

## Stage 6 – HSC Earth and Environmental Science

Wastewater Depth Study Program



**Depth Study Inquiry Question** - “How does scientific knowledge in an industrial setting (Sydney Water) enable effective treatment of wastewater (sewage) to produce high quality recycled water and biosolids for re-use and to protect the environment?”

**Duration:**  
4 – 8 hours

Sydney Water Depth Study program is designed to complement our free excursion program. The depth study includes:

- full syllabus links (reference to module content points, working scientifically outcomes and skills, ideas for practical first-hand investigations, secondary sources investigations, sample assessment and data analysis ideas)
- (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).

**Suggested Assessment:**  
1. Fieldwork Report  
2. Presentation

### Syllabus content

**Inquiry question:** how can water be managed for use by humans and ecosystems?

- investigate the treatment and potential reuse of different types of water, including but not limited to sewage
- describe ways in which human activity can influence the availability and quality of water both directly (eg over-extraction) or indirectly (eg algal blooms)

**Inquiry question:** How is waste managed?

- outline the management options for different types of solid waste
- evaluate the sustainability of a named waste management option, for example:
  - environmental impact of waste disposal
  - demand for reused or recycled waste
  - energy used to produce and/or recycle the waste
- investigate human activities that affect sustainability, including but not limited to water pollution
- research and present information about a sustainability initiative in their community

### Sydney Water aim for activity

- Students will investigate the importance of wastewater treatment to produce high quality recycled water for human re-use and ecosystems (environmental flows).
- Students will learn the need for water and waste management to mitigate human impacts (water pollution), ensure reliable supply of water (recycled water as an alternative source) and sustainable management of our waste (biosolids an alternative source to chemical fertilisers).
- Our excursion is the starting point for Wastewater Depth Study, looking at how scientific knowledge in an industrial/ real-life setting enables efficient use of water resources for us and to protect the environment.

### Syllabus Knowledge and Understanding outcomes

**Knowledge and understanding EES11-11** describes human impact on the Earth in relation to hydrological processes, geological processes and biological changes

**EES12-15** describes and assesses renewable and non-renewable Earth resources and how their extraction, use, consumption and disposal affect the Earth’s systems

### Working Scientifically outcomes

**Planning EES11/12-2** 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 EES11/12-5** 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 EES11/12-7** Communicates scientific understanding using suitable language and terminology for a specific audience or purpose

**Conducting Investigations (Optional) CH11/12-3** 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
<p><b>Lesson 1 – Introduction</b></p> <p>This Depth Study program plan applies some content from Module 4 and 8 relating to human impacts (water management) and resource management (water and waste). The resources for this study are found on our High School webpage under HSC Earth and Environmental Science.</p> <ol style="list-style-type: none"> <li>1. Explain details of the task - your expectations, assessment guide and final report/presentation expectations. <ul style="list-style-type: none"> <li><b>Q.</b> Why is a first-hand investigation important?</li> <li><b>A.</b> Because it allows you to develop the following skills: <ul style="list-style-type: none"> <li>- fieldwork observations</li> <li>- applying theory to real life</li> <li>- replicating practical activities</li> <li>- communication skills</li> </ul> </li> </ul> </li> <li>2. Explain Sydney Water’s role and responsibility in water management. See our Education webpages for more information. <ul style="list-style-type: none"> <li>- Who is Sydney Water and what do they do? See our About us webpage for more information.</li> <li>- Why is managing wastewater so important? See our Wastewater treatment webpage for more information.</li> <li>- Where does my wastewater go? See our Wastewater network webpage for more information.</li> </ul> </li> <li>3. Excursion preparation. <ul style="list-style-type: none"> <li><b>Q.</b> What will we be doing during the excursion?</li> <li><b>A.</b> See the High school webpage for more information.</li> <li><b>Q.</b> Where can I find more information about the excursion site?</li> <li><b>A.</b> See our Penrith Water Recycling Plant webpage for more information.</li> <li><b>Q.</b> What are the basic safety and risk assessments on industrial sites?</li> <li><b>A.</b> 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?</li> </ul> </li> </ol> <p><b>Activity:</b> Students can create a risk assessment table according to the use of PPE.</p> <p>Hints and tips from HSC markers</p> <ul style="list-style-type: none"> <li>- First-hand investigations involve great opportunities to develop essential numeracy skills through practical measurement and the collection, representation and interpretation of data.</li> <li>- Fieldwork reports and engagement with community experts involve systematic scientific inquiry of real-life application promote students to achieve top marks in the HSC.</li> </ul>	<p><b>Sydney Water resources</b></p> <p><a href="#">High school</a> see HSC Earth &amp; Environmental Science</p> <p><i>Make a simple filter experiment</i></p> <p><i>Keep wipes out of pipes experiment</i></p> <p><a href="#">Education</a></p> <p><a href="#">About us</a></p> <p><a href="#">Wastewater treatment</a></p> <p><a href="#">Wastewater network</a></p> <p><i>Wastewater treatment plant webpages</i></p> <p><i>EPA pollution data monitoring reports</i></p> <p><a href="#">Water recycling</a></p> <p><a href="#">Environmental protection</a></p> <p><a href="#">Community grants</a></p> <p><b>Other resources</b></p> <p><a href="#">Water corporation – Water recycling around the world</a></p> <p><a href="#">AWA – Water Recycling Fact Sheet</a></p>



Teaching learning and assessment	Resources
<p>Further investigations and extension options:</p> <ul style="list-style-type: none"> <li>• First-hand practical investigations at school <ul style="list-style-type: none"> <li>- Conduct a wastewater audit – understand the individual and community impact to wastewater quality that can disrupt treatment. See our High School webpage for wastewater audit resources.</li> <li>- Conduct a stormwater audit - understand the individual and community impact on urban run-off into local waterways. See our High School webpage for stormwater audit resources</li> <li>- Compare filtration techniques – particle filtration, distillation, and membrane filtration such as syringe or straw filter. Think about the advantages and disadvantages of each. See our High School webpage for our <i>Make a simple water filter experiment</i> and lesson plan.</li> <li>- Test a claim – find out whether wipes are flushable (breakdown when shake in jar or mixed in bowl), check whether break-down in other conditions such as whether they are biodegradable in soil. See our High school page for our <i>Wipes out of pipes experiment</i> and lesson plan.</li> </ul> </li> <li>• Secondary sourced investigations <ul style="list-style-type: none"> <li>- Comparative study of the different wastewater treatment techniques at different plants and the water quality requirements of each. See our Wastewater network webpage for information about <i>Wastewater treatment plants</i> and <i>EPA pollution monitoring reports</i>.</li> <li>- Comparative study of water treatment and recycling in another country. See our Water recycling webpage and other resources for more information.</li> </ul> </li> <li>• Communication surveys – What do people think about their wastewater and recycled water? <ul style="list-style-type: none"> <li>- Investigate the perceptions and environmental impact of using recycled water and biosolid on the community.</li> <li>- Research and present information about a sustainability initiative by Sydney Water, create their own. Research our latest campaign or go to our Community grants webpage and Environmental protection webpage for inspiration.</li> </ul> </li> </ul>	
<p><b>Lesson 2 – Secondary research</b></p> <p><b>Q.</b> Have you thought about where your water comes from and where it goes?</p> <p><b>A.</b> Probably not daily. 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? See our Urban water management webpage with the <i>Urban water cycle diagram</i> for more information</p> <p><b>Activity:</b> Students can investigate our network using the Urban water cycle diagram on our Urban water management webpage.</p> <p><b>Q.</b> How do you use your water?</p> <p><b>A.</b> The average breakdown in Sydneysider is ~200L per day. See our Water use and conservation for more information.</p> <p><b>Q.</b> Have you ever wondered what happens to water after you've used it?</p> <p><b>A.</b> 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. See our Water use and conservation page for a list of what we put down our drains. Sydney Water takes this wastewater and treats it to discharge into the environment or re-use as recycled water.</p>	<p><b>Sydney Water Resources</b></p> <p><a href="#">High school</a> see HSC Earth &amp; Environmental Science</p> <p><a href="#">Urban water management</a> <i>Urban water cycle diagram</i></p> <p><a href="#">Water use &amp; conservation</a></p> <p><a href="#">Water recycling</a></p> <p><a href="#">Glossary</a></p> <p><a href="#">Wastewater network</a> <i>Wastewater network map</i> <a href="#">Wastewater treatment</a></p>

Teaching learning and assessment	Resources
<p><b>Did you know:</b> We call it wastewater, but your syllabus uses sewage. See our Glossary for more information about the terms and definitions we use in the water industry.</p> <p><b>Activity:</b> Look at the <i>Wastewater network map</i> and see which plant your wastewater goes to.</p> <p><b>Q.</b> What is in that one percent? How do you think we treat a mixture like wastewater, make recycled water?  <b>A.</b> 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 pollutants before being released into the environment or reused (recycled water). See our Wastewater Treatment webpage for more information.</p> <p><b>Q.</b> How can we use our understanding of science to help remove the waste from the wastewater?  <b>A.</b> Based on the properties of matter (heterogeneous mixture), we can apply different techniques to separate substances. For example, we could use physical separation methods such as sedimentation, filtering or decanting.</p> <p><b>Q.</b> After the water has been treated, how do we use the recycled water?  <b>A.</b> 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 places use it as part of their drinking water supply, such as Singapore and San Diego. See PUB Singapore and San Diego Public Utilities for more information.</p> <p>Another use of recycled water is for environmental flows, to keep creeks and rivers running. Keeping the water captured in the dams as a source of drinking water. Using high-quality recycled water, we can also have a positive influence on the water quality of the Hawkesbury Nepean-River. See our Water recycling webpage for more information.</p> <p><b>Q.</b> What do you think happens to all the waste removed from the wastewater?  <b>A.</b> 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, this could be a Depth study extension option.</p> <p>Set up to go on the excursion.</p>	<p><a href="#">Penrith Water Recycling Plant</a></p> <p><a href="#">St Marys Advanced Water Recycling Plant</a></p> <p><a href="#">Solids recycling</a></p> <p><b>Other Resources</b></p> <p><a href="#">PUB - Singapore's National Water Agency</a></p> <p><a href="#">San Diego – Recycled Water</a></p>
<p><b>Lesson 3 – Field trip</b>  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.</p> <p>Refer to our program outline on our Excursion request webpage for more information.</p>	<p><b>Sydney Water resources</b>  <a href="#">Excursion request</a></p> <p><a href="#">High school</a> see HSC Earth &amp; Environmental Science</p>
<p><b>Lesson 4 – Analysing Data and Information</b>  <b>Activity:</b> 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:</p>	<p><b>Sydney Water resources</b>  <a href="#">Penrith Water Recycling Plant</a></p>

Teaching learning and assessment	Resources
<ul style="list-style-type: none"> <li>• Penrith Water Recycling Plant webpage provides additional details for the excursion site</li> <li>• <i>What's in wastewater? factsheet</i> to identify what we deal with at the plants</li> <li>• EPA pollution monitoring data reports for all our wastewater systems. These reports measure concentration limits of pollutants such as nutrients, organic matter and other elements after wastewater has been treated. See our EPA pollution monitoring data reports for more information.</li> </ul> <p>Extension:</p> <ul style="list-style-type: none"> <li>• Sydney Water's drinking water analysis results provide drinking water quality report for up to 70 different characteristics. This is the source water of wastewater. Students may want to compare wastewater, recycled water and drinking water and can assess the relevance and reliability of the gathered information. See Water analysis for drinking water analysis results and information.</li> <li>• EPA webpage also provide information on the regulation of water pollution and quality. Students can assess the relevance and reliability of the gathered information. WaterNSW, Beachwatch and Water Quality Australia webpage provides information on water quality in natural systems. Students can evaluate the importance and assess the relevance and reliability of the gathered information. See other resources for more information.</li> </ul> <p><b>Activity:</b> After students gathered all the relevant data and information, they can analyse and create a scientific report or presentation. Think about:</p> <p><b>Q.</b> Why was it valuable to learn about the greater context of wastewater treatment and water recycling?</p> <p><b>A.</b> To understand Earth and Environmental Science and apply it in real-life water management to protect public health and the environment. We need to understand the role of organisations like Sydney Water, organisations and individuals, how we all contribute to sustainable water management.</p>	<p><a href="#">High school</a> see HSC Earth &amp; Environmental Science <i>What's in wastewater factsheet</i></p> <p><a href="#">St Marys Advanced Water Recycling Plant</a></p> <p><a href="#">Wastewater network</a> <i>Wastewater treatment plant webpages</i> <i>EPA pollution data monitoring reports</i></p> <p><a href="#">Water analysis</a> <b>Other resources</b></p> <p><a href="#">EPA Water</a></p> <p><a href="#">WaterNSW</a></p> <p><a href="#">Beachwatch</a></p> <p><a href="#">Water Quality Australia</a></p>
<p><b>Lesson 8</b></p> <p><b>Example: Depth Study – Fieldwork Report /Presentation</b></p> <p>A report may require students to:</p> <ul style="list-style-type: none"> <li>• describe the context of the site <ul style="list-style-type: none"> <li>- How does wastewater treatment and recycling work?</li> <li>- How does the application of science form predictable outcomes require for recycled water (and biosolid waste)?</li> <li>- How did the procedure of the separation activity affect its efficiency and function?</li> </ul> </li> <li>• describe and justify methods used during the investigation <ul style="list-style-type: none"> <li>- What were some of the flaws? What needed improvements?</li> <li>- How valid, accurate and reliable were the results?</li> </ul> </li> <li>• assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation</li> <li>• process and analyse first-hand lab activities, fieldwork and secondary data <ul style="list-style-type: none"> <li>- Did the theory fit the results observed on the day?</li> <li>- What tables and graphs can you compile?</li> <li>- How could this be information be useful, for example, testing the efficiency of water recycling? Designing a new wastewater treatment system?</li> </ul> </li> <li>• communicate the results and conclusions of the fieldwork, lab and research investigations.</li> </ul>	<p><b>Sydney Water resources</b></p> <p><a href="#">High school</a> see HSC Earth &amp; Environmental Science</p> <p><b>Other resources</b></p> <p><a href="#">NESA - The scientific research report</a></p>

Teaching learning and assessment	Resources
<p><b>Conclusion</b></p> <p><b>Evaluation questions</b></p> <ul style="list-style-type: none"> <li>• What role do you play in helping manage our water for the future?</li> <li>• How is science applied in sustainable water management?</li> <li>• Why are working scientifically, collaboration and communication skills important?</li> <li>• What could you do to help manage our water for the future?</li> </ul> <p><b>Reflection activity</b> - students finish these statements:</p> <ul style="list-style-type: none"> <li>• I used to think (at the start of these lessons) ...</li> <li>• but now I think (at the end of these lessons).</li> </ul> <p><b>Got students interested in a career with Sydney Water or research and development?</b> 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.</p>	<p><b>Sydney Water resources</b></p> <p><a href="#">Careers</a></p> <p><a href="#">Reports &amp; publications</a></p> <p><b>Find out more</b></p> <ul style="list-style-type: none"> <li>• <a href="http://sydneywater.com.au/education">sydneywater.com.au/education</a></li> <li>• <a href="https://facebook.com/SydneyWater">facebook.com/SydneyWater</a> </li> <li>• <a href="https://instagram.com/sydneywater">instagram.com/sydneywater</a> </li> <li>• <a href="https://twitter.com/SydneyWaterNews">twitter.com/SydneyWaterNews</a> </li> </ul>