Stage 6 Chemistry - Separation techniques and chemical monitoring

Wastewater Depth Study Program

Sydney WATER

Depth Study inquiry question - "How does the application of chemistry (separation techniques and chemical monitoring) in an industrial setting (Sydney Water) help treat wastewater to protect the environment?

Sydney Water Depth Study program is designed to complement our free excursion program. Our excursion program includes:

- full syllabus links (reference to module content points, working scientifically outcomes and skills, ideas for practical first-hand investigations, secondary sources investigations, creating fieldwork report/presentation and data analysis)
- (Optional) Delivery of an excursion by a Sydney Water Education Officer.
- Sydney Water website links to content pages, experiments and resources (PowerPoint presentations, animations and videos).

Duration:
4 – 8 hours

Suggested Assessment:
1. Fieldwork Report
2. Presentation

Inquiry question: How do the properties of substances help us to classify and separate them?
Students:

- explore homogeneous mixtures and heterogeneous mixtures through practical investigations:
  – using separation techniques based on physical properties

Inquiry question: How are the ions present in the environment identified and measured?

- analyse the need for monitoring the environment

Sydney Water aim for activity

- Students will learn about the importance of separation techniques in our treatment of wastewater.
- Students will also investigate the need for monitoring water and the environment and how this knowledge is used to make reliable predictions to treat wastewater and biosolids.
- Our excursion is the starting point for Wastewater Depth Study, looking at how various chemical theories are applied in an industrial/ real-life setting to protect the environment.

Syllabus knowledge and understanding outcomes
Module 1: Properties of Matter and/or Module 8: Applying Chemical Idea
CH 11-8 explores the properties and trends in the physical, structural and chemical aspects of matter
CH12-15 describes and evaluates chemical systems used to design and analyse chemical processes analyse the need for monitoring the environment

Working scientifically outcomes
Planning CH11/12-2 Designs and evaluates investigations in order to obtain primary and secondary data and information

- assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation.

Analysis and problem solving CH11/12-5 Analyses and evaluates primary and secondary data and information

- assess relevance and reliability of the gathered information
- collate useful and relevant information into water filtration process that relates to acid/base and their uses and applications
- evaluate the effect of buffers in natural systems.

Communicating CH11/12-7 Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

- propose ideas in a coherent and logical way and correctly use scientific terminology and principles
- present information on the science and chemistry of acid/base reactions and buffers
- summarise from a range of sources and appropriately acknowledge sources.

Conducting investigations CH11/12-3 (Optional) Conducts investigation to collect valid and reliable primary and secondary data and information

- employ and evaluate safe work practices and manage risks
- use appropriate technologies to ensure and evaluate accuracy
- select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style.

Teaching learning and assessment	Resources
Lesson 1 – Introduction This Depth Study program plan applies some content from Module 1/8 relating to Properties of Matter (separation techniques) and apply chemical ideas in (environmental monitoring). The resources for this study are found on our HSC Chemistry webpage. 1. Explain details of the task **Q.** Why is a first-hand investigation important? **A.** Because it allows you to develop the following skills: - fieldwork observations - applying theory to real life - replicating practical activities. 2. Explain Sydney Water's role and responsibility in water management. See our Education webpages for more information. - Who is Sydney Water and what do they do? See our About us webpage for more information. - Where does my water come from, where does it go? See our Water network and Wastewater network webpages for more information.  2. Excursion preparation. **Q.** What will we be doing during the excursion? **A.** See the High school webpage for more information. **Q.** Where can I find more information about the excursion site? **A.** See our Penrith Water Recycling Plant webpage for more information. **Q**. What are the basic safety and risk assessments on industrial sites? **A.** This photo shows you how people dress and work in an industrial site. Various personal protective equipment (PPE) is used to minimise risks. Can you come up what risks this PPE is for? **Activity:** Students can create a risk assessment table according to the use of PPE. Hints and tips from HSC markers - First-hand investigations involve great opportunities to develop essential numeracy skills through practical measurement and the collection, representation and interpretation of data. - Fieldwork reports and engagement with community experts involve systematic scientific inquiry of real-life application promote students to achieve top marks in the HSC. Further investigations and extension options: • First-hand practical investigations at school	**Sydney Water resources** High school see HSC Chemistry *Wastewater audit lesson plan* *Make a simple filter experiment* *Keep wipes out of pipes experiment* Education About us Wastewater treatment Wastewater network *Wastewater treatment plant webpages* *EPA pollution data monitoring reports* Water recycling Environmental protection Community grants **Other resources** Water corporation – Water recycling around the world AWA – Water Recycling Fact Sheet

- Conduct experiments looking at wastewater treatment and separation techniques – sedimentation, coagulation, particle filtration, distillation and membrane filters such as syringe or straw filter are easily accessible. See our *Make a simple water filter* resource for more information. - Investigate optimal filter design or effect of wastewater quality by creating mock wastewater samples. - Investigate separation using chromatography such as paper chromatography of chlorophyll or even marker ink pigments. These are techniques we use in labs for environmental monitoring such as extracting and measuring concentrations of chlorophyll-a as an indicator of algal blooms. • Secondary sourced investigations (Research) - Comparison of the different wastewater treatment techniques and chemical monitoring at different plants and EPA requirements of each. See our Wastewater treatment plants webpage for more information. - Comparative study of water treatment and recycling in another country. See Water corporation – Water recycling around the world webpage for more information. • Communication surveys – What do people think about their wastewater and recycled water? - Do a wastewater audit in your home to identify your contribution. See our wastewater audit webpage for more information. - Investigate the perceptions and environmental impact of using recycled water and biosolid on the community. See the Australian Water Association (AWA) Water Recycling Fact Sheet for more information	
Lesson 2 – **Secondary research** **Q.** Have you thought about where your water comes from and where it goes? **A.** Probably not! Here in Sydney, we have some of the best drinking water in the world, it's clean, safe, reliable and affordable. But where does it come from and where does it go? **Activity**: Students can investigate our network using the Urban water cycle diagram on our Urban water management webpage. **Q.** How do you use your water? **A.** The average breakdown in Sydneysider is ~200L per day. See our Water use and conservation for more information. **Q.** Have you ever wondered what happens to water after you've used it? **A.** The water you used becomes wastewater which is 99% water. The remaining one per cent is made up of things you've added to water as you've used it. We take this wastewater and treat it to re-use as recycled water or discharge into the environment. See our Wastewater treatment webpage for more information. **Activity:** Look at the wastewater network map and see which plant your wastewater goes to. **Q.** What is in that one percent? How do you think we treat a mixture like wastewater to make recycled water? **A.** The remaining 1% is made up of things you've added to water as you've used it, such as toilet paper and human waste. To protect public health and environment, treated wastewater has been treated to separate and remove	**Sydney Water Resources** High school see HSC Chemistry Urban water management *Urban water cycle diagram* Water use & conservation Water recycling Glossary Wastewater network *Wastewater network map* Wastewater treatment Penrith Water Recycling Plant St Marys Advanced Water Recycling Plant Solids recycling

pollutants before being released into the environment or reused (recycled water). See our Wastewater Treatment webpage for more information. **Q.** How can we use our understanding of organic chemistry to help remove the waste from the wastewater? **A.** Based on physical and chemical properties of matter (heterogeneous mixture), we can apply various effective separation techniques to remove the waste. For example, sedimentation technique is used to separate waste with different density. **Q.** What do you think happens to all the waste removed from the wastewater? **A.** We recycle waste from wastewater to minimise the impact on the environment. Waste, minus litter such as plastics, can make a great fertiliser and even energy. See our Solids recycling webpage for more information. **Q.** After the water has been treated, how do we use the recycled water? **A.** Recycled water is an alternate source of water saving drinking water from being used. We can use it for purposes like irrigation, flushing toilets, washing cars and in manufacturing processes. Some other places use it as part of their drinking water supply such as Singapore and San Diego. **Did you know?** Another use of recycled water is for environmental flows, to keep creeks and rivers running as we extracted water from the dam which stores water in the catchment. Using high-quality recycled water, we can make a positive influence on the availability and water quality of the Hawkesbury Nepean-River downstream of Warragamba Dam. **Q.** What are Environmental Protection Licenses (EPL)? Why is it important to monitor and manage wastewater and recycled water quality? **A.** The NSW Environment Protection Authority (EPA) issues Environmental Protection Licences (EPLs) for all our wastewater systems. These licenses dictate the concentration limits of parameters such as nutrients, organic matter and other chemicals after wastewater has been treated. EPLs vary depending on the end-use of the treated wastewater. It ensures our operations minimise impacts on the environment and the community. **Optional activity** – Complete the *Wastewater audit* lesson. See our HSC Chemistry webpage for more information. **Extension** – Secondary investigation of Biosolids.	**Other Resources** PUB - Singapore's National Water Agency San Diego – Recycled Water
Lesson 3 – Field trip Students will visit a working water recycling plant to explore how we treat and manage wastewater for re-use to protect public health and the environment. Refer to our program outline on our Excursion request webpage for more information.	**Sydney Water resources** Excursion request High school see HSC Chemistry

Lesson 4 – Analysing Data and Information **Activity**: Students can use secondary sourced data (lessons 1-2) to compare with excursion observations. Students can also investigate the following sources of information and data. • What's in wastewater factsheet provide details about the composition of wastewater. See this factsheet for more information. • Penrith Water Recycling Plant webpage provides additional technical details for the excursion site. Students can identify the water separation techniques that relates to the properties of matters, and ways that re-using the water to protect the environment. • Sydney Water provide EPA pollution monitoring data reports for all our wastewater systems. These reports measure concentration limits of parameters such as nutrients, organic matter and other elements after wastewater has been treated. Students can assess the relevance and reliability of the gathered information. • EPA webpage also provide information on water pollution and quality. Students can assess the relevance and reliability of the gathered information. **Activity**: After students have gathered all the relevant data and information, they can analyse and create a scientific report or presentation. **Q.** What did we find out about the separation techniques and chemical monitoring? **A.** We saw that wastewater needed multiple stages of separation and treatment according to their physical/chemical properties to produce recycled water and biosolids. Wastewater also contained many dissolved ions such as chloride, barium, nitrate and phosphate which needed to be monitored before and after treatment, to ensure that we can produce reliable results within EPA guidelines protecting the environment. **Q.** Why was it valuable to learn about the greater context of wastewater treatment and see the plant? **A.** Water treatment processes shows the application of Chemistry in real-life and is essential to protect the environment.	Penrith Water Recycling Plant High school see HSC Chemistry *What's in wastewater factsheet* St Marys Advanced Water Recycling Plant Wastewater network *Wastewater treatment plant webpages* *EPA pollution data monitoring reports* Water analysis **Other resources** EPA Water WaterNSW Beachwatch Water Quality Australia Penrith Water Recycling Plant
Lesson 5 **Example: Depth Study – fieldwork report / presentation** A report may require students to: • describe the context of the site: - how wastewater is treated at Penrith Water Recycling Plant and re-used - why it is necessary to monitor and manage pollutant(s)? What could be the impact to the environment - what are some challenges in the industry (e.g. individuals behaviours that can have an adverse impact on wastewater quality, wastewater network and the environment) • describe and justify methods used during the investigation: - how valid, accurate and reliable the results are - what were some of the flaws and improvements. • assess risks, consider ethical issues and select appropriate materials and technologies when designing and	High school see HSC Chemistry **Other resources** NESA sample work for Chemistry NESA - The scientific research report

planning an investigation • process and analyse first-hand laboratory activities, fieldwork and secondary data: - how the theory fit the results observed on the day and record how they conducted and analysed their wastewater audit or separation activity. - what graphs can were compiled, for example, a pie chart for wastewater components or diagram and calculation for the separation techniques. • make recommendations on how to reduce impacts on our wastewater systems and waterways. • communicate the results and conclusions of the fieldwork, laboratory and research investigations.	
Conclusion **Evaluation questions** • How can chemistry be applied in the sustainable water management? • Why are working scientifically, collaboration and communication skills important? • Why do we have to continuously evaluate our scientific methods? • What could you do to help manage our water for the future? • How has your excursion experience helped you understand chemistry's real-world applications? **Reflection activity** - students finish these statements: 1. I used to think (at the start of these lessons) 2. but now I think (at the end of these lessons). **Practice questions -** practice some sample HSC questions using your Water Recycling Depth Study knowledge. See our HSC Chemistry webpage for links to questions. **Got students interested in a career with Sydney Water or research and development?** See our Sydney Water careers webpage for more information on working here. Find out about the latest research from Sydney Water on our Reports and publications webpage.	**Sydney Water resources** High school see HSC Chemistry Careers Reports & publications **Find out more** • sydneywater.com.au/education • facebook.com/SydneyWater • instagram.com/sydneywater • twitter.com/SydneyWaterNews