blooms are a common natural phenomena along the NSW east coast and can result from upwelling of colder nutrient rich water. Although the distribution of marine and estuarine algae is uncertain in Australia , the number and intensity of marine algal blooms is believed to be increasing world–wide due to: * Expansion of aquaculture in coastal areas
* Coastal eutrophication and unusual climatic conditions

**(21) ALGAL BLOOM IMPACTS** Harmful algal blooms are common seasonal events occurring throughout Queensland in both fresh and coastal marine waters. Blooms caused by organisms including cyanobacteria, diatoms and dinoflagellates may pose a direct threat to human and animal health, and can have:* economic impacts (e.g. significant increase in the cost of treating the water supply; need to use alternate supplies)
* social impacts (e.g. disruption of recreational use of the waterway)

 Marine blooms may threaten fish resources, human health, ecosystem function and recreational amenity of beaches and bays.  Similar to freshwater blue–green algae, some estuarine and marine algal species produce irritants that can cause respiratory irritation and severe contact dermatitis. The major route for human exposure is through consumption of seafood and shellfish as some species produce potent toxins that can be accumulated in fish and shellfish.  Even low densities of toxic algae may be sufficient to cause illness or death in humans, while some species can selectively kill fish by inhibiting their respiration.  Not all potentially toxic algal species are toxic in every situation. |
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| [For this lesson, use overhead to read as a class and discuss, then provide questions on the board for them to write their notes from.]

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**(22) Algal Blooms handy web sites:**

<http://www.water.nsw.gov.au/Water-management/Water-quality/Algal-information/Algal-information/default.aspx>

<http://www.clw.csiro.au/issues/water/rivers_estuaries/algal.html>

<http://www.science.org.au/nova/017/017key.htm>

<http://www.abc.net.au/news/stories/2009/03/28/2528633.htm>

<http://www.derm.qld.gov.au/water/blue_green/index.html>

**(24 + 25) Alternative to chemical use in Agriculture**

*Information sourced from*: http://wps.prenhall.com/wps/media/objects/1027/1052055/Regional\_Updates/update30.htm

Pesticides, herbicides, and fungicides are used to kill pests and control the growth of weeds can enter and contaminate water through direct application, runoff, wind transport, and atmospheric deposition. To reduce water contamination, methods such as Integrated Pest Management (IPM) techniques, based on the specific soils, climate, pest history, and crop for a particular field. IPM helps limit pesticide use and manages necessary applications to minimize pesticide movement from the field.

 There are numerous initiatives underway to reduce agricultural chemical impacts on water resources.

**1. Improved understanding of and data on agricultural impacts on water resources** data are critical to decision-makers in identifying the agricultural chemicals and geographic/geologic areas of greatest concern and risk. Information will assist in development of the most beneficial and cost-effective approaches to preventing water pollution while maintaining agricultural productivity.

**2. Improved utilization and management of fertilizers and nutrient-rich wastes.**

Chemical analyses to determine nutrient needs of soils are routine and relatively inexpensive. Coupling these analyses with more precise fertilizer applications will reduce both agricultural costs and runoff of excess nutrients that result in water pollution.

**3. Increased utilization of integrated pest management.**

[Integrated pest management](http://www.csrees.usda.gov/) minimizes the use of pesticides in agricultural production. If widely implemented, these practices would substantially reduce water pollution by toxic agricultural pesticides.

**5. Increased utilization of organic farming techniques:**

[Organic farming practices](http://www.csrees.usda.gov/ProgView.cfm?prnum=1550) could substantially reduce agricultural impacts on water quality. These practices produce food and fiber without utilization of anthropogenic chemical pesticides and fertilizers. Instead, organic farmers rely upon natural methods of pest control and maintenance of soil fertility.

**(24 + 25) Technology Reducing Water Pollution**

*Interesting sites*

<http://english.peopledaily.com.cn/200305/03/eng20030503_116204.shtml>

<http://www.steripen.com/proven-technology>

http://green.tmcnet.com/topics/green/articles/52594-ibms-silicon-chip-material-science-treat-water.htm

Good starting point, ideas about technology types:

http://www.pollutionissues.com/Te-Un/Technology-Pollution-Prevention.html

**Students are to answer the following questions using the internet as a resource:**

Reducing water pollution:

Identify an example of technology being used and developed to reduce water pollution.

 How does it work?

 Are there any effects or by products related to this technology?

 What are the long term effects of this technologies use?

Purifying and Treating Water Pollution:

Name a technology currently being used to treat water

Is it still being developed?

Briefly, how does it work?

Does it have any negative impacts?

(26) Water use experiment outline

Aim: to determine the amount of water **used** per household for water used per shower

Hypothesis:

Equipment: Bucket, stopwatch

Method:

1. Before taking your shower, place a bucket below the shower head and run the shower at the pressure you would normally shower under for 1minute.
2. Place the bucket aside and then using a stop watch time how long you spend having a regular shower.
3. When you get out record the time you spent showering and measure the contents of the bucket you filled earlier.
4. Ask your family to record the time they spend showering also.
5. In class fill out the worksheet to complete the experiment.

Pre-questions:

How much water do you think you will use?

How much do you think your household will use?

Results:

How much water fell in the bucket in the 1minute time period?

How long did you shower for?

What was the total time spent in the shower for your family?

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| Family member | Time(min) |
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Below, multiply the litres of water measured from bucket by the total minutes spent in the shower

Lts X time = total water used to shower per day in your household.

Total time =

Conclusion:

Some questions to answer:

Was this experiment valid? Why?

Are results reliable?

Would results be the same for all households?

What may account for differences between your results and your peers results?

How might you be able to reduce the amount of water your family uses?

*Household total water consumption calculator:*

http://www.csgnetwork.com/waterusagecalc.html

**(27) Indicator Organisms**

*Information sourced from:*

<http://www.wqra.com.au/crc_archive/consumers/Consumersp12.htm>

<http://www.muhlenberg.edu/pdf/main/aboutus/graver/outreach/slide_outline_a.pdf> (see attached pdf in resources folder for full pdf)

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| Indicator organisms |
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| **Non-pathogenic microorganisms which point to the presence of pathogens.** |

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One method of measuring microbiological water quality is to monitor for organisms that might indicate that the water is contaminated with faecal material or that disinfection is inadequate. These organisms are referred to as indicator organisms. They are not harmful to health but their presence indicates that other faecal organisms (including harmful pathogens) may also be present in water.

Members of the coliform group of bacteria are used as indicators of water quality. This group contains many species of bacteria that grow in the environment, but a sub-group of coliform bacteria, called thermotolerant coliforms (coliforms preferring warmer temperatures), are found predominantly in the intestine and faeces of humans and other warm-blooded animals.

One member of the thermotolerant coliform group, *Escherichia coli* (often referred to as *E. coli* ) is recognised as the most specific indicator of recent faecal contamination in water supplies. This organism is now the preferred indicator for assessing the microbiological quality and safety of drinking water.

Safe water:

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| If lots of organisms that are intolerant of low oxygen levels are found living in the stream then the water quality is assumed to be good. If only the only organisms that can be found are those that tolerate low levels of dissolved oxygen, then the water can be considered poor quality and possibly polluted. Pollution intolerent reflect safe water:

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| These organisms need high levels of DO and are sensitive to chemicals and fertilizers. The quality of water needed for these organisms is very high. Examples: Dobsonfly Larva, Stonefly Nymph and Water Pennies  |

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# Pollution- Tolerant

Organisms can survive low DO, high nutrient levels, sewage and sedimentation. Most of these organisms are bottom feeders and actually eat the organic material that may be clogging the streams. Examples: Nematodes, Aquatic Earthworm and Rat-tailed Maggot



**(28) Newcastle Catchment.**

*Use the following data and website to hand out to students to extract relevant info*

**HUNTER WATER BOARD:**

**http://www.hunterwater.com.au/1247.aspx**

**Catchment**

A catchment is an area of land that collects water which has drained to the lowest point in that area. This could be a lake, a dam, or underground reservoir. Rain that falls on land will make its way to this lowest point, through creeks, rivers, stormwater systems, groundwater, wastewater and water-related infrastructure. As water cycles through a catchment, its condition is affected by the:

* surfaces with which it comes into contact
* degree to which the area has been changed by human activity such as land clearing, farming, urban development, etc.

Keeping catchments clean is an essential first step in maintaining water quality. As we all live in a catchment, this is an area where we can all co-operate to protect water quality.

We have three main catchments in the Hunter Water system:

* Grahamstown Dam Catchment
* Chichester Catchment
* Tomago and Anna Bay Sandbeds Catchment

**Grahamstown Dam Catchment**

Grahamstown Dam is the lower Hunter region’s major urban water supply dam – supplying 30-45% of our water. The catchment is nearly 100 square kilometres and is located in the Williams River area between Seaham and Raymond Terrace. Grahamstown Dam itself is located relatively close to the river at Raymond Terrace.

There are many different activities and land uses in the Grahamstown Dam catchment – including agriculture, residential and urban developments, tourism and recreation.

Hunter Water routinely monitors water quality in the lower Williams River for nutrients and pathogen quality before any transfer to Grahamstown Dam. Like most Australian rivers, the Williams is highly influenced by climatic conditions and is consequently highly variable in its amount of daily river flow.

**Chichester Catchment**

The Chichester catchment is around 197 square kilometres and supplies about 40% of the lower Hunter’s drinking water. It is bound on the north and east by the Great Dividing Range, which separates it from the Gloucester, Barrington and Manning Rivers.

The catchment for Chichester Dam is largely incorporated into the Barrington Tops National Park and is a declared wilderness area. As a result, it is one of the most pristine catchments in Australia with large areas unaffected by human activity. The extensive virgin forests and the high ranges at the head of the rivers ensure a large rainfall and minimum evaporation, resulting in a high runoff with good water quality. The catchment receives water from the Chichester and Wangat Rivers.

Because Hunter Water extracts water under the Water Act of 1912 we must meet strict conditions outlined in the Water Management Licence, which came into effect in 1998. Therefore, we have increased environmental flow releases from Chichester Dam into the Williams River to manage and minimise environmental impacts. These flows help sustain natural ecosystems along the Chichester River.

**Tomago Sandbeds Catchment**

Groundwater reserves also form an integral part of Hunter Water’s bulk water supply, augmenting surface sources as required and providing critical backup during periods of drought. The Tomago Sandbeds are a major source and the sole supply to Tilligerry Peninsula.

The Anna Bay Sandbeds supply the Tomaree Peninsula, which is also augmented from Grahamstown Dam, while the North Stockton Sandbeds act as a potential drought reserve.

The Tomago-Tomaree-Stockton aquifers cover an area of 275 square kilometres, along a coastal strip some 10 to 15 kilometres wide, extending from the Hunter estuary (in the south) to Port Stephens (in the north) and Raymond Terrace (in the west). Most of the aquifer area has porous sandy soils lying over porous sand. This allows rain to percolate down to the aquifer quickly and hence, there is very little surface run-off and little defined drainage pattern, except in areas of bedrock.

Tilligerry Creek is the most prominent surface drainage feature. Fields of complex dunes contribute to the characteristic hilly dune terrain. The porosity of the sand allows for considerable groundwater storage and direct rainfall is the major method of recharge, or filling, of the groundwater reserves. The groundwater is then either used by vegetation, is extracted for human use or drains to low lying parts of the land surface (such as wetlands) or to the ocean and local estuaries.

 

**(29 + 30) Indicator Organisms and Water Purity**

**Hunter water board: http://www.hunterwater.com.au/1247.aspx**

 **Catchment management**

The following covers possible contamination risks from a real case
The land in the groundwater catchments is used for a wide variety of purposes, including:

* Residential
* Industry
* Manufacturing
* Construction
* Transport (road and air)
* Agriculture (dairying, animal grazing, poultry, vegetable growing)
* Mining
* Utilities
* National park and nature reserves
* Defence force activities
* Recreational sites
* Viticulture.

There are two important issues that can potentially affect groundwater quality within the aquifer system:

* The presence of many domestic septic tanks scattered across the area
* The past history of sand mining in the catchment.

Therefore, careful management of the catchment area is needed to protect the water supply system in conjunction with the other land use functions as well as protect the interests of adjoining land holders. For example, the impact of heavy mineral sandmining on sections of the sandbeds between 1972 and 1999 led Hunter Water to cease water extraction from these zones.

Catchment management practices at Tomago include monitoring water levels using an extensive network of water level monitoring piezometers to ensure that water is extracted on a sustainable basis. Special attention is given to ensuring that water levels remain high enough at all times to prevent the drawing in of salt water from the periphery of the system. Other catchment management practices at Tomago include feral animal and weed control and bushfire management.

The Department of Water and Energy (DWE) regulates water extraction from Tomago by way of a Water Management Licence with Hunter Water Corporation. Port Stephens Council, in conjunction with Hunter Water and DWE, regulates development in the area, and there are special development controls in place within the Tomago catchment area.

Some parts of the groundwater catchments are declared Water Reserves under the Crown Lands Act, 1989 and Hunter Water is the nominated Trustee of these reserves.
A National Park was gazetted over the Anna Bay Sandbeds in 1996, further protecting water quality of the area. A Water Sharing Plan developed for the Tomago/Tomaree/Stockton Ground Water Sources was implemented on 1 July 2004.

**(31) What happens to our local waters?**

**Water Disasters!**

Hunter Water: <http://www.hunterwater.com.au/1247.aspx>

Newcastle council: <http://www.newcastle.nsw.gov.au/environment/climate_cam/climatecam/water>

Water Pollution Disasters:

Alamosa River, **Spanish waste water spill,**

**(32) Water Quality and Impacts**

http://www.crcwater.org/wqmanual.html

## Description of Water Quality Parameters

### pH Parameter

pH, or the "potential of hydrogen", is a measure of the concentration of hydrogen ions in the water. This measurement indicates the acidity or alkalinity of the water. On the pH scale of 0-14, a reading of 7 is considered to be "neutral". Readings below 7 indicate acidic conditions, while readings above 7 indicate the water is alkaline, or basic. Naturally occurring fresh waters have a pH range between 6 and 8. The pH of the water is important because it affects the solubility and availability of nutrients, and how they can be utilized by aquatic organisms.

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### Dissolved Oxygen Parameter

Dissolved oxygen is the amount of oxygen dissolved in water, measured in milligrams per liter (mg/L). This component in water is critical to the survival of various aquatic life in streams, such as fish. The ability of water to hold oxygen in solution is inversely proportional to the temperature of the water. For example, the cooler the water temperature, the more dissolved oxygen it can hold.

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### Biological Oxygen Demand (BOD) Parameter

Biological Oxygen Demand is a measure of how much oxygen is used by microorganisms in the aerobic oxidation, or breakdown of organic matter in the streams. Usually, the higher the amount of organic material found in the stream, the more oxygen is used for aerobic oxidation. This depletes the amount of dissolved oxygen available to other aquatic life. This measurement is obtained over a period of five days, and is expressed in mg/L.

### Temperature Parameter

Temperature is a measure of how cool or how warm the water is, expressed in degrees Celsius (C). Temperature is a critical water quality parameter, since it directly influences the amount of dissolved oxygen that is available to aquatic organisms. Water temperature that exceeds 18 degrees Celsius (for Class A Waters) has a deleterious effect on several fish species in streams. Salmonids, for example, prefer waters of approximately 12 to 14 degrees Celsius

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### Conductivity Parameter

Conductivity is the ability of the water to conduct an electrical current, and is an indirect measure of the ion concentration. The more ions present, the more electricity can be conducted by the water. This measurement is expressed in microsiemens per centimeter (uS/cm) at 25 degrees Celsius.

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### Total Dissolved Solids (TDS) Parameter

Total dissolved solids is a measure of the amount of particulate solids that are in solution. This is an indicator of nonpoint source pollution problems associated with various land use practices. The TDS measurement should be obtained with the conductivity meter and is expressed in (mg/L).

### Turbidity Parameter

Turbidity is a measure of the clarity of the water. It is the amount of solids suspended in the water. It can be in the form of minerals or organic matter. It is a measure of the light scattering properties of water, thus an increase in the amount of suspended solid particles in the water may be visually described as cloudiness or muddiness. Turbidity is measured in Nephelometric Turbidity Units (NTU).

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### Streamflow/Discharge Parameter

The streamflow, or discharge, is the volume of water passing a single point in the stream over time. It is measured by determining the cross-sectional area and velocity (speed and direction) of the flowing water. The measurement is usually expressed in cubic feet per second (cfs).

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### Fecal Coliform Bacteria Parameter

Fecal coliform bacteria are microscopic organisms that live in the intestines of all warm blooded animals, and in animal wastes or feces eliminated from the intestinal tract. Fecal coliform bacteria may indicate the presence of disease carrying organisms which live in the same environment as the fecal coliform bacteria. The measurement is expressed as the number of organisms per 100 mL sample of water (#/100mL).

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## Analytical Procedures

All trained volunteers who will be involved in monitoring water quality and quantity parameters on the subject waterbody and its tributaries should follow specific procedures and protocols for the collecting and processing the data.

The volunteers should monitor all water quality and quantity parameters at all stations once every two weeks, or twice a month. All parameters should be sampled on the same day. The water quality parameters that should be monitored, field tested, and recorded on the data sheets include pH, temperature, dissolved oxygen, conductivity, and total dissolved solids (Data Sheet I, Appendix). All parameters should be tested on the same day with the potential exception of turbidity and fecal coliform samples. While the fecal coliform samples must be delivered to the lab, on the same day, the turbidity samples may be refrigerated at the office overnight, and may be tested the next day at the office. The biological oxygen demand results should be recorded after five days of testing.

### Turbidity

Turbidity samples should be tested in the office, and results recorded on data sheets. The turbidity samples should be tested at the office at the end of the day, or within 30 hours from the time they were collected. If they are left overnight, they should be stored in a refrigerator at the office. If the turbidity samples are taken to a laboratory, they must be tested within 30 hours from the time they were collected in the field.

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### Fecal Coliform

Fecal coliform bacteria samples should be collected by the volunteers and brought to a certified laboratory. The fecal coliform samples need to arrive at the laboratory by the end of the sampling day unless other arrangements have been made. However, the fecal coliform samples will need to be tested within 30 hours from the time the first sample in the field was taken. All attempts should be made to get the samples to the lab on time. The lab should be called a day ahead of the actual sampling day, and also on the day of sampling, to remind the laboratory when samples will be brought to them to be tested.

### Streamflow

Stream flow should be measured in the field and discharge results compiled in the office (Data Sheet II, Appendix). Data gathered should be compiled into a spreadsheet and analyzed by the project leader, the Washington Department of Ecolog. Stream flow measurements should be taken at specific locations at the same time the other water quality parameters are sampled. Stream flows should be measured at the following locations:

* Your monitoring stations should be identified here

Stream gages may be needed installed . The stream gages should provide the stream height of the water and can be used in concert with the stream discharge data.

Volunteers should work as a two-person crew while conducting all the necessary water quality monitoring in the field. The crew may decide to determine who is responsible for taking various measurements. For example, while one volunteer is obtaining the pH and temperature readings, the other volunteer may wish to conduct the conductivity and TDS sampling and testing. This may be beneficial due to time constraints in the field. However, streamflow measurements will require that both volunteers work together.

The day of the week that the sampling will occur may be decided by the project leader and the volunteer crew. Once a day is chosen, the sampling must be conducted on the same day of the week each time.

**(33 + 34) Topic Revision (3%)**

The following revision questions are to be completed in the class room and finished off at home if needed. They are designed to take students back to their own class work and learned knowledge of the topic. They are also an opportunity for students to check they are up to date with all work and to ask the teacher to go over anything they are unclear of. The completion of the revision sheet is worth marks towards their assessment of learning, both to motivate students and to have them recognise the importance of being able to use their notes as a valuable learning and revision tool.

Marking of Revision:

 The sheets will be student marked as we go through them in class so that they are able to be added in red pen if the student wishes. These will be collected and revised by the teacher. The scheme is focussed on the student using the revision as a tool not a test.

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| **Description** | **Mark for Question** |
| **No attempt at answering** | **0** |
| **Very brief answer, pretty well correct** | **1** |
| **Full answer** | **3** |

**(35)Topic test**

This is designed to be completed in a single period of school. The questions come almost directly from the syllabus which also is the way tittles of lessons will have been given to students in class. The marking rubric is given next to each question and suggests along with the HSC Verbs, the standard of answer required.

**(33) Topic Revision**

Why did we need to understand solutes and solvents and how are they related to the amount of water found in different living things?

What is one way a plant may minimise water loss?

How did you determine the amount of water present in fruit and veg? What were your findings?

What are some different types of surface and ground waters? Explain how they are different from each other.

In Australia why do we use herbicides, pesticides and fertilizers?

What impact on water do household wastes have?

What are algal blooms? How do they occur?

How might we reduce water pollution?

What indicator organisms did we discover in the water sample we tested and who did we know they were there?

Name a technology being used to reduce water pollution or to treat and purify water.

**(35) Single Period Topic Test (12%)**

**1. If you dissolve a teaspoon of salt into a litre of water, what is the term given to describe the: (1mark)**

Dissolving Salt

Water

**2. Describe the importance of water as a solvent in the: (3marks)**

 – bloodstream

 – cells

 – transpiration stream

**3.Give one example each of how a plant and an animal may reduce water loss (3marks)**

Plant:

Animal:

**4. Name 2 types of water from the hydrological cycle and outline what they are (4marks)**

**5.(6marks)**

**a Define:**

Herbicide-

Pesticide-

Fertiliser-

**b.** Why are each used in Australia?

**c**. How might they be carried into our waterways?

**6. What are the causes of Algal blooms and what impact can they have in waterways? (5marks)**

**7. (5marks)**

**a. what is an indicator organism how can we use them in testing water quality?**

**b. give an example of an organism that would be present in safe waters**

**c. give an example of an indicator organism that would be present in polluted waters**

**Continued on next page.**

**8. Explain how water quality in one area can impact on the water quality in other areas? Include in your answer an example of a type of pollution, how it gets into the water system and a possible solution to purifying or treating the water of the system. (8marks)**