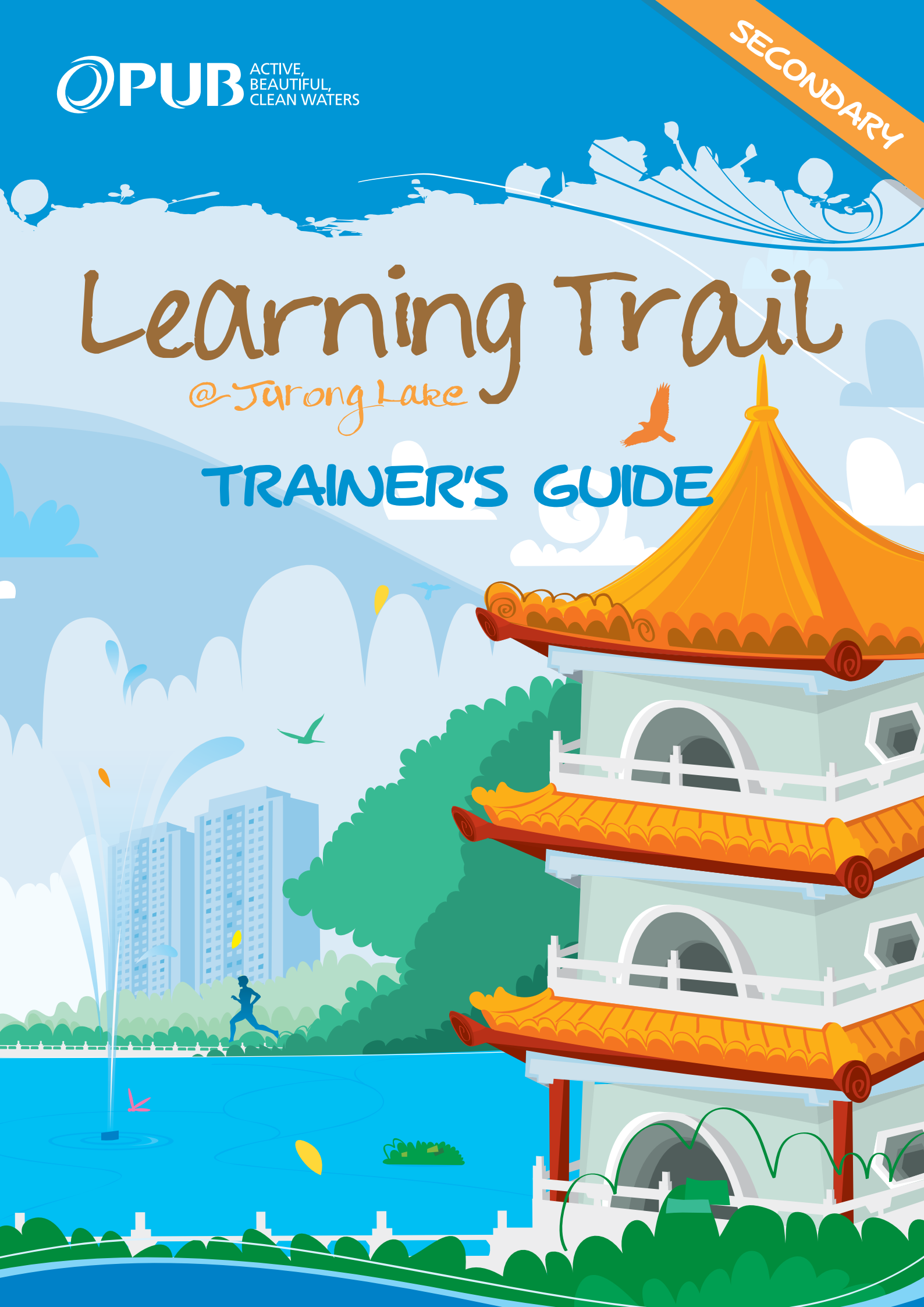
PUB ACTIVE, BEAUTIFUL, CLEAN WATERS

SECONDARY

Learning Trail

@Jurong Lake

TRAINER'S GUIDE



For more information, please visit us at www.abcwaterslearningtrails.sg
or email us at PUB_Learning_Trails@pub.gov.sg.

Contents

Objectives of the Active, Beautiful, Clean (ABC) Waters Learning Trail @ Jurong Lake

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 Jurong Lake Reservoir. 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.

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.

Details of the ABC Waters Learning Trail @ Jurong Lake

Level: Lower Secondary Students (13 – 15 years old)
Programme Duration: 1.5 hours – 2 hours
Ratio of Facilitator to Students: 1 : 15 – 20 students
Recommended maximum group size: 75 students (or 2 classes)
Before the Trip:

- 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 inquire-based and experiential learning.

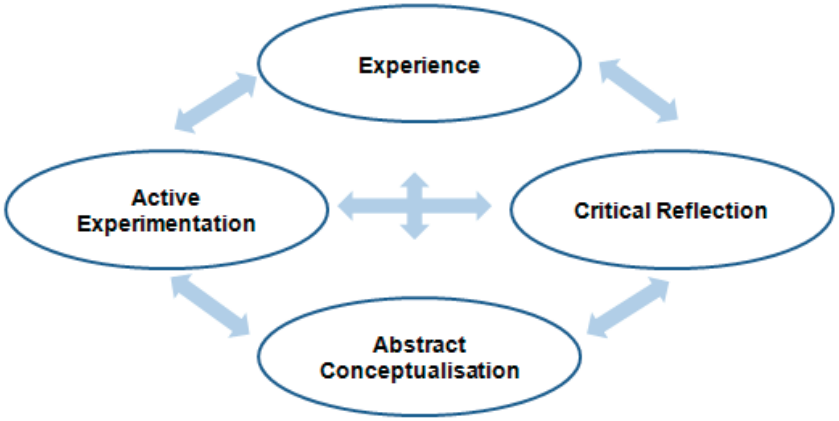
What is Inquiry-Based Learning?
The inquiry-based approach focuses on student constructed learning, as opposed to teacher or guide-transmitted information.

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 Jurong Lake 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.
  - Dial the lightning advisory number at 6282-6821 (Sector 1 and 2)
- If there is a heavy downpour or the Lightning Category 1 is still not cleared:
  - Do not start the trail
  - Take shelter at the Southern Pavilion to carry out discussions and other activities that can be conducted indoors
- 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 sheltered area 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 indoor area as soon as they can.

Summary of the ABC Waters Learning Trail @ Jurong Lake

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
-	10min	In front of car park	**Introduction** • Preparation for the trail. • Safety briefing.		5	
1	15min	Lakeside – Opposite the Pagodas of Chinese Gardens	**Jurong Lake and Jurong Lake District** • Aims of the Learning Trail. • The history of Jurong Lake. • The land use around Jurong Lake. • The Jurong Lake District attractions. • Tips on observing plants and animals in the park.	**Geography** • Managing the changing environment – water resources • Understanding the environment – environments through maps • Land use **History** • History and the development of Jurong Town District **National Education** • Singapore is our homeland. This is where we belong	2,4,5 6,7	Student Booklet

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
2	10min	Shaded area by the lake, near the pledge board	**Our Water Story and the First National Tap** • Our Water Story and the strategy of having Four National Taps. • The First National Tap – the 17 reservoirs in Singapore.	**Geography** • Managing the changing environment – water resources **National Education** • No one owes Singapore a living • We have confidence in our future **Science** • Science and water technology Character and Citizenship Education • Resilience	3	Rope, "Reservoirs" cards (Annex 4)
3	15min	Viewing Stage	**ABC Waters Design Features at Jurong Lake** • Understand the concept of the ABC Waters Programme. • Identify ABC Waters features at Jurong Lake. **The Water Cycle**	**Geography** • Managing the changing environment – water resources **Science** • Water cycle	8,9	
4	25min	Start of the Boardwalk	**Water Quality at Jurong Lake** • Test and analyse some key water parameters. • The importance of good water quality.	**Geography** • Managing the changing environment – water resources • Water quality **Science** • Measuring water parameters, pollution	10-12	Pail with a rope, water testing kits, data logger

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
5	15min	Part of the Boardwalk, near floating wetlands	**Floating Wetlands** • Understand the parts and functions of the floating wetlands. • Benefits of the floating wetlands. • Biodiversity of wetland plants and animals. **Human Activities and their Potential Impact** • Observe human activities at Jurong Lake (E.g. fishing, jogging, etc.). • Observe some impacts and link this to park users.	**Geography** • Managing the changing environment – water resources **Science** • Habitat – freshwater wetlands and community	14-18	Optional: nature guide cards/books, binoculars
-	30min	Southern Pavilion / Shaded area	**Debrief and Reflection** • Water sustainability in Singapore. • ABC Waters Programme. • Water quality at Jurong Lake. • Biodiversity at Jurong Lake. • The potential human impact at Jurong Lake and the solutions. • Student reflections.	**Character and Citizenship Education** • Respect • Responsibility • Integrity • Care	2-21	"Water Wise" cards (Annex 5)
Total Duration: 2 hours						
EXTENSION ACTIVITY						

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
-	25min	Sungei Lanchar	**Sketching** • Students may sketch ABC Waters features and iconic buildings at the lake. **Water Testing at Second Site** • Comparison of the water parameters at the 2 different locations at Jurong Lake **Virtual Water** **Our Water Story**	**Geography** • Sketching • Water quality • Conserving and protecting our water resources **Science** • Measuring water parameters, pollution (comparison) • Water used for food production **National Education** • No one owes us a living. We have to depend on ourselves.	19 10-12	Ruler Pail with a rope, water testing kits, data logger

Lesson Plan for the ABC Waters Learning Trail @ Jurong Lake

Introduction

Duration: 10min
Location: In front of car park
Learning Points:

- Preparation for the trail.
- Safety briefing.

Trainer's Notes	Cross Reference/ Materials
1. **Welcome students to Jurong Lake** 2. **Preparation** • Ask students to apply insect repellent/sunblock, refill their water bottles and go to the toilet. • Divide students into groups of 15-20 students and assign the instructors. • Instructors meet their groups and distribute the student booklets. 3. **Conduct a safety briefing** Students should: • Inform you or the teacher if they do not feel well, if they have a cut or have been stung or bitten. • Be careful as trees and branches may fall. • Be alert, and look out for potentially dangerous animals (E.g. snakes, bees along the trail, and move away from them if encountered. • Do not enter the reed beds or lake. • Stay hydrated by drinking water along the way. • Always move in pairs or a group. Do not work or wander off alone. • Listen to instructions from the guide if the weather changes. The Learning Trail will be stopped if there is an impending thunderstorm (lightning category 1 warning). The group will return to the sheltered areas (the main entrance of Chinese Garden or the pavilion in the lakeside plaza) to wait out the storm.	

Station 1: Jurong Lake and Jurong Lake District

Duration: 15min
Location: Lakeside – Opposite the Pagodas of Chinese Garden
Learning Points:

- Aims of the Learning Trail
- The history of Jurong Lake
- The land use around Jurong Lake
- The Jurong Lake District attractions
- Tips on observing plants and animals in the park

Trainer's Notes	Cross Reference/ Materials
1. **Briefing.** • What the trail will cover – Treasures on the Trail.	Pg 2
2. **Observe Features at Jurong Lake** • Ask students to identify where they are on the map. • Jurong Lake is a freshwater lake formed by the damming of Sungei Jurong. Rainwater from Boon Lay, Jurong East and Jurong West are channelled here. • What are the features they can observe? (Pagodas of Chinese Garden, water sports centre, etc.)	Pg 4, 5
3. **Identify land use around the lake** • Ask students to set the map on pages 4 and 5. (Use the compass or land features) • Ask students to look around them and identify the land use around the lake (residential, tourism, education, industry, etc.) Get them to write these land uses in their booklets.	Pg 4, 5 Optional: Compass

4. **Introduce the Jurong Lake District**
• Jurong Lake District consists of two parts: Lakeside in the west and Jurong Gateway in the east. The district is being transformed into a unique lakeside destination with edutainment attractions.
• The huge water body and lush greenery around Jurong Lake:
  ○ Creates an aesthetic environment.
  ○ Helps to reduce urban heat island effect (where an urban area is significantly warmer than its surrounding rural areas).
  ○ Supports biodiversity.
  ○ Is an important recreational/sports and tourist location for western Singapore.
• Ask some students to read about the Chinese Garden, Science Centre Singapore and the Japanese Garden on page 7 and tell the class about these features:
	Pg 6,7

Chinese Garden: ○ Built in 1975, Chinese Garden is modelled after the ancient northern Chinese imperial architectural style of the Sung Dynasty period (960 to 1279 AD). ○ It is designed by Professor Yuen-Chen Yu, a Taiwanese architect. ○ In the Chinese Garden, we can see the Bonsai Garden which is designed to be the largest Suzhou-styled one outside of China, the imposing seven-storey Pagoda and Twin Pagoda and eight Chinese legendary heroes statues surrounded by evergreen shrubs. **Japanese Garden:** ○ The Bridge of Double Beauty connects Japanese Garden to Chinese Garden. Japanese Garden aims to recreate a traditional garden in Japan from the Muromachi period (1392 – 1568) to the Momoyama period (1568 – 1615). ○ There we can enjoy the architecture of medieval Japan, the migratory birds near ponds and parks, the native timbre tree grove and the kampong fruit tree within the garden. **Science Centre Singapore:** ○ Officially opened in 1977, Science Centre Singapore promotes interest, learning and creativity in science and technology, through imaginative and enjoyable experiences. ○ In partnership with Science Centre Singapore, the water play area was launched in 2005 at the centre. It is for children/students to enjoy water as well as to teach many water-related phenomena, such as the water vortices.	
5. **Discuss the history of Jurong Lake**. • Run through the highlights of Jurong Lake's history: ○ The town Jurong was named after the Malay word "jerung". What does this word mean? (Shark) ○ What was the original vegetation at Jurong? (Mangroves) ○ When was Jurong Lake constructed and by whom? (1960s by Jurong Town Corporation) ○ When did works to improve Jurong Lake under PUB's ABC Waters programme start? (May 2009) ○ When was ABC Waters Programme at Jurong Lake opened? (September 2010)	Pg 6,7
6. **Introduce the Photo Hunt** • Ask students to take photos based on the 6 different descriptions on page 2. Students should complete the photo hunt by the time the trail ends. • Ask students to spot/observe animals and plants throughout the trail. As you walk along the trail, point out plants in the park found on page 13.	Pg 2 Pg 13

Station 2: Our Water Story and the First National Tap

Duration: 15min
Location: Shaded area by the lake, near the pledge board
Learning Points:

- Our Water Story and the strategy of having four National Taps
- The First National Tap – the 17 reservoirs in Singapore

Trainer's Notes	Cross Reference/ Materials
1. **Play the Reservoirs-in-Singapore game.** • Give out the reservoir cards randomly to the students. • Students who do not have a card are to use the given rope to form the outline of Singapore. • Students with the cards are to locate the position of their reservoir card and holding the card, stand in the position of their reservoir card. • Give students 5 min to complete their task and then debrief (Take a photo of the group): Discuss each reservoir: ○ MacRitchie Reservoir – centre of Singapore; the first reservoir formed. ○ Jurong Lake – where we are. ○ Kranji Reservoir – north-west of Singapore, water from Jurong Lake is channelled there before being pumped to a water treatment plant. ○ Marina Reservoir – south of Singapore; the first reservoir in the city, formed by damming up Marina Channel. ○ Pandan Reservoir – south-west of Singapore. ○ Punggol and Serangoon Reservoirs – north-east of Singapore; these are the latest reservoirs connected by Punggol Waterway. 2. **Explain the first National Tap – Local Catchment water.** • Two-thirds of Singapore's land area is used as water catchment. Rainwater falling on these urban and reserve areas is channelled to our waterways, which eventually carries the water to our reservoirs/ABC Waters sites for storage, before it is treated and supplied to homes. • Highlight the fact that since water from urban drains are channelled to the reservoirs, we need to help keep the waters as clean as possible as this water is part of our water supply.	Rope, "Reservoirs" cards (Annex 4) Pg 3

Station 3: ABC Waters Design Features at Jurong Lake

Duration: 15min
Location: Viewing stage
Learning Points:

- Understand the concept of the ABC Waters Programme
- Identify the ABC Waters Features at Jurong Lake
- The Water Cycle

<table>
<tr><th>Trainer's Notes</th><th>Cross Reference/ Materials</th></tr>
<tr><td>
1. Ask students to turn to page 8 and describe the Water Cycle.

2. Ask students where the water from Jurong Lake is channelled to. (Kranji Reservoir first for storage. The water is then channelled to a water treatment plant where it is treated to become potable water and then piped to our taps.)

3. ABC Waters Programme
• Ask students, "What does the “ABC” in ‘the ABC Waters Programme' stand for?" (Active, Beautiful and Clean)
• Explain the concept of the ABC Waters Programme, where waterways and reservoirs have been transformed to bring people closer to water, provide a beautiful environment for all to enjoy and create community spaces for new lifestyle activities and attractions.
• Explain the individual components that make up the ABC Waters Concept i.e. Ecology, Hydrology and Community.
• Ask students to classify the features at Jurong Lake according to these 3 components:
<table>
<tr><th>Ecology</th><th>Hydrology</th><th>Community</th></tr>
<tr><td>• Freshwater lake – habitat for aquatic and bird life
• Park – vegetation /plants
• Floating wetland</td><td>• Lake – storage of stormwater
• Inlets which channel stormwater from the neighbourhoods of Boon Lay, Jurong East and Jurong West
• Natural cleansing of stormwater by wetland plants
• Aeration of water by “geyser”</td><td>• Location for water sports – dragon boating and kayaking
• Chinese and Japanese gardens – recreation and tourism
• Park facilities – viewing gallery, pavilion, jogging path, fishing area, etc. encourage people to use parks for exercise, leisure and events
• Educational site – Science Centre Singapore</td></tr>
</table>
</td><td>Pg 8

Pg 9</td></tr>
</table>

Station 4: Water Quality at Jurong Lake

Duration: 25min
Location: Start of the Boardwalk
Learning Points:

- Test and analyse some key water parameters
- The importance of good water quality

Trainer's Notes	Cross Reference/ Materials
1. Bring students or let students navigate to the start of the boardwalk. 2. 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.) • Why does the water in a reservoir need to be of good quality? (It is a source for our water supply and to support aquatic life.) 3. Tie the rope of the pail to the railing and collect some water. Pour the water into one water kit and bring students to a shaded area to put down their bags. 4. Ask students to turn to the pages 10 and 11 of their booklet. Explain why we carry out this water testing – to see what the water quality in the reservoir is like. It needs to be good as it is for our water supply. Although all the raw water undergoes treatment, the cleaner the water, the easier and cheaper it will be to treat. Also, water in the reservoir sustains aquatic life. The water testing activity during this trail is not an extensive one, but we will have a quick indication of water quality for that day and hour. 5. **Conduct a demonstration** on how to use the water kits. You may also use the data loggers brought by the school. Introduce the World Water Monitoring test kit. Pour water from the pail into an emptied water kit to the fill-line. Highlight that for accuracy, the water needs to be filled exactly to this level. 6. Run through the water parameters progressively, as in pages 10 and 11, 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. 7. After your demonstration, assign the teams and distribute the test kits to each team. 8. Collect more water from the reservoir in a pail to distribute to the students. Ensure that no student is allowed to collect water directly from the reservoir and that no equipment falls into the reservoir. Give teams 10-15 minutes to complete their tests and record their answers in the "observation" boxes in	Pg 10, 11 Pail, rope, data logger and sensors or water quality testing kits, turbidity disc

their booklets. They should not fill in the “analysis” boxes yet. You will analyse the results of all the teams after they have obtained their results.

9. 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.

10. Discuss the readings obtained and **evaluate the state of the reservoir 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.

  Explain that it is important not to litter. Throwing litter will pollute the waterways and reservoirs. For example, plastic bottles thrown in by inconsiderate people. These bottles are unsightly and non-biodegradable.

- **Colour** – the water should be colourless or slightly green (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 reservoir. The clearer the water, the higher the light penetration – allowing more aquatic plants/algae to grow in the reservoir.

- **Temperature** – expected results is between 28 – 30^{o}C. Ask students what factors can affect water temperature (weather conditions, rain).

  Reiterate that temperature can affect the amount of dissolved gases, like dissolved oxygen. The higher the temperature, the lower the level of dissolved oxygen. Water temperature also affects aquatic life. The metabolic reactions that are catalysed by enzymes in the body of organisms will be adversely affected when the temperature is too high or too low. High temperatures can kill living organisms.

- **Dissolved Oxygen** – this should be at least 4ppm (parts per million), below which the water will be too low and poor to support aquatic life. Ask students what affects the level of dissolved oxygen in the water (previously mentioned under temperature).
  - Organic materials that are present in the water will be decomposed by bacteria. These bacteria will use up oxygen in the water.

○ When the water is turbulent, for example due to windy conditions, more oxygen will be mixed into the water. ○ When photosynthesis takes place, plants take in carbon dioxide and release oxygen and vice versa when they respire. When there is sufficient light, like on sunny days, aquatic plants will photosynthesise more than they respire and therefore the level of oxygen in the water will increase. • **pH** – pH of 6 – 9. The water may tend to be slightly acidic as it is fed from forest streams which have dissolved tannins (from leaf litter). ○ The pH scale is from 0 to 14, with pH 0 being very acidic, pH 7 being neutral and pH 14 being very alkaline. ○ H^+ ions contribute to acidity while OH^- ions contribute to alkalinity. A solution is neutral when there is an equal amount of both ions. Most aquatic organisms survive well in pH range that is near neutral.	
11. Summary. Ask students to turn to page 12. Give them 5 min to answer the water quality questions before you discuss them: • What is your team's conclusion for the water quality in Jurong Lake: Overall quality of water is generally good. • What are the consequences for our water supply and aquatic life? (If water quality is good, less cleansing and treatment is needed and it will support a rich aquatic community (enhancing biodiversity in the area).) • What are the limitations of today's water testing? ○ Only one measurement was taken at each location – at the water's surface ○ For a more comprehensive water testing we need to test water from different depths, different times of day, from many locations throughout the year. ○ The test kit may pose some limitations as well: temperature strip does not work well or is inaccurate; water was sampled from only two sites.	Pg 12

Station 5: Floating Wetlands; Human activities and their potential impact

Duration: 15min
Location: Part of the boardwalk near the floating wetlands
Learning Points:

- Understand the past and functions of the floating wetlands
- Benefits of the floating wetland
- Biodiversity of wetland plants and animals
- Observe human activities at Jurong Lake (fishing, jogging, etc.)
- Observe some impact and link this with park users

<table>
<tr><th>Trainer's Notes</th><th>Cross Reference/ Materials</th></tr>
<tr><td>

1. Observe the floating wetlands along the boardwalk.

- Ask students to name the main components of each wetland unit.

<table>
<tr><th>Main Parts</th><th>Functions</th></tr>
<tr><td>Wetland Plants</td><td>Improve the water quality, provide shelter and food for animals, and beautify the reservoir.</td></tr>
<tr><td>Planting Support Materials</td><td>Provide support for initial establishment and growth of wetland plants.</td></tr>
<tr><td>Floating Materials</td><td>Provide flotation for the wetland, support plant life and a community of micro-organisms for additional cleansing.</td></tr>
<tr><td>Plant Roots</td><td>Absorb nutrients from the water including nitrates, ammonia, phosphates, etc.
Provide a surface for micro-organisms to attach to. These micro-organisms are able to break down pollutants, improving the water quality.</td></tr>
</table>

- Additional information on floating wetlands:
  - Floating wetlands are systems where wetland plants grow on floating mats on the surface of the water rather than being rooted in sediments of the pond/reservoir.
  - The floating wetlands are made up of 3 buoyant layers of AquaGreen Repofloat I-3 mats (made from Polypropylene and Polyethylene), wrapped with coir webbings (made from coconut fibre) that promote plant establishment.
  - Sengkang Floating Wetland at Punggol Reservoir has the largest man-made floating wetland in Singapore. The whole wetland measures 2,400 m^2.

2. **Observe the plants on the floating wetlands** – identify them using the guide on page 15.
   - Additional information on the wetland plants:
     - The wetland plants were chosen for their natural cleansing and aesthetic properties.

</td><td>Pg 14

Pg 15</td></tr>
</table>

○ Plants absorb nutrients and pollutants through their roots. ○ The selected species are emergent plants with their roots on the mats that penetrate into the water. Their stems, leaves and flowers stay above the water surface.	
3. **Discuss the benefits of the floating wetlands** (ask students to fill in their answers). • Improve the water quality of the lake. • Provide a habitat for animals (provide shelter and food for animals) and enhance biodiversity in the area. • Increase the aesthetic value – beautifies the lake	Pg 14
4. Observe life on and around the floating wetland. • These could include: Monitor lizards, White-Breasted Waterhens, sunbirds, bees, dragonflies, etc. • What are they doing (behaviour)? (Resting, feeding, etc.).	Pg 16, 17
5. **Observe life in and around the lake.** • These could include: Fishes, Red-Eared Sliders, birds, etc.	Pg 16, 17
6. Observe the fishing gallery. • Walk to the fishing gallery area and ask students to read the “rules” of fishing at Jurong Lake. • Discuss why these rules are necessary. Is the fishing area clean?	
7. Observe and record other **human impact** in and around the water.	Pg 18

Debrief and Reflection

Duration: 30min
Location: Southern Pavilion or any shaded area
Learning Points:

- Water Sustainability in Singapore
- ABC Waters Programme
- Water Quality at Jurong Lake
- Biodiversity at Jurong Lake
- The potential human impact at Jurong Lake and solutions
- Student Reflections

Trainer's Notes	Cross Reference/ Materials
1. **Play the "Water Wise" game.** • Form up to 5 teams and explain the game: o Each team will be given a card with a topic written on it. They must not show the card to anyone or say the words of the topic out loud. o For 5-10 minutes, the team is to brainstorm examples related to the topic (they can write on a piece of paper). If there is more time, each team can be given 2 cards. o After 5-10 minutes, each team will take turns coming up to the front. Each team member will provide clues to what their topic is. However, they are not allowed to use any of the words that are underlined on their card. The first team to guess the right topic wins. o Example: If the topic on the card is "Reservoirs of Singapore". Team members can provide clues such as "MacRitchie, Lower Seletar or Bedok". The word "reservoir" or "reservoirs" cannot be used. • Once all the topics have been covered, you may use the facts covered by the students and the topics discussed to lead towards your debrief. 2. **Debrief the learning points of the trail.** • **Water Sustainability in Singapore** o This trail is about "water sustainability". What is water sustainability? (To continue to have sufficient water for a growing population.) o How has Singapore achieved this? (Four National Taps.) o Which tap is Jurong Lake and other reservoirs part of? (First National Tap – Local Catchment water.) o What is the source of water for Jurong Lake? (Rain falling over it and rain falling on the surrounding estates of Boon Lay.)	"Water Wise" cards (Annex 5)

- **ABC Waters Programme**
  - Recap the concept of the ABC Waters Programme – includes the Hydrology (Blue), Ecology (Green) and Community (Orange) components.

- **Water Quality at Jurong Lake** — Pg 12
  - Recap the analysis and conclusions from Page 12.

- **Biodiversity at Jurong Lake**
  - Jurong Lake attracts a substantial number of animals – especially birds. The trees in the park are mature and support a relatively rich park life too.
  - Ask students to recap all the animals observed as a class and discuss the number of animals seen.

- **Potential human impacts at Jurong Lake and its solutions** — Pg 18

Activity	Potential impacts	Solutions
Nature walks Joggers	Littering Noise pollution (scaring animals away)	• Educate users on consequences of their actions • Enforcement of laws
Water sports: kayak	Negative pollution of water – littering (losing their water bottles)	• Educate kayakers not to pollute waters
Fishing	Disturbance of native fish species Depletion of fish population – bringing fish home Littering –food waste, fishing lines, etc.	• Restriction of fishing grounds (not to include inlets) • Return of all fishes caught back to the reservoir • Educate fishermen • Restriction to only artificial baits • Enforcement of laws
Feeding of fish and other animals	Pollute the water when there is extra food Populations of animals become abnormally high	• Educate users on consequences of their impact • Enforcement of laws
Release of animals in the lake	Affect the population in the lake and the ecosystem	
Vandalism	Damage to public property	• Officers/ volunteers to check and advise public • Install CCTV

3. Ask students to turn to page 20 and 21 and **write their reflections**. Ask a few students to share. Here are some expected answers: — Pg 20, 21

• What are some ways you can personally minimise impact at our ABC Waters Sites?
  ○ Throw rubbish responsibly into bins
  ○ Do not throw chemicals into drains
  ○ Do not feed fishes or any other animals at our water bodies and parks
  ○ Do not release any animals at our water bodies and parks
  ○ Help to pick litter you see
  ○ Tell others about the need to be responsible for our waters
  ○ Learn to conduct this learning trail for other students
  ○ Report to PUB if you encounter any undesirable activities	

Extension Activity: Sketching and Water Quality Testing at a Second Site

Duration: 25min
Location: Sungei Lanchar
Learning Points:

- Students may sketch ABC Waters features, iconic buildings at the lake.
- Comparison of the water parameters at 2 different locations at Jurong Lake
- Virtual Water
- Our Water Story

Trainer's Notes	Cross Reference/ Materials
1. Sketching • Ask students to place their bags on the ground and give them 5-10 minutes to sketch a feature at Jurong Lake. Remind them to title their sketch, calculate the scale and label the different parts of the feature drawn.	Pg 19
2. Water quality testing at second site • Collect water from the inlet at Sungei Lanchar with pails and test for the water parameters. Write these down under the column "Location 2" or the alternative box on pages 10 and 11. • Compare the second set of readings with that of the first set and discuss your results. This question on page 12 becomes relevant: • **Are there any differences between the water parameters at Location 1 and Location 2?** • Answers may vary according to how polluted these locations are. You can compare parameter by parameter.	Pg 10-12 Pail, rope, data logger and sensors or testing kits, turbidity disc
3. If you have time, you could ask students to try out the activities on pages 22 and 23. • **How much water to make food?** o Answers (in descending order of amount of water required) 1. Hamburger (2400 litres) 2. Glass of milk (200 litres) 3. Egg (135 litres) 4. Apple (70 litres) 5. Slice of bread (40 litres) 6 Potato (25 litres) • **The Singapore Water Sustainability Quiz** o Answers 1. First National Tap – Local Catchment ▪ About 2/3 of Singapore's land is used for local water catchment	Pg 22, 23

▪ A Singaporean uses an average of 152 litres of water/pax/day ▪ As a nation, Singapore needs about 1.73 billion litres of water every day. 2. Recreational activities available at ABC Water sites: kayaking, water skiing, fishing, sailing, dragon boating 3. Low capacity flushing cistems that use not more than 4.5 litres of water per flush. 4. Use the sink stopper and fill the sink with water.	

References

- *Active, Beautiful, Clean Waters Design Guidelines,* (2009, 2011), PUB.
- Water for All: Conserve, Value, Enjoy – Meeting our water needs for the next 50 years, *(2010), PUB Public Document*.
- 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.

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. Raincoat or umbrella (in case of rain)
5. Ziploc bag for waterproofing valuables (e.g. camera, hand phone)
6. A pen, or pencil and eraser

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

Optional

- Snacks
- Digital camera or camera hand phone
- Cap

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			
Activity:	ABC Waters Learning Trail	**Venue:**	Jurong Lake
Outgoing		**Returning**	
Date:	To be filled by teacher	**Date:**	To be filled by teacher
Estimated Time of Departure:	To be filled by teacher	**Estimated Time of Arrival:**	To be filled by teacher
Person-in-charge:	To be filled by teacher	**Assistant(s):**	To be filled by teacher

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

OVERSEAS VENDOR CONTACT DETAILS (IF ANY)			
Company name & full address:	NA		
Office number:	NA	**Mobile number:**	NA
Contact Person:	NA		

WHY
State learning objectives: This programme aims to: 1. Foster a sense of national identity and emotional rootedness to Singapore 2. Learn about the Singapore Water Story, appreciating Singapore's unique challenges and successes 3. 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 4. Better understand ecological and water topics in the Science syllabus 5. 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
WHAT (GENERAL)									
1.	**Equipment**								
	a) Appropriate equipment is available.								
	b) Appropriate equipment is serviceable.								
	c) Others :								
2.	**Transport**								
	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.	**Food**								
	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 :								
WHEN (TIMING)									
4.	**Programme**								
	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 prolong 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 :								
WHO (PEOPLE)									
5.	**Teachers and Adult Supervisors**								

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	- Facilitators are experienced in supervising/managing students - Program ratio will be 1 facilitator to 20 maximum students.		
	b) Personnel is certified and competent to conduct activity.	Participants risk possible danger when outdoors	Participants may injure themselves	2	1	2	- Facilitators are experienced in conducting activities for students in indoor and outdoor settings.		
	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	- Facilitators are first-aid certified. (please verify) - 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.		
	d) Personnel is competent to co-ordinate/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	- Should there be a medical emergency involving the injured student, the main facilitator will call for an ambulance and the teacher/parent volunteer will		

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.	**Participants**								
	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.						- A SAFETY briefing will be given at the start of the programme. Facilitators will reiterate safety points during the programme, when necessary. - Students will be briefed to react if they encounter potentially dangerous animals e.g. snake, monkeys, etc. - Students will be briefed not to enter water bodies; not cause anyone to fall into the water bodies. - Water collection for testing will not be carried out by students, but only by facilitators or teachers.		
	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 :								
WHERE (LOCATION)									
7.	**Venue**								
	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 :								
WEATHER									
8.	**Inclement Weather**								
	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 **impending thunderstorm, heavy rain or**		

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
							levels of PSI above 100, it is advised to delay the departure for the location, until Lightning Category 1 is lifted. - If there is **Lightning category 1 or PSI level of equal or greater than 100 during the Learning Trail,** all activities will be stopped and students will be led to take shelter. - If the conditions persist, the programme will be aborted and students brought back to school.		
	b) Others :								

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

Excursion Checklist		Action Plan	Implementation	
			Action Officer	Follow-up Date
1.	**Communication**			
	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.	**Medical**			
	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.	**Overseas Travel**			
	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.	**Others**			
	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 at least 3 days before departure

Approved by:

Name of Chief Safety Officer/Principal	Signature	Date
Comments:		

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, water supply and water sustainability	Technology and an integrated approach for a robust supply of 'WATER FOR ALL'	**Geography** • Managing the changing environment – Water resources: Water as a precious resource. • Responses to the rising demand of water. Case study of water supply in Singapore. **Science** • Process of reverse osmosis in NEWater and desalination to get clean water. **National Education** • No one owes Singapore a living. • We find our own way to survive and prosper, turning challenges into opportunity. • We have confidence in our future. • United, determined and well-prepared, we have what it takes to build a bright future for ourselves, and to progress together as one nation. **Character and Citizenship Education** • Respect: Respect our homeland. • Resilience: Being a resilient nation.
2	ABC Waters Programme that integrates ecology (green parks), hydrology (blue waters) and the community (the public) at Jurong Lake	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	**Geography** • Understanding the environment – Physical and human environments. • The inter-relationships between people and the environment. • Understanding the environment – Environments through maps. • Map skills. • The physical environment – Introduction. • Components of the physical environment. • The human environment – Introduction. • The human environment is a product of interaction with the physical environment.
3	Retaining the rich historical and cultural background of Jurong Lake	Importance of history and culture despite urbanisation of Jurong Lake for all to value	**History** • The history of Jurong Lake – The growth and development of a place from a rural area to an urban settlement. **Geography** • Managing the changing environment – ○ Introduction: Role of humans in managing the changing environment, land supply. • Understanding the environment –

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula
			Environments through maps: ○ Types of maps and their uses (e.g. sources of information, records of changes in the environment, basis of planning and decision-making). ○ Importance of maps in the past and today. **National Education** • Singapore is our homeland; this is where we belong. **Character and Citizenship Education** • Respect: Respect our homeland. • Care: Caring for the community and the nation.
4	Park features around Jurong Lake	Enjoy and CONSERVE WATER by bringing people close to water ways	**Geography** • Introduction to geography – Earth as home. • Earth as part of the Solar System. • Only one Earth and home (e.g. food, shelter) for all human kind. • Understanding the environment – Environments through maps. • Map skills. • The physical environment: Natural vegetation. • Inter-relationship between climate and vegetation. • The human environment – Introduction. ○ The human environment is a product of interaction with the physical environment. • Managing the changing environment – Global Warming: • Measures to reduce the impact at different levels.
5	The water cycle and water quality at Jurong Lake	Clean WATER FOR ALL	**Geography** • The physical environment – Rivers: The Hydrologic Cycle (evaporation, transpiration, condensation, rainfall, runoff). • The physical environment – Weather and Climate: ○ Weather elements (temperature, rainfall, wind); ○ Weather, climate and people. • Managing the changing environment – Water resources: ○ Water as a scarce resource.

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula

			Science
			• Process skills: Observing, comparing, using apparatus, analysing and interpreting.
			• Diversity of matter.
			• Solutions (chemical or minerals) and suspensions (turbidity).
			• Measurements:
			  ○ Use of measuring instruments.
			  ○ Physical quantities and units.
			• Parameters for water quality: appearance, smell, temperature, pH, dissolved oxygen.

6	Human activities and their impact	WATER IS PRECIOUS.
		
		Use water wisely at all times.
			Character and Citizenship Education
			• Respect: Respect for life and nature.
			• Responsibility: Being responsible members of the community.
			• Being an active citizen.
			• Integrity: Practising integrity in all spheres of our lives.
			• Care: Caring for the community and the nation.
			Harmony: Living in harmony with our environment.
			Geography
			• Understanding the environment.
			• Physical and human environment.
			• The inter-relationships between people and the environment.
			• Managing the changing environment – Introduction:
			  ○ The impact of human activities on the environment at local, regional and global scales.
			  ○ Protecting and conserving the environment at different levels (individual, national, international).
			Science
			• Ethics and attitudes:
			  ○ Impact of humans' actions on the environment
			  ○ Show an appreciation of humans' responsibility to have care and concern of living things and the environment.
			  ○ Conservation of the environment.
			• Water pollution-sources, impact and measures to curb or reduce the pollution.

7	Biodiversity at	Creating an environment	**Character and Citizenship Education**

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula

	Jurong Lake	for the BIODIVERSITY in Jurong Lake	• Respect: Respect for life and nature.
			• Harmony: Living in harmony with our environment.
			Geography
			• Understanding the environment.
			• Physical and human environment.
			• The physical environment as a natural resource
			• The physical environment - Introduction:
			  ○ Components of the physical environment – natural vegetation.
			• The inter-relationships of all the components in the physical environment.
			• Managing the changing environment –
			  ○ Introduction: Protecting and conserving the environment at different levels (individual, national, international).
			Science
			• Diversity (of plant and animal life)
			• Classification of plants and animals
			• Interaction
			• Population, community and ecosystem
			• Food chain in the natural environment
			• Energy
			• Photosynthesis – land and water
			• Energy transfer process in the ecosystem.

Annex 4: “Reservoir” Cards

Bedok

MacRitchie

Lower Seletar

Punggol

Serangoon

Pandan

Jurong Lake

Lower Peirce

Marina

Kranji

Annex 5: “Water Wise” Cards

Reservoirs of Singapore	Four National Taps of Singapore
Uses of Floating Wetlands	Uses of Water
What you should not do in Parks	Activities in the Parks
Benefits of Plants	Animals in Parks

Ways to Save Water	Ways to Clean Water

Annex 6: Suggested Packing List (of Resources) – for Trainers

1. First Aid Kit
2. Insect repellent
3. 4-5 Compasses
4. 4-5 sets of “Reservoir” Cards (Annex 4)
5. 4-5 sets of “Water Wise” Cards (Annex 5)
6. 4-5 pails with rope attached (for collection of water)
7. Water Monitoring Kits with pH strips, turbidity discs, thermometer and dissolved oxygen tablets, glass vial and pH vial
8. Plastic bag to collect used pH strips and water which has been tested

Optional:

9. Charged data loggers including temperature, pH and Dissolved oxygen sensors
10. Bird and insect cards, nature guide books
11. Camera

Acknowledgements

Keppel Land Sponsor of the ABC Waters Learning Trail @ Jurong Lake

Bukit View Secondary School

Shuqun Secondary School

Swiss Cottage Secondary School

Westwood Secondary School

Yuan Ching Secondary School

Ministry of Education,
Curriculum Planning and Development Division, Science 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.

PUB SINGAPORE'S NATIONAL WATER AGENCY

www.pub.gov.sg