



# Learning Trail

@ Lorong Halus Wetland

**TRAINER'S GUIDE**





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# Contents

<b>Objectives of the Active, Beautiful, Clean (ABC) Waters Learning Trail @ Lorong Halus Wetland</b>	<b>1</b>
<b>Details of the ABC Waters Learning Trail @ Lorong Halus Wetland</b>	<b>2</b>
<i>Educational Approaches</i>	2
<i>Before the Trip</i>	3
<i>Wet Weather Procedure</i>	3
<b>Summary of the ABC Waters Learning Trail @ Lorong Halus Wetland</b>	<b>4</b>
<b>Lesson Plan for the ABC Waters Learning Trail @ Lorong Halus Wetland</b>	<b>6</b>
<i>Station 1: Introduction</i>	6
<i>Station 2: Our Reservoirs</i>	9
<i>Station 3 and 4: The Lorong Halus Challenge and the Wetland</i>	13
<i>Station 5: Debrief and Reflections</i>	15
<b>References</b>	<b>17</b>
<b>Annexes</b>	<b>18</b>
<i>Annex 1: Preparation Brief for ABC Waters Learning Trail</i>	18
<i>Annex 2: Suggested Information for Risk Assessment Management (RAM) Form</i>	19
<i>Annex 3: Subject Links</i>	31
<i>Annex 4: Suggested Packing List (of Resources) – for Trainers</i>	33

# Objectives of the Active, Beautiful, Clean (ABC) Waters Learning Trail @ Lorong Halus Wetland

**This place-based inquiry experience aims to help students:**

1. Foster a sense of national identity, pride as Singaporeans, and emotional rootedness to the nation.
2. Learn about the Singapore Water Story vis-a-vis Lorong Halus Wetland. Appreciate Singapore's unique challenges, constraints, and where we have succeeded.
3. Develop leadership skills, instilling core values and the will to prevail, to ensure Singapore's continued success.
4. Understand PUB's ABC Waters Programme which will transform Singapore's pervasive network of drains, canals and reservoirs into beautiful and clean streams, rivers and lakes. By integrating the streams, rivers and lakes with the parks and gardens, new community spaces can be created. These will be bustling with life and activities, and transform Singapore into a City of Gardens and Water, a vision outlined by Singapore's Prime Minister Lee Hsien Loong.
5. Evoke a sense of wonder towards innovations, as students understand water treatment processes that give us clean water. Also understand a healthy ecosystem supports rich biodiversity, and that water quality is affected by the physical environment and human activities.
6. Promote stewardship for our strategic water resources and the need for everyone to play a part to keep our waterways and reservoirs active, beautiful and clean. Practise good saving water habits and practise safety precautions even as we enjoy our water bodies.

# Details of the ABC Waters Learning Trail @ Lorong Halus Wetland

<b>Level:</b>	Lower Secondary Students (13 – 15 years old)
<b>Programme Duration:</b>	2 hours
<b>Ratio of Facilitator to Students:</b>	1 : 15 – 20 students
<b>Ratio of iPad to Students:</b>	1 : max 3 students
<b>Recommended maximum group size:</b>	75-80 students (or 2 classes)
<b>Before the Trip:</b>	

- Show students and teachers the preparation brief (Annex 1) to help them prepare. Print these only if necessary.
- Fill in the information required for your Risk Assessment Management (RAM) form. Some information is given in Annex 2.

## Educational Approaches

This trail uses inquiry-based and experiential learning.

### What is Inquiry-Based Learning?

The inquiry-based approach focuses on student constructed learning, as opposed to teacher or guide-transmitted information.

This process aims to enhance learning through:

1. Increased student involvement
2. Multiple ways of knowing

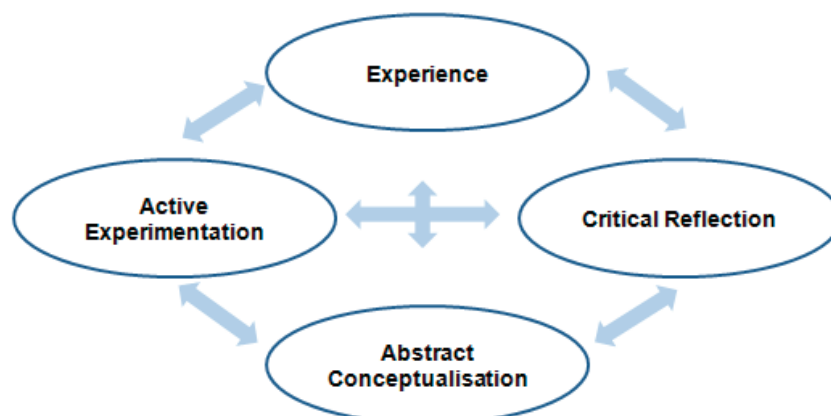
This is achieved by:

- Starting with an open-ended question or demonstration.
- Gather responses and subsequent questions from students with little comment or direction.
- Requiring students to collaborate on designing experiments or methods of inquiry.



### What is Experiential Learning?

Experiential learning is the process of making meaning from direct experience.



## Before the Trip

- Brief students on the field trip and what to bring and wear. Refer to Annex 1.
- To prepare students, show students the Pack List (Annex 1). Assign students to carry/be in charge of equipment/materials.
- Conduct a reconnaissance of Lorong Halus Wetland and familiarise yourself with the area and stations.
- Fill in the Risk Assessment Management (RAM) form required by Ministry of Education (MOE). Suggested information is given in Annex 2.
- Inform the relevant authorities – PUB and NParks and make a booking for your school visit.

## Wet Weather Procedure

On the day of the field trip:

- Check the weather forecast and lightning status 1 to 2 hours before the Learning Trail begins:
  - Visit the National Environment Agency website [www.weather.gov.sg](http://www.weather.gov.sg).
  - Dial the lightning advisory number at 6282-6821.
- If there is a heavy downpour or the Lightning Category 1 is still not cleared:
  - Do not start the trail.
  - Take shelter at the educational kiosk and familiarise students with all five stations from the iPad application.
  - If lightning or heavy rain persists, stop the programme and plan for another make-up session if possible.
- Should a storm be expected during the Learning Trail, bring students back to the educational kiosk as soon as possible. If it is impossible to reach the sheltered area in time, students should wait under shelters along the trail and move back to the educational kiosk as soon as they can.

## Summary of the ABC Waters Learning Trail @ Lorong Halus Wetland

Station	Duration	Location	Main Points	Subject Links	Cross-reference/ Materials
1	30min	Educational Kiosk	<b>Introduction to Lorong Halus</b> <ul style="list-style-type: none"> <li>Introduce the Lorong Halus Wetland Learning Trail programme.</li> <li>Introduce the interactive iPad application for the Learning Trail.</li> <li>Inform students of the responsibility and liability of using the iPad.</li> <li>Understand the Singapore Water Story and the Four National Taps.</li> <li>Learn about the history of Lorong Halus.</li> <li>Conduct a safety briefing.</li> </ul>	<b>History</b> and culture of a place in Singapore  <b>Geography</b> <ul style="list-style-type: none"> <li>Managing our water resources</li> <li>Map reading skills</li> <li>Changing environment in Singapore</li> </ul>	iPad "Station 1"
2	35min	Sheltered area at the bridge	<b>Our Reservoirs</b> <ul style="list-style-type: none"> <li>Identify the dam which helped create the Serangoon Reservoir.</li> <li>Understand the concept and features of the ABC Waters Programme.</li> <li>Illustrate the importance of good water quality.</li> <li>Test the water quality in the reservoir.</li> <li>Learn about the water cycle and human impact on our environment and waters.</li> </ul>	<b>Science</b> <ul style="list-style-type: none"> <li>Water cycle and water sustainability</li> <li>Water quality testing – colour, smell, pH level, dissolved oxygen, turbidity and temperature</li> </ul> <b>Geography</b> <ul style="list-style-type: none"> <li>Weather studies in particular rainfall</li> <li>Processes in water cycle</li> </ul>	iPad "Station 2"  Pail, rope, water testing kits, data loggers with temperature, pH and dissolved oxygen testing tablets, turbidity discs, and a water container.

Station	Duration	Location	Main Points	Subject Links	Cross-reference/ Materials
3	10min	Collection well	<b>The Lorong Halus Challenge</b> <ul style="list-style-type: none"> <li>Find out about the key challenges of maintaining Serangoon Reservoir.</li> <li>Learn the special techniques and tools to protect our water resources.</li> <li>Understand how the Lorong Halus Wetland treats leachate naturally.</li> </ul>	<b>Geography and Science</b> <ul style="list-style-type: none"> <li>Sources of pollution and their respective impacts</li> <li>Conserving and protecting our environment</li> </ul>	iPad "Station 3"
4	20min	At the wetland	<b>The Lorong Halus Wetland</b> <ul style="list-style-type: none"> <li>Learn about the whole treatment (phyto-remediation) process of leachate at the wetland.</li> <li>Study the biodiversity at the wetland and recognise the wetland as a new habitat for wildlife to inhabit and thrive.</li> </ul>	<b>Science</b> <ul style="list-style-type: none"> <li>Water cycle and water treatment processes</li> <li>Biodiversity – diversity of plants and animal life</li> </ul>	iPad "Station 4"
5	25min	Educational Kiosk	<b>Debrief and Reflections</b> <ul style="list-style-type: none"> <li>Recap the challenges faced by Singapore as a nation without natural water source.</li> <li>Recap the ABC Waters concept and how it is linked to water sustainability.</li> <li>Recap the challenges faced by Serangoon Reservoir which is beside Lorong Halus Landfill.</li> <li>Recap the pre-treatment and main treatment of leachate.</li> <li>Discuss key concepts of water sustainability and the need for clean water.</li> <li>Motivate students to protect water resources in Singapore.</li> </ul>	<b>Geography and Science</b> <ul style="list-style-type: none"> <li>Sources of pollution and respective impacts</li> <li>Conserving and protecting our environment</li> </ul> <b>National Education</b> <ul style="list-style-type: none"> <li>No one owes us a living. We have to depend on ourselves</li> </ul>	iPad "Station 5"
<b>Total Duration: 2 hours</b>					



# Lesson Plan for the ABC Waters Learning Trail @ Lorong Halus Wetland

## Station 1: Introduction

**Duration:** 30min

**Location:** Educational kiosk

**Learning Points:**

- Introduce the Lorong Halus Wetland Learning Trail programme
- Introduce the interactive iPad application for the Learning Trail
- Inform students of the responsibility and liability of using the iPad
- Understand the Singapore Water Story and the Four National Taps
- Learn about the history of Lorong Halus
- Conduct a safety briefing

Trainer's Notes	Cross Reference/ Materials
<p><b>1. Welcome students to Lorong Halus Wetland</b></p> <ul style="list-style-type: none"> <li>• Preparation: give students a few minutes to apply mosquito repellent and sunblock and go to the washroom or buy a drink.</li> </ul> <p><b>2. Divide the students into groups</b></p> <ul style="list-style-type: none"> <li>• Divide the students into groups depending on the number of instructors you have. Recommendation is 1 instructor: 15-20 students.</li> <li>• Divide the students further into small groups of 3 students and assign a leader for each small group. Recommended ratio for the small group is based on maximum of 3 students per iPad.</li> </ul> <p><b>3. Conduct a safety briefing</b></p> <ul style="list-style-type: none"> <li>• Students should:               <ul style="list-style-type: none"> <li>○ Inform you or the teacher if they do not feel well, if they have a cut, are stung or bitten.</li> <li>○ Be alert, and look out for potentially dangerous animals like scorpions, snakes or bees along the trail and move away from them if encountered.</li> <li>○ Stay hydrated by drinking water along the way.</li> <li>○ Always move in pairs or a group. Do not work or wander off unsupervised.</li> <li>○ Do not enter the reed beds or pond.</li> <li>○ Listen to instructions from the guide if the weather changes. The Learning Trail will be stopped if there is an impending thunderstorm i.e. Category 1 warning. The group will return to the sheltered area to wait out the storm.</li> </ul> </li> </ul> <p><b>4. Introduce Lorong Halus and the Learning Trail programme</b></p>	



<p><b>7. Describe the history timeline of Lorong Halus:</b></p> <ul style="list-style-type: none"> <li>• Get students to study the Lorong Halus Wetland timeline and their important historical milestones.</li> <li>• Test students' understanding after they finish browsing:</li> </ul> <p><u>Guiding Questions</u></p> <p>a) What was Lorong Halus before it was a landfill?</p> <ul style="list-style-type: none"> <li>○ It was an estuary for wildlife.</li> <li>○ Lorong Halus, along what was then the Sungei Serangoon, faces the Straits of Johor. Where you now stand was once part of one of the most expansive mangrove / mudflat ecosystems in Singapore. Birds that could be found in the estuary included grey herons, plovers, sandpipers and egrets.</li> </ul> <p>b) How long was Lorong Halus used as a landfill?</p> <ul style="list-style-type: none"> <li>○ About 30 years, from 1970 to 1999.</li> <li>○ Ever-expanding amounts of solid waste generated by a growing population and a host of domestic and industrial sources had to be disposed of, and from 1970 to 1999 Lorong Halus served as Singapore's solid waste landfill. Waste management is the unglamorous – but vitally important – flip side of economic development, and it has to be carried out properly to protect the health of the land and of people – especially in a country with limited space such as Singapore.</li> <li>○ The Lorong Halus landfill housed solid waste accumulated over nearly 30 years, and it occupies an area of 234 hectares (or 2.34 square kilometres) along the eastern bank of the Sungei Serangoon.</li> </ul> <p>c) Look around you. Does this place look like a landfill? How about its smell, does it smell like a landfill?</p>	<p>iPad App:  <i>“Station 1: History Lorong Halus Wetland”</i></p>
<p><b>8. Proceed to the next station.</b></p> <ul style="list-style-type: none"> <li>• Get the students to click on <i>“Exit to Map”</i> to get back to the <i>“Main Map”</i> interface.</li> <li>• Ask the students to locate the next station on the <i>“Main Map”</i> and find their way using the map and <i>“Compass”</i> on the iPad.</li> </ul>	<p>iPad App:  <i>“Main Map” Interface; “Tool: Compass”</i></p>



- Explain that not all our 17 reservoirs are ABC Waters sites. Some are in protected catchment areas. Different reservoirs have different characteristics and hence different attributes and plans.
- Explain the significance of some prominent reservoirs like MacRitchie Reservoir being the first reservoir in Singapore.

### 3. How has the ABC Waters Programme benefitted the community living in the area and yourself?

- Appreciation of the water supply
  - Reservoir where the ABC Waters Programme is launched is one of the sources of our water supply. The natural features we see are designed to treat the waters before they enter our reservoir, thus ensuring cleaner water in our reservoirs.
- Recreation
  - Creates more spaces close to water for the community to mingle and come together to relax. This is one of the common aims for all ABC Waters sites.
  - In the future, the reservoir will become a popular recreational ground for the community to jog, fish, and take part in water sports like kayaking, canoeing and dragon boat racing.
- Ecology
  - The enhanced greening forms natural habitats, enhancing biodiversity and wildlife.

### 4. Test the Water Quality.

- Explain to the students the importance of good water quality in a reservoir i.e. costs of treating polluted water, sustaining aquatic life, etc.
- The iPad contains the instructions and videos on how to use the water testing kits, as well as the significance of each parameter that the students are testing.
- Ask students to watch the video for water collection demonstration in the iPad application.
- Bring students to the **water collection point** to observe the water:
  - What do they think the water quality is like - good or poor? (Answers vary.)
  - Tie the rope of the pail to the railing and collect some water.
  - Pour water from the pail into an emptied water testing kit to the fill-line. Highlight that for accuracy, the water needs to be filled exactly to this level.
  - Run through the water parameters progressively, as in the iPad, explaining each parameter as you go (what each parameter is and some implications of the readings). Demonstrate how the Dissolved Oxygen (D.O.) and pH tests should be conducted.

After your demonstration, assign the teams and distribute the water testing kits to each team.

iPad App:  
“Station 2:  
Water  
Quality”

Pail, rope,  
water testing  
kits, data  
loggers with  
temperature,  
pH and  
dissolved  
oxygen  
testing  
tablets,  
turbidity  
discs, and a  
water  
container.

Collect more water in a pail to distribute to the students. Ensure that no student is allowed to collect water directly and that no equipment falls in. Also remind students not to get the iPads wet, or leave it on the floor where other students may accidentally step on it.

Give teams 10-15 minutes to complete their tests and record their answers. They should not fill in the “analysis” boxes yet. You will analyse the results of all the teams after they have obtained their results.

After teams have obtained their readings, gather everyone for debrief. Ask them to give you their D.O and pH bottles. Place these together and start debrief.

Discuss the readings obtained and **evaluate the state of the water**.  
Expected results:

- **Debris and Smell** – there should not be any smell. “Nothing” is not considered a good answer as there is usually a natural smell for reservoirs and ponds, due to algae, soil particles and other natural materials in the water. There should not be any oil, rotting, etc. smell as this would indicate pollution. There may be debris washed down from upstream after a rain. Analysis: natural if there is no oil or rotting smell.
- **Colour** – the water should be slightly green or yellow in colour (due to the presence of some algae, which is normal). Analysis: normal. Some algae is good as this can add to the level of dissolved oxygen in the water.
- **Turbidity** – this should be as clear as possible. The usual reading is the lightest or second lightest number. Reiterate that turbidity is caused by small particles suspended in the water. It affects the light penetration in the water. The clearer the water, the higher the light penetration – allowing more aquatic plants/algae to grow in the water.
- **Temperature** – expected results is between 28 – 30°C. Ask students what factors can affect water temperature (expected answers: weather conditions, rain). Reiterate that temperature can affect the amount of dissolved gases, like dissolved oxygen. The higher the temperature, the lower the amount of dissolved oxygen.

Temperature can also affect the metabolic reactions that are catalysed by enzymes in the body of organisms. These will be affected if the temperature is too high or too low.

- **Dissolved Oxygen** – this should be at least 4ppm (parts per million), below which the water will be too low poor to support aquatic life.
- **Salinity** – 0-0.5ppt is expected for a freshwater reservoir. Do note

<p>however, the tested salinity might be slightly higher than freshwater because Serangoon Reservoir is not completely desalted yet. The salinity would fall around 0.05-0.2ppt.</p> <ul style="list-style-type: none"> <li>• <b>pH</b> – pH of 6-9. The pH scale is from 0 to 14, with pH 0 being very acidic, pH 7 being neutral and pH 14 being very alkaline. Most aquatic organisms survive well in a pH range that is near neutral.</li> </ul> <p>Ask students what might cause water in the reservoir to be acidic. Decomposition of leaves, with the release of tannic acid, which makes the water acidic and brownish.</p> <p><b>5. Discuss the limitation of this water testing activity.</b></p> <ul style="list-style-type: none"> <li>• Only one measurement is taken at one location, at a certain time and water was only collected from the water surface. A more accurate testing method requires many measurements at several locations, at several times of the day and at different depths.</li> <li>• Limited numbers of water parameters are tested. Additional parameters that could be tested include exclusion of bacterial count, heavy metal testing etc.</li> <li>• There are also limitations in the accuracy of the water testing kit.</li> </ul> <p><b>6. Illustrate the water cycle.</b></p> <ul style="list-style-type: none"> <li>• Once students are done with the water quality tests, get them to pack all the equipment back into the container. Do not pour the chemicals into the reservoir.</li> <li>• Use “<i>The Water Cycle</i>” animation in the iPad to help students identify and point out the hydrological processes that are happening at Lorong Halus Wetland.</li> </ul> <p><b>7. Discuss human impact on biodiversity and water quality.</b></p> <ul style="list-style-type: none"> <li>• How do pollutants affect the water quality in the reservoir? (If there are pollutants in the rain such as particles or other gases, it could affect the pH or turbidity of the water in the reservoir. If people throw rubbish and chemicals into the drains, all these will be flowing to the reservoir. Illegal discharge (i.e. sewage water, food waste, washed water) can also cause high nutrients and bacteria in waterways and reservoirs.)</li> <li>• What can we do to prevent pollution in our waterways and reservoirs? (Throw rubbish responsibly into bins, do not pollute the drains with chemical and do not feed fishes and other aquatic animals in waterways or reservoirs. Do not release animals into our reservoirs and waterways. Do not discharge used water from car-washing into the drains.)</li> </ul> <p><b>8. Proceed to the next station.</b></p> <ul style="list-style-type: none"> <li>• Get the students to click on “<i>Exit to Map</i>” to get back to the <i>Main Map</i> interface.</li> <li>• Ask the students to locate the next station on the “<i>Main Map</i>” and find their way there using the map and “<i>Compass</i>” on the iPad.</li> </ul>	<p>iPad App: “<i>Station 2: The Water Cycle</i>”</p> <p>iPad App: “<i>Main Map</i>” Interface; “<i>Tool: Compass</i>”</p>
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- Remind students of safety and staying as a group.

Guiding questions for Station 4

- a) Does the treatment process require any addition of chemicals into the water?  
No. They are mostly natural or biological process.
- b) Does the treatment process involve pumping the water from one stage to another?  
Yes. It is needed from the equalisation tank to aeration lagoons in the leachate treatment process.
- c) What is phyto-remediation? What happens to the nutrients that the plant uptakes?  
It is a natural process in which the nutrients are absorbed by plants. Plants use these nutrients for their own biological metabolism. In the meanwhile, there is also microbial degradation of the nutrients.
- d) What differences do you notice between the first stage of the treatment process and the last stage? i.e. The equalisation tank versus the polishing pond.  
The water has been cleaned and is suitable for aquatic life.
- e) What animals do you see at the station?  
Use the iPad application to aid.

iPad App:  
"Station 4:  
Lorong  
Halus  
Wetland  
Treatment  
Process"

iPad App:  
"Main Map"  
Interface;  
"Tool:  
Compass"

## Station 5: Debrief and Reflections

**Duration:** 25min

**Location:** Educational kiosk

**Learning Points:**

- Recap the challenges faced by Singapore as a nation without natural water source
- Recap the ABC Waters concept and how it is linked to water sustainability
- Recap the challenges faced by Serangoon Reservoir which is beside Lorong Halus Landfill
- Recap the pre-treatment and main treatment of leachate
- Discuss key concepts of water sustainability and the need for clean water
- Motivate students to protect water resources in Singapore

Trainer's Notes	Cross Reference/ Materials
<p><b>1. Recap the Singapore Water Story.</b></p> <ul style="list-style-type: none"> <li>• What is the population of Singapore? (5.1 million people)</li> <li>• How much water does each of us need a day? (151 litres of water per person per day)</li> <li>• How much water does Singapore need a day? (About 400 million gallons of water a day)</li> <li>• Where does Singapore get all its water from? (Four National Taps – Local catchment water, Imported water, NEWater (recycled water) and Desalinated Water)</li> <li>• How much of Singapore's land area is used for local catchment? (Two-thirds of our land area)</li> </ul> <p><b>2. Recap the Punggol-Serangoon Reservoir Scheme.</b></p> <ul style="list-style-type: none"> <li>• Serangoon Reservoir is the 17<sup>th</sup> reservoir in Singapore. It is formed by building dams at the river mouths of Sungei Punggol and Sungei Serangoon.</li> </ul> <p><b>3. Recap the challenges at Lorong Halus Wetland.</b></p> <ul style="list-style-type: none"> <li>• What were the challenges faced by Serangoon Reservoir, being situated at Lorong Halus? (Landfill and leachate seepage into the reservoir.)</li> <li>• What were the solutions? (Bentonite walls, collection wells, leachate pumps and Lorong Halus Wetland treatment to prevent from entering the reservoir.)</li> <li>• Why is there a need to keep the reservoir water clean? (For the purpose of aesthetics, hygiene, lower water treatment cost, good water quality for animals' survival and recreational water activities, etc.)</li> <li>• What is phyto-remediation and what are the benefits? (It is a natural process of treating water to remove nutrients using plants and microbes. Phyto-remediation reduces the cost of downstream water treatment and eliminates the use of chemicals and filters.</li> </ul>	<p>iPad App:  <i>"Station 5: The Leachate Treatment Process"</i></p>

<p>The use of plants also creates new habitats, enhancing the biodiversity of the area.)</p> <ul style="list-style-type: none"> <li>• Did you notice the colour of the water in the equalisation tank and the polishing ponds? Is there aquatic life in the polishing ponds? What does this show? (The water has been treated and is clean enough for aquatic life to thrive.)</li> </ul> <p><b>4. Discuss the need for clean water.</b></p> <ul style="list-style-type: none"> <li>• What do the glasses represent? (Our drinking water)</li> <li>• What does the goldfish represent? (We need freshwater, but not saltwater)</li> <li>• How much water on earth is available for drinking? (Only 1% of earth's water is available)</li> <li>• What's the difference in water quality for both glasses? (The left glass is clean water, whereas the right glass is dirty water)</li> <li>• How can we be sure that the left glass is clean water? Could it have deadly chemicals that are colourless? (Goldfish is sensitive to pollution. From the swimming goldfish, it indicates that the water is clean and suitable for aquatic life. It shows good quality of the water.)</li> <li>• Remind the students that clean water is a valuable resource that we have.</li> </ul> <p><b>5. Share the wildlife that you spotted during the trail.</b></p> <ul style="list-style-type: none"> <li>• What kind of wildlife did we see along the Learning Trail today? (Answers vary. Use the iPad application to aid.)</li> <li>• Does this evidence show that wildlife is flourishing at Lorong Halus Wetland? (Many of the mangroves that originally lined the Sungei Serangoon are no longer here and thus the animals associated with mangroves and mudflats are not likely to be found here. However, nature, if given a chance, can demonstrate remarkable resilience. The greater Lorong Halus area, for example, is home to several species of rare birds. The Lorong Halus Wetland will over time develop into a habitat as the wetland's plants, the pond system, and nearby parkland matures and creates a larger green area.</li> </ul> <p><b>6. Discuss the reservoirs, natural habitats and water conservation.</b></p> <ul style="list-style-type: none"> <li>• Recall the history timeline of Lorong Halus and Serangoon Reservoir. What did Serangoon Reservoir used to be? (It used to be a river.)</li> <li>• What was Lorong Halus before it became a landfill? (It was an estuary to wildlife.)</li> <li>• Was there a need to use Lorong Halus as a landfill? Is there a need to use Serangoon River for our water supply? (Yes, both needs were/are crucial and important to the development of our nation.)</li> <li>• Is there a way to balance societies' needs with our natural habitats conservation? (Research, reforestation, keeping the place clean, allowing wildlife to re-establish, etc.)</li> <li>• What can we personally do to help ensure water sustainability in Singapore?</li> </ul>	<p>iPad App:  <i>"Station 5: Reflection – (Picture 1)"</i></p> <p>iPad App:  <i>"Station 5: Reflection – (Picture 2)"</i></p> <p><i>"Main Map" Interface; "Tool: Nature Guide"</i></p> <p>iPad App:  <i>"Station 5: Reflection – (Picture 3)"</i></p>
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<ul style="list-style-type: none"> <li>○ Keep our waterways and water catchment areas clean by not littering and not disposing any waste, solid or liquid into our waterways.</li> <li>○ Explain to people the consequence of their actions on the water if you encounter them.</li> <li>○ Report to NEA or PUB if you encounter such undesirable activities.</li> <li>○ Be aware of the safety features and help us keep the park safe for everyone to use.</li> </ul> <p><b>7. End the Learning Trail Programme.</b></p> <ul style="list-style-type: none"> <li>● Get the students to return the iPads in exchange for their Identity Cards.</li> <li>● Check that iPads are in good working order and not damaged.</li> <li>● Ask students to complete the feedback form.</li> </ul>	
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## References

- *Active, Beautiful, Clean Waters Design Guidelines*, (2009, 2011), PUB.
- Kwok, Chen Ko, (2011) *Your first guide to water quality monitoring in Singapore*, PUB.
- Tan Yong Soon, Lee Tun Jean and Karen Tan (2009) *Clean, Green and Blue. Singapore's Journey Towards Environmental and Water Sustainability*, Ministry of the Environment and Water Resource.
- *Water for All: Conserve, Value, Enjoy – Meeting our water needs for the next 50 years*, (2010), PUB Public Document.

## Annexes

### Annex 1: Preparation Brief for ABC Waters Learning Trail

#### Suggested What-to-bring List for Students (Print only if you have to)

1. A fieldtrip bag (small bag for items below)
2. Water bottle
3. Insect repellent
4. A hat / cap with a broad brim or extended sun shade
5. Raincoat or umbrella (in case of rain)
6. Ziploc bag for waterproofing valuables (e.g. camera, hand phone)
7. A clipboard, pen, or pencil and eraser
8. A hand towel
9. A spare change of clothes

**Do not bring:**  
Digital hand held gaming devices, text books, sports equipment for the fieldtrip.

#### Optional

- Snacks
- Digital camera or camera hand phone

#### Suggested Attire for Students

- T-shirt
- Shorts, or track pants (lighter colours preferable)
- Covered shoes (no slippers)

## Annex 2: Suggested Information for Risk Assessment Management (RAM) Form

Risk Assessment Management System  
'W Checklist'

PROGRAMME DETAILS			
<b>Activity:</b>	ABC Waters Learning Trail	<b>Venue:</b>	Lorong Halus Wetland
<b>Outgoing</b>		<b>Returning</b>	
<b>Date:</b>	To be filled by teacher	<b>Date:</b>	To be filled by teacher
<b>Estimated Time of Departure:</b>	To be filled by teacher	<b>Estimated Time of Arrival:</b>	To be filled by teacher
<b>Person-in-charge:</b>	To be filled by teacher	<b>Assistant(s):</b>	To be filled by teacher

LOCAL VENDOR CONTACT DETAILS (IF ANY)			
<b>Company name &amp; full address:</b>	<b>Facilitator's Name</b> Singapore Environment Council 1 Kay Siang Road #04-02 Singapore 248922		
<b>Office number:</b>		<b>Mobile number:</b>	HP of facilitator
<b>Contact person:</b>	Facilitator's name		

OVERSEAS VENDOR CONTACT DETAILS (IF ANY)			
<b>Company name &amp; full address:</b>	NA		
<b>Office number:</b>	NA	<b>Mobile number:</b>	NA
<b>Contact Person:</b>	NA		

## WHY

### State learning objectives:

This programme aims to:

1. Learn more about the Lorong Halus history and appreciate the current wetland.
2. Foster a sense of national identity and emotional rootedness to Singapore
3. Learn about the Singapore Water Story, appreciating Singapore's unique challenges and successes
4. Understand one of PUB's long term initiatives – the ABC Waters Programme, which will transform Singapore's pervasive network of drains, canals and reservoirs into beautiful and clean streams, rivers and lakes
5. Better understand ecological and water topics in the Science syllabus
6. Promote stewardship for our strategic water resource and the need for everyone to play a part to keep our waterways and reservoirs active, beautiful and clean

Does the activity meet learning objectives? (Yes / No)

**Note:** Please attach the programme / itinerary.

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
<b>WHAT (GENERAL)</b>									
1.	<b>Equipment</b>								
	a) Appropriate equipment is available.								
	b) Appropriate equipment is serviceable.								
	c) Others :								
2.	<b>Transport</b>								
	a) Transportation service is reliable (e.g. driver, vehicle).						To be filled by teacher		
	b) Chartered vehicle is appropriate (e.g. using a 4WD for off-road terrain).						To be filled by teacher		
	c) Others :								
3.	<b>Food</b>								
	a) Food is provided by licensed caterer / restaurants.								
	b) Nutrition is appropriate.								
	c) Special dietary needs are met.								



S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	d) If self-catering, additional hygiene measures are in place.								
	e) Water is potable.								
	f) Others :								
<b>WHEN (TIMING)</b>									
4.	<b>Programme</b>								
	a) Duration of activity is appropriate (e.g. start/stop/rest time).	Participants tired out from the activity	Dehydration/ Physical exhaustion	2	1	2	- The trail will last for 2 hours in the outdoors, with activity stops at the stations.		
	b) Timing of activity is appropriate (e.g. 5km run conducted before 10.30am or after 3.30pm).	Possible heat injuries due to weather	Dehydration/ Physical exhaustion	2	1	2	- Activities at stations will be conducted in shady areas or under available shelter. - Students will not be under the sun for a prolonged period of time. - Students will be reminded to hydrate frequently.		
	c) Possible delay in activity (e.g. day hike extended into night).	NA							
	d) Others :								
<b>WHO (PEOPLE)</b>									
5.	<b>Teachers and Adult Supervisors</b>								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	a) Teacher(s)/adult supervisor(s) are competent to supervise activity and manage participants (e.g. teacher/adult supervisor: participant ratio met for specific activity, female adult supervisor present for overnight activity involving female participants).	Participants fall sick and need attention/ evacuation	Not enough teachers/ adult supervisors	2	1	2	<ul style="list-style-type: none"> <li>- Facilitators are experienced in supervising/managing students</li> <li>- Program ratio will be 1 facilitator to 20 maximum students.</li> </ul>		
	b) Personnel is certified and competent to conduct activity.	Participants risk possible danger when outdoors	Participants may injure themselves	2	1	2	<ul style="list-style-type: none"> <li>- Facilitators are experienced in conducting activities for students in indoor and outdoor settings.</li> </ul>		
	c) Certified First Aider or paramedic is on site.	Injured students do not get the proper first aid.	Minor injuries could manifest to major injuries if not treated well.	3	1	3	<ul style="list-style-type: none"> <li>- <b>Facilitators are first-aid certified. (please verify)</b></li> <li>- Should there be any student who is injured, he/she will be accompanied by a teacher/parent volunteer to the nearest shelter to be attended to by the main facilitator.</li> </ul>		
	d) Personnel is competent to coordinate/execute emergency evacuation plan (e.g. search and rescue).	Students with serious injuries cannot get to the hospital in time.	Injuries could be life threatening.	4	1	4	<ul style="list-style-type: none"> <li>- Should there be a medical emergency involving the injured student, the main facilitator will call for an ambulance and the teacher/parent volunteer will</li> </ul>		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
							accompany him/her to the hospital.		
	e) Others :								
6.	<b>Participants</b>								
	a) Participants understand the objectives of activity.						- A briefing will be given at the start of the Learning Trail.		
	b) Participants are competent for activity (e.g. participate in pre-activity training).								
	c) Participants are aware of and adhere to safety requirements of activity.						<ul style="list-style-type: none"> <li>- A SAFETY briefing will be given at the start of the programme. Facilitators will reiterate safety points during the programme, when necessary.</li> <li>- Students will be briefed to react if they encounter potentially dangerous animals e.g. snake, monkeys, etc.</li> <li>- Students will be briefed not to enter water bodies; not cause anyone to fall into the water bodies.</li> <li>- Water collection for testing will not be carried out by students, but only by facilitators or teachers.</li> </ul>		
	d) Special needs of participants are met.								

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
	e) Medical declaration and information of participants are documented and disseminated to relevant personnel.						- Teacher/s to inform facilitators about any special cases – students with medical conditions.		
	f) Others :								
<b>WHERE (LOCATION)</b>									
7.	<b>Venue</b>								
	a) Accommodation is adequate (e.g. number of rooms).								
	b) Fire safety and evacuation route is communicated to all.								
	c) Area map is available for use during activity.	Students find themselves lost.	Injuries may ensue.	1	1	1	- Map of location is included in the student booklets. These are carried by both facilitators and students during the programme. - Students should be with the facilitators at all times.		
	d) Reconnaissance of area is conducted.	Dangerous hazards appear in between time of recon and actual	Injuries may ensue due to unforeseen hazards.	1	1	1	- Facilitators would have conducted a reconnaissance of the location before the date of the learning trail.		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
		day							
	e) In-country authorities and facilities (e.g. police, national park rangers and hospital) are accessible and/or contactable for assistance and support in the event of an emergency.								
	f) Water conditions (e.g. tides, currents, flash floods) and traffic (e.g. ships, power boats).								
	g) Others :								
<b>WEATHER</b>									
8.	<b>Inclement Weather</b>								
	a) Weather forecast and warning (e.g. lightning, flash flood, hot or cold spell, haze).	Sudden down-pour	Participants get drenched which will cause participants to fall ill eventually.	1	1	1	- Facilitators to check NEA Rain animation and PSI level at these timings: ○ 2 hours before LT ○ 1 hour before LT ○ During LT if needed		
		Lightning	Participants strike by lightning	4	2	8	- Before students board bus for the location: In the case of <b>impending thunderstorm, heavy rain or</b>		

S/n	Categories to consider:	Hazards Identification		Risk Evaluation Score			Risk Control: Strategies to reduce risk to an acceptable level	Implementation	
		Possible hazards	Potential incidents/ accidents	Severity (a)	Likelihood (b)	Risk level (a) x (b)		Action Officer	Follow-Up Date
							<p>levels of PSI above 100, it is advised to delay the departure for the location, until Lightning Category 1 is lifted.</p> <ul style="list-style-type: none"> <li>- If there is <b>Lightning category 1 or PSI level of equal or greater than 100 during the Learning Trail</b>, all activities will be stopped and students will be led to take shelter.</li> <li>- If the conditions persist, the programme will be aborted and students brought back to school.</li> </ul>		
	b) Others :								

**Note:** Please indicate "N.A." in cells that are not applicable.

Excursion Checklist		Action Plan	Implementation	
			Action Officer	Follow-up Date
1.	<b>Communication</b>			
	a) Establish communication with school and service provider via hand phone, satellite phone and/or other appropriate devices.			
	b) Establish communication with in-country authorities and facilities (e.g. police, national park rangers, hospital) for assistance and support in the event of an emergency.			
	c) Compile contact list of stakeholders (e.g. parents, MFA Duty Office, and in-country medical facilities).			
2.	<b>Medical</b>			
	a) Arrange for medical screening and vaccinations for teachers/adult supervisors and participants (if necessary).			
	b) Procure comprehensive travel insurance for all (e.g. International SOS for emergency evacuation).			
	c) Ensure accessibility to medical facilities or personnel in the event of an emergency.			
3.	<b>Overseas Travel</b>			
	a) E-register with MFA at least 3 days before departure.			
	b) Monitor and comply with MFA travel advisory on natural disasters, pandemic outbreak, social-political unrest.			
4.	<b>Others</b>			
	a)			

**Risk Assessment Team comprises:**

Name of Officer(s)	Designation

Name of Person-in-charge	Signature	Date

**Vetted by:**

Name of HOD	Signature	Date

**Chief Safety Officer/Principal Checklist**

**To ensure that the following are completed prior to the programme:**

- Communicate programme details to parents and participants
- Compile medical information and consent forms
- Ensure that personnel conducting activity is qualified
- Ensure that pre-activity training is carried out
- Ensure that relevant safety and emergency procedures are in place



**Submission of Overseas Excursion details to MFA via MFA eRegister (if applicable):**

- Prepare details of itinerary and participants for overseas excursion
- Enter details for BF01\_MFA-MOE form via the Overseas Excursion Management (OEM) Module in the School Cockpit
- Generate the BF01\_MFA-MOE form from the Reports Portal in the School Cockpit
- Submit BF01\_MFA-MOE form as an attachment at [www.mfa.gov.sg](http://www.mfa.gov.sg) at least 3 days before departure

**Approved by:**

Name of Chief Safety Officer/Principal	Signature	Date
<b>Comments:</b>		

**Assessment Review:**

Name of Person-in-charge	Signature	Date

## Annex 3: Subject Links

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula
1	Our Four National Taps and water supply and sustainability	Technology and an integrated approach for a robust supply of WATER FOR ALL	<p><b>History</b></p> <ul style="list-style-type: none"> <li>History and culture of a place in Singapore</li> </ul> <p><b>Science – Biology</b></p> <ul style="list-style-type: none"> <li>Process of phyto-remediation to treat leachate at Lorong Halus Wetland</li> </ul> <p><b>Geography</b></p> <ul style="list-style-type: none"> <li>Managing our changing environment in particular our water resources, rising demand of water and response to it</li> </ul> <p>National Education</p> <ul style="list-style-type: none"> <li>No one owes us a living. We have to depend on ourselves to solve the challenges we face and overcome these to create a better future for our nation</li> </ul>
2	The ABC Waters design features of integrating ecology (green parks), hydrology (blue waters) and the community (the public) at Lorong Halus Wetland	Appreciating our active, beautiful and clean waters for ALL TO VALUE AND ENJOY by encouraging the community to play a responsible role in its upkeep	<p><b>Geography</b></p> <ul style="list-style-type: none"> <li>Components of the physical and human environment</li> <li>Important inter relationship and inter-dependence between man and his environment</li> <li>Phyto-remediation</li> <li>Land use</li> </ul>
3	Retaining the rich historical and cultural background of Lorong Halus	Importance of history and culture despite urbanisation of Lorong Halus for all to VALUE	<p><b>History</b></p> <ul style="list-style-type: none"> <li>The history of Lorong Halus</li> <li>The growth and development of a place from a landfill to an urban settlement</li> </ul> <p><b>Geography</b></p> <ul style="list-style-type: none"> <li>The changing environment and factors responsible for the change</li> <li>Skills in basic inference techniques namely, comparing and contrasting the changes and inferring information through photos and maps</li> </ul>
4	The water cycle and water quality at Lorong Halus	Clean WATER FOR ALL	<p><b>Science</b></p> <ul style="list-style-type: none"> <li>Process skills relating to testing and inferring</li> </ul> <p><b>Geography</b></p> <ul style="list-style-type: none"> <li>Weather studies in particular the processes of water cycle in the atmosphere</li> </ul>

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula
5	Human activities and impact	<p>WATER IS PRECIOUS.</p> <p>CONSERVE the waterway at all times</p>	<p><b>Science and Geography</b></p> <ul style="list-style-type: none"> <li>• Conservation of the environment</li> <li>• Water pollution – sources, impact and measures to curb or reduce the pollution</li> <li>• Conserving the environment at national and individual levels</li> </ul>
6	Biodiversity of Lorong Halus Wetland	Creating an environment for the biodiversity in Lorong Halus Wetland	<p><b>Science</b></p> <ul style="list-style-type: none"> <li>• Classification of plants and animals</li> <li>• Conserving and protecting the natural habitat</li> <li>• Food chain in the natural environment</li> <li>• Managing the environment</li> </ul> <p><b>Geography</b></p> <ul style="list-style-type: none"> <li>• Conservation and measures to prevent an environmental crisis</li> </ul>

## Annex 4: Suggested Packing List (of Resources) – for Trainers

1. First Aid Kit
2. Insect repellent
3. 4-5 compasses
4. 4-5 pails with rope attached (for collection of water)
5. 4-5 sets of salinometer
6. Water Monitoring Kits with pH strips, turbidity discs, thermometer and dissolved oxygen tablets, glass vial and pH vial
7. Plastic bag to collect used pH strips and water which has been tested
8. A small bag pack or knapsack to fill your necessary belongings
9. Water bottle
10. A hat or cap with a broad brim or extended sun shade
11. Ziploc bag for valuable items for water-proofing, for e.g. digital camera and mobile phones
12. Stationeries like clip board, pencil and pen

Optional:

13. Charged data loggers including temperature, pH and Dissolved oxygen sensors
14. Bird and insect cards, nature guide books
15. Camera

## **Acknowledgements**

Greendale Secondary School

North Vista Secondary School

Punggol Secondary School

Seng Kang Secondary School

Ministry of Education, Curriculum Planning and Development Division,  
Humanities Branch and Sciences Branch

## **PUB, Singapore's national water agency**

PUB is the national water agency that manages Singapore's water supply, water catchment and used water network in an integrated way. PUB won the 2007 Stockholm Industry Water Award and was named Water Agency of the Year at the Global Water Awards 2006.

## **About PUB's tagline: Water for All: Conserve, Value, Enjoy**

PUB has ensured a diversified and sustainable supply of water for Singapore with the Four National Taps (local catchment water, imported water, NEWater, desalinated water).

To provide water for all, PUB calls on all Singaporeans to play our part to conserve water, keep our water catchments and waterways clean and build a relationship with water so we can enjoy our water resources. We can then have enough water for all uses – for industry, for living, for life.