CASE STUDY: ROCKY CREEK DAM

The Catchment Area

The Rocky Creek Dam catchment area is a 29 km^2 area once used for logging but is now a pristine catchment environment for the North Coast of New South Wales.
The dam itself covers around two square kilometres (478 acres) and can hold about 14,000 mega litres of water when at 100% capacity.
The dam wall is 27 metres high and is made up of about 80,000 tonnes of rock, soil, clay and concrete.
The dam wall was built in 1949 and Bangalow became the first to begin receiving water from Rocky Creek Dam in 1953.

Contamination in the Catchment

As no agricultural farms or properties exist inside the catchment area, Rocky Creek Dam is one of the most pristine catchments in the entire country.
However, there are still a number of possible contaminants in the area, mainly due to the natural flora and fauna.
Organic runoff from birds and other warm blooded animals can introduce unwanted nutrients into the water, which can cause algal blooms. Also, the soil in the catchment area is a red clay substance, and contains iron, meaning contamination in regards to iron, must be considered.
Also, whilst scarcely used, there are a number of roads in the catchment area due to the old logging days. Runoff from cars and the activities of loggers would also have an impact on the health of the ecosystem.

Purification of Water

Rocky Creek Dam water is treated at the Nightcap Water Treatment Plant, where a number of problem substances are dealt with.
The Nightcap Water Treatment Plant uses a process known as the DAFF process (Dissolved Air, Floatation & Flocculation).
The water is firstly pumped out of Rocky Creek Dam and transported to the Nightcap Water Treatment Plant where it will be treated.
The process begins with the addition of three additives; Alum (Aluminium Sulfate – Al_2SO_4), Lime (Calcium Carbonate – $CaCO_3$) and a long chained chemical known as a poly-electrolyte. These additives are added in the flash mixer.
The addition of the alum and poly-electrolyte allow suspended solids to coagulate so they can be easily removed whilst the lime increases the pH (decreases the acidity) of the water to an ideal level of 6.1 to assist with this process.
This clumping together of solids is called flocculation and can be seen in diagram 3 as the water is mixed with huge stirrers.

Diagram 3 – The Flash Mixer

The water is then passed into the saturation tank where millions of micro-bubbles are passed through it. It then moves on to the floatation and filtration tank where these micro-bubbles attach themselves to the clumped solids and float them to the surface. These solids form a floating sludge which can be skimmed off (see diagram 4).
The clean water underneath the sludge is passed through a bed of fine sand so any remaining solids are filtered out.
The dirt and clumped solids is pumped off site and the remaining water contained in the sludge is allowed to evaporate. The sludge can then be used for topsoil.

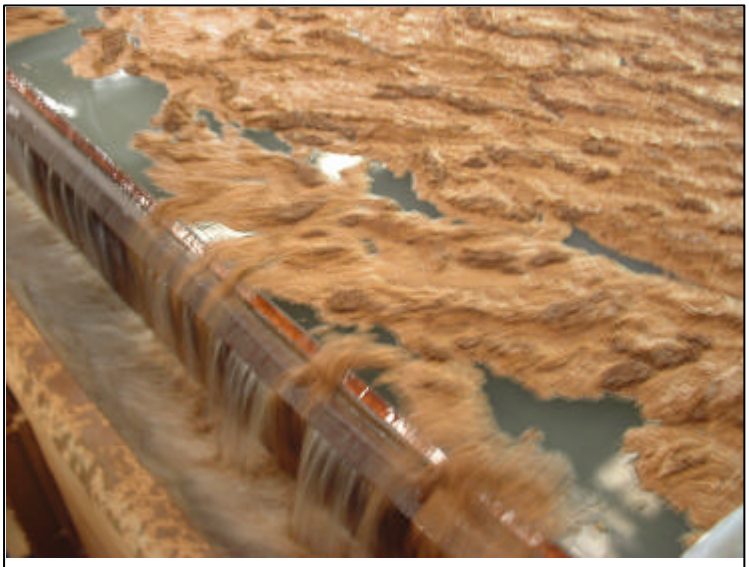

Diagram 4 – The Floating Sludge being filtered off

Following this, more lime is added to increase the pH to between 7.5 and 8.5 so that it meeds drinkable standards. This also increases the hardness of the water. Liquid carbon dioxide is also used for pH correction.
Following this process, chlorine, hypochlorous acid and ammonia are added as disinfectants to kill any remaining pathogens. This water is then transported to a 13 mega litre reservoir where it can be distributed to various towns.

Chemical Additives

As mentioned above, there are a number of chemical additives included in the treatment process. These include aluminium sulfate (Al_2SO_4) and a poly electrolyte, which are added as coagulants that allow the suspended solids to clump together.
Calcium carbonate ($CaCO_3$) is added to control the pH of the water during flocculation and increase the alkalinity (buffering capacity) of the water. Liquid carbon dioxide is also used to help regulate the pH.
Chlorine, Hypochlorous acid and Ammonia are added to kill pathogens during the disinfection process.

Diagram 5 – Liquid CO_2

Chemical Tests Used to Identify Contaminants

There are a number of methods used to identify various forms of contaminants and determine the levels of these contaminants.
Turbidity is one of the properties of the water that needs to be monitored. Turbidity is a measure of the suspended solids in a solution and is measured in NTU (Nephelometric Turbidity Units).
Total Dissolved Solids (TDS) are also measured using either evaporation or conductivity measurements. They are expressed as a mass per unit volume.
Salinity is also measured used electrical conductivity tests as salts are ionic compounds which will conduct electricity when in solution.
The hardness of water can be measured by determining the total concentration of calcium and magnesium ions in the water and they are expressed as a result of milligrams of $CaCO_3$ per litre.
Phosphate is tested for using colour spectroscopy, whilst nitrates, nitrites and ammonia are tested for using the discrete analyser or a flame spectrophotometer.

Chemical Tests for Heavy Metals

Atomic Absorption Spectroscopy (AAS) is used to determine the presence and concentration of various heavy metals in the water including lead, iron, silver, copper and cadmium.
At Rocky Creek Dam, the biggest problem with heavy metal concentrations is iron due to the nature of the soils as mentioned previously.
Also, the graphite furnace can be used to give more accurate concentrations of the presence of mercury, lead and arsenic.

Monitoring Possible Eutrophication

Many of the tests mentioned above will test for the presence of substances that could indicate eutrophication. The key is to monitor any sudden changes in concentrations that could lead to possible algal blooms.
This includes monitoring the levels of nitrates and phosphates using a discrete analyser. Also being able to recognise algal blooms if it does occur.
Water samples are also tested by being kept in an incubator and then viewed under a binocular light microscope to determine whether dangerous bacteria such as giardia are present.

Dot Points Covered:

Gather, process and present information on the features of the local town water supply in terms of:

- *Catchment area*
- *Possible sources of contamination in the catchment*
- *Chemical tests available to determine levels and types of contaminants*
- *Physical and chemical processes used to purify water*
- *Chemical additives in the water and the reasons for the presence of these additives*

Gather, process and present information on the range and chemistry of the tests used to:

- *Identify heavy metal pollution of water*
- *Monitor possible eutrophication of waterways*