PUB ACTIVE, BEAUTIFUL, CLEAN WATERS

SECONDARY

Learning Trail

@MacRitchie Reservoir

TRAINER'S GUIDE

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

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

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 MacRitchie Reservoir, Singapore's first 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 @ MacRitchie

Level: Lower Secondary Students (13 – 15 years old)
Programme Duration: 2 hours 50min – 3 hours
Ratio of Facilitator to Students: 1 : 10 – 20 students
Recommended maximum group size: 80 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

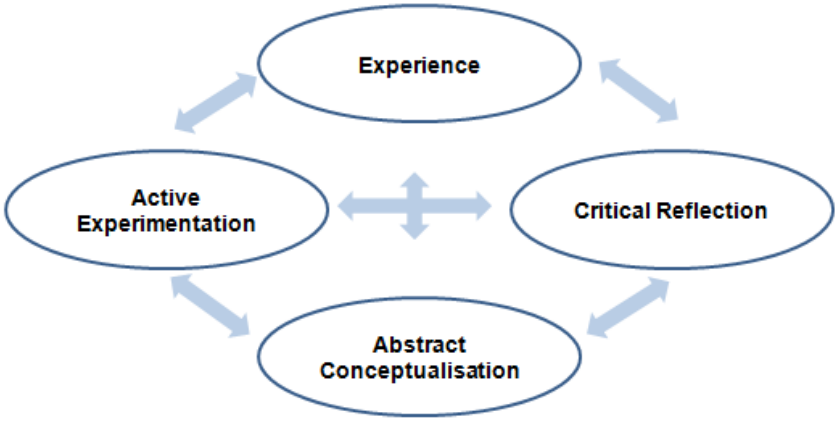
This is achieved by:

- 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 MacRitchie 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 Amenities Centre and conduct the problem based learning activity on page 19 of the student booklet and the “Journey of Water” card activity
- 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. Conduct the problem-based learning activity at the Amenities Centre.

Summary of the ABC Waters Learning Trail @ MacRitchie

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
	15min	Amenities Centre	**Introduction** • Aims of the ABC Waters Learning Trail. • History of MacRitchie Reservoir with some links to the history of Singapore. • The location of MacRitchie Reservoir and land use around it. • The route and trail stations of the Learning Trail. • Safety briefing.	**History** of Singapore **Geography** – understanding the environment (environments through maps), the physical environment (natural vegetation)	2-5	Student booklets, optional: compass

1	30min	Trellis Walk, Hill, ZigZag Bridge, Submerged Boardwalk	**MacRitchie's Secrets**
			• Main features in MacRitchie Reservoir, including some ABC Waters features like the Trellis Walk, Focal Garden, Submerged Boardwalk and gravel swales.
			• The ABC Waters programme integrates 3 components in the Urban Sustainable Environment model: hydrology, ecology and community.
			• Evaluate the value/significance of MacRitchie Reservoir.
			• Optional:
			  ○ Sketching an iconic feature in MacRitchie Reservoir (+ 10-15min)
			  ○ Water Testing at ZigZag or Submerged Bridge (+25min)
				Science – process skills (observing, inferring)
				
				Geography – understanding the environment (physical and human environments)
					6,7,10
					
					11
					
					14,15
						Pail, water testing kits, data loggers

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
2	15min	Draw-off Tower/ Focal Garden area	**Our Water Story** • Four National Taps and how this Learning Trail helps students to better understand the First National Tap – Local Catchment Water. • Potable Water and the Journey of Water to our taps. • First-hand observation of some water facilities at MacRitchie Reservoir. • Optional: Water testing at Draw-Off Tower (+25min)	**Geography** – managing the changing environment (water resources) **National Education** – no one owes Singapore a living	8,9 14,15	"Journey of Water" cards Pail, water testing kits, data loggers
3	30min	Green Car Park, Landscape Retention Pond, Landscape Pond, Amenities Centre	**Sustainable ABC Waters Features at MacRitchie Reservoir** ABC Waters design features and concepts • Bio-filtration at the Landscape Pond and Green Car Park Bioretention Planter Boxes. • Urban Catchment and the Green Car Park. • Water cleansing by wetland plants at the landscape retention pond. • Green roof of the Amenities Centre.	**Geography** – managing the changing environment (water resources)	12,13	

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
4	25min	ZigZag Bridge, Submerged Boardwalk, Draw-off Tower or Spillway	**Water Watch - What's the Water Quality Like?** • Understand the importance of good water quality and some key parameters. • Collect water from the reservoir, test and evaluate water quality. • Relate water quality to water supply and aquatic life.	**Science** – process skills (observing, comparing, using apparatus, inferring), solutions and suspensions, importance of various physical factors to the life of the organisms **Geography** – managing the changing environment (pollution)	14,15	Pail with a rope, water testing kits, data logger
5	35min	From Spillway to Prunus Trail (second platform) and back	**The Meeting of the Habitats and Human Impact** • Recognise that MacRitchie Reservoir and surrounding forests have a rich biodiversity. • Recap, spot and record plants and animals around the reservoir (park area, forest edge, over the water) and in the water. • Recognise that MacRitchie Reservoir/park/trail is an important community space that promotes social bonds, healthy lifestyle and water sports. • Recognise that usage by the community results in human impact. Recap, spot and record human activities and human impact at the reservoir. • How to minimise human impact at MacRitchie reservoir and help enhance the biodiversity in the area.	**Science** – biodiversity of plant and animal life (classification), identifying habitats and some of the organisms associated with the habitats, importance of conserving the environment **Geography** – managing the changing environment (water resources)	16,17, 18	Optional: nature guide cards/books, binoculars

Station	Duration	Location	Main Points	Subject Links	Page No.	Materials
-	20min	Amenities Centre, Reservoir Deck, shelter	**Debrief and Reflection** • Recap of learning points of the Trail. • Debrief the Biodiversity and Human impact "survey". • Reflection questions.	**Geography** – protecting and conserving the environment at different levels (individual, national, international) **National Education** – no one owes Singapore a living **Social and Emotional Learning (SEL)**	18	
Total Duration: 2 hours 50min - 3 hours						
EXTENSION ACTIVITY						
-	1.5-2hr	As preferred	**A Problem-Based Learning Activity** • Discuss and come up with a ten-year plan for MacRitchie Reservoir.	**Geography** – managing the changing environment (water resources)	22	Flipchart paper, markers (for each team)

Lesson Plan for the ABC Waters Learning Trail @ MacRitchie

Introduction

Duration: 15min
Location: Amenities Centre
Learning Points:

- Aims of the ABC Waters Learning Trail
- History of MacRitchie Reservoir with some links to the history of Singapore
- The location of MacRitchie Reservoir and land use around it
- The route and trail stations of the Learning Trail
- Safety briefing

Trainer's Notes	Cross Reference/ Materials
1. **Welcome** students to MacRitchie Reservoir. **Distribute the booklets to students** and ask them to write their names.	
2. Explain the **aims of the trail** on page 2 and themes that the Learning Trail will cover.	Pg 2
3. **History of MacRitchie** - Ask students to **study the timeline** on page 3 and answer the question: "What can you learn from the timeline?" Expected answers: • MacRitchie was completed in 1867; it was the first reservoir in Singapore and was needed to supply water for the growing population of the British trading port. • It was involved in the Japanese Occupation and was captured by the Japanese a few days before the British surrendered to the Japanese. • Its original name was "Impounding Reservoir" and was later named after James MacRitchie, who was the Municipal Engineer.	Pg 3
4. **Location of MacRitchie Reservoir and land use around it** – Ask students to study the maps on page 4. Suggested questions: • Where is MacRitchie Reservoir found? (In the central area of Singapore) • Where is your school? (Answer varies) • What can you see surrounding MacRitchie Reservoir? Fill in the land use boxes. Expected answers: ○ North of MacRitchie Reservoir: forest reserve. Explain that this is the Central Catchment Nature Reserve; ○ West of MacRitchie Reservoir: golf club/course (Singapore Island Country Club) • What does the shape of MacRitchie Reservoir look like to you? (This is a	Pg 4

creativity-based question. Some possible answers - an amoeba, ginger, roots, etc.) • Explain that the bird mascot that asked the question is a male Olive-backed Sunbird. 5. **Setting the map** - Ask students to **set the map** on page 5 (optional use a compass or landmarks, like the dam). 6. **Route and trail stations** - Explain that the trail will consist of 6 stations. Students are to navigate from Stations 1 – 6, and carry out a task/activity at each station. If there are more than one group, students may be moving in a different order, to avoid having too many people at the same station (e.g. Station 6 → 3 → 4 → 5 → 1 → 2). 7. **Conduct a safety briefing:** • Students should inform you or their teacher if they are not feeling well, or if they have been injured, bitten by an animal (monkey) or stung by an insect. • They need to look out for potentially dangerous animals like snakes, scorpion, centipede and move away from them if these are encountered. • They are not to enter the reservoir or pollute it. • They need to be aware of weather changes and listen to you or their teacher for instructions. Should there be an impending thunderstorm (lightning category 1 warning), the learning trail will be stopped and students will be asked to return to the Amenities Centre. 8. Give students 3 min of preparation time to: • Apply mosquito repellent • Use the washroom • Buy a drink or drink water 9. Start the trail – let students navigate their way to the first station.	Pg 5 (optional: compasses)

Station 1: MacRitchie's Secrets

Duration: 30min
Location: Trellis Walk, Hill, ZigZag Bridge, Submerged Boardwalk
Learning Points:

- Main features in MacRitchie Reservoir, including some ABC Waters features like the Trellis Walk, Focal Garden, Submerged Boardwalk and gravel swales
- The ABC Waters programme integrates 3 components in the Urban Sustainable Environment model : hydrology, ecology and community
- Evaluate the value/significance of MacRitchie Reservoir
- Optional:
  - Sketching an iconic feature in MacRitchie Reservoir (+10-15min)
  - Water Testing at ZigZag or Submerged Bridge (+25min)

Trainer's Notes	Cross Reference/ Materials
1. Students should find their way to the top of the hill. Along the way, you could point out the **Trellis Walk and Focal Garden**. The Focal Garden is the area where the large fig tree is, near the foot of the stairs leading to the top of the hill.	
2. At the top of the hill, explain the activity – Students will need to look and spot as many features on page 6 and 7 of their booklet. They will be given 10 minutes, after which you will go through the features. Optional: they could take their own photographs of these features. After most of your students have spotted the features nearer the dam, ask them to follow you to the other side near the ZigZag Bridge to see the other features.	Pg 6, 7
3. After 10 minutes, gather the students and debrief the activity: • Which features could they spot? (All, except the golf course and gravel swales. Explain that the golf course can be seen when they are near the Kayak Platform. The gravel swales will be seen along the route from station 1 to 2.) • Highlight a few of the features they had spotted and ask students to read the information given in their booklet e.g. Lim Bo Seng Memorial, Bandstand and ZigZag Bridge.	

4. Ask students to turn to page 10.
• 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 using these 3 components in the sustainable urban environment:
  ○ **Hydrology** – comprising reservoirs and waterways, our first National tap.
  ○ **Ecology** – comprising the parks and surrounding land and aquatic habitats which support biodiversity.
	Pg 10

○ **Community** – comprising the people visiting and enjoying the reservoir/park. • Next, ask what they think MacRitchie is important or significant for. Give them a few minutes, before going through the answers. ○ MacRitchie Reservoir is important and significant for all of the points, except "tourism" and "residential site". Additional notes for each point: – It is important for supplying water by collecting and storing water. – It is an important historical site being the first reservoir in Singapore, and the location for Lim Bo Seng's Memorial. The iconic Bandstand and ZigZag Bridge is remembered by many people. – MacRitchie Reservoir is important as a recreation site: today it is a venue for kayaking, jogging and nature walks. It is bounded by a golf course and the Bandstand is a venue for musical performance. – MacRitchie Reservoir is significant for the conservation of local plants and animals, with the Central Catchment Nature Reserve flanking the north of the reservoir.	Pg 10
5. Lead students across the **ZigZag Bridge and walk the Submerged Boardwalk** (remove shoes before walking). Explain that the water feature found landward, which is planted with wetland plants, "cleanses" the rainwater draining into the reservoir by absorbing nutrients through their roots and trapping sediments.	
6. **Optional: Sketching (10-15min)** – Ask students to select an interesting feature in MacRitchie and sketch it on page 11 of their booklet. Ask students to include a title and labels for their sketches and to calculate and record the scale of their sketch.	Pg 11
7. **Optional: Water Testing (25 min)**. If you choose to do so, collect water from the Submerged Boardwalk. 8. Next, lead students up to the road and show them the **Gravel Swales**. As with the water feature found near the Submerged Boardwalk, the plants in the swales cleanse the rainwater (absorbing nutrients and trapping sediments) before it is channelled to the Marina Reservoir.	Pg 14,15; Pail, water testing kits, data loggers.

Station 2: Our Water Story

Duration: 15min
Location: Draw-off Tower / Focal Garden area
Learning Points:

- Four National Taps and how this Learning Trail helps students to better understand the First National Tap – Local Catchment Water
- Potable Water and the Journey of Water to our taps
- First-hand observation of some water facilities at MacRitchie Reservoir
- Optional: Water testing at Draw-Off Tower (+25min)

Trainer's Notes	Cross Reference/ Materials
1. Ask students some inquiry questions about **Singapore's water supply**: • How many National taps are there in Singapore? (Four) • What are they? (Local Catchment Water – water collected from rain, canals and reservoirs, NEWater, Imported water and Desalinated Water) • How many reservoirs are there in Singapore? (17) • What does potable water mean? (Safe, drinkable water. Explain that our tap water in Singapore is potable.)	
2. Ask students how water from this reservoir reaches their taps. Distribute **'Journey of Water' cards** to each team and give them 5 minutes to arrange the cards in the correct order.	Template of cards found in Annex 4
3. Gather all teams and run through the answers: Rain → Natural Bio-filtration (through the forest) → Collection at ABC Waters Sites → Draw-off Tower → Pumping Station → Water Treatment Plant → City, Homes and Industrial Areas.	
4. Ask student to turn to pages 8 and 9, highlighting the Four National Taps, the 17 reservoirs and the processes involved in getting the water to our taps.	Pg 8, 9
5. Ask students what features (in the cards) can they observe from where they were? (Forest - where bio-filtration takes place, Draw-off Tower, dam and pumping station). Optional: take photos, ask a few students to explain the function of these features.	
6. **Optional: Water Testing (25 min)**. If you choose to do so, collect water from the Draw-off Tower.	Pg 14,15; Pail, water testing kits, data loggers.
7. Start down the **Trellis Walk** to the MacRitchie Pond.	

Station 3: Sustainable ABC Waters Features at MacRitchie Reservoir

Duration: 30min
Location: Green Car Park, Landscape Retention Pond, Landscape Pond, Amenities Centre
Learning Points:

- ABC Waters design features and concepts
  - Bio-filtration at the Landscape Pond and Green Car Park Bioretention Planter Boxes
  - Urban Catchment and the Green Car Park
  - Water cleansing by wetland plants at the Landscape Retention Pond
  - Green roof of the Amenities Centre

Trainer's Notes	Cross Reference/ Materials
1. Bring students to the **Green Car Park**, near a Bioretention Planter Box. Remind them to be aware of traffic in the car park.	Pg 12, 13
2. Explain that traditionally, reservoirs only collected water from pristine forest catchment area. Today, to meet our water demands, we are turning to another form of catchment – **urban catchment**. This means that rainwater (storm-water) falling in urban areas are also being channelled into reservoirs as a source of water, as part of our First National Tap.	
3. Point out the pipes and the **Bioretention Planter Boxes** to students and ask them if they can guess what is happening here. (Expected answer: Water from the car park is collected and distributed over the Bioretention Planter Box). Praise students for their good inference skills.	
4. Show students the piping over the Bioretention Planter Box and explain that the rainwater passes through the boxes and is cleansed by the plants (plant roots absorbing some nutrients and possible pollutants; and then being "filtered" by the layers of materials (sand, gravel, etc.) within the planter boxes). Explain that there are many such planter boxes at the car park including one that is in series in the middle of the car park. They can refer to the student's booklet on page 13 to see a cross-section of a Bioretention Planter Box.	Pg 13
5. Trace the grey pipes in the drain to the **Landscape Retention Pond**. Remind students to be careful of traffic again as the pond is at a roundabout. At the pond, explain: • How the wetland plants planted around the pond cleanses the water another step (after the bio-filtration at the Bioretention Planter Box) by absorbing nutrients and possible pollutants from the water in the pond (some wetland plants include Papyrus, Cat-tail, Blue Rush, Canna, etc.) • The water from the pond is then channelled through an underground channel to the Marina Reservoir. Point out the gully where the water overflows into.	

6. Next bring students to the sign of the **Landscape Pond**. Ask students to read the sign. 7. Walk the students to the Landscape Pond, pointing out some wetland plants in the water and other plants around the pond. • Explain the process at the Landscape Pond: Water flows by gravity through layers and is filtered by the sand and soil and by the plants (bio-filtration). The filtered water is channelled to the Landscape Retention Pond, which will in turn be piped to the Marina Reservoir. • Ask them to turn to page 12 of their booklet and answer the questions. • After a few minutes, run through the answers: o What are the benefits of having wetland plants in the landscape pond and landscape retention pond? (The wetland plants planted in the water, algae in the water and plants planted around the ponds help to absorb nutrients and pollutants; cleansing the water through natural means, before it is channelled to Marina Reservoir) o What is the process used? (Bio-filtration – a process of filtering and removal of particles and some pollutants using living material (e.g. plants and algae) as well as non-living materials (e.g. sand, gravel etc.)) o Additional points: Bio-filtration occurs naturally in tropical rainforests and wetlands (including freshwater and mangroves). It is advantageous over normal filtration as plants uptake nutrients and pollutants through their roots. o Explain that the water from the Landscape Pond then overflows into a gully and is channelled to the Landscape Retention Pond, as with the water from the Green Car Park. Refer to map on pages 12, 13. Show students the gully if you are walking near it. 8. Recap the **ABC Waters model** – hydrology, ecology and community. Ask which of the three aspects do the Green Car Park, Landscape Pond and Landscape Retention Pond can be categorised into? (All three. Hydrology – cleansing of water by plants, the green Car Park collects rainwater; Ecology – the plants/water feature are habitats; Community – improve the aesthetics of the place; the car park is an important amenity) 9. Move towards the **Amenities Centre**. Spot the other ABC Waters features.	Pg 12 Pg 12,13

Station 4: Water Watch - What's the Water Quality Like?

Duration: 25min
Location: ZigZag Bridge, Submerged Boardwalk, Draw-off Tower or Spillway
Learning Points:

- Understand the importance of good water quality and some key parameters
- Collect water from the reservoir, test and evaluate water quality
- Relate water quality to water supply and aquatic life

Trainer's Notes	Cross Reference/ Materials
1. Bring students or let students navigate to the **Spillway**. Point out the dam if you have not done so. 2. At the spillway, highlight its function: to release excessive water from the reservoir and maintain its water level. This prevents additional stress on the dam during rainy weather or wet season, protecting the surrounding areas. 3. 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, to support aquatic life.) 4. Tie the rope of the pail to the railing and collect some water. Pour the water into one water testing kit and bring students to a shaded area to put down their bags. 5. Ask students to turn to the pages 14 and 15 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 and 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. 6. **Conduct a demonstration** on how to use the water testing 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 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 pages 14 and 15, 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 water testing kits to each team.	Pg 14, 15

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 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. 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 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 (expected answers: weather conditions, rain). Reiterate that temperature can affect the amount of dissolved gases, like dissolved oxygen.

    - **Dissolved Oxygen** – this should be at least 4ppm (parts per million), below which the water will be too low poor to support aquatic life.

    - **pH** – pH of 5 – 8.2. The water may tend to be slightly acidic as it is fed from forest streams which have dissolved tannins (from leaf litter).

    - Additional points: There is normally no oil film on the surface or things floating on the water (perhaps some organic matter – remnant of twigs and leaves).

11. Summary. Ask students to answer the 3 questions at the bottom of page 15:
    - Conclusion: Overall quality of water. (Expected answer: generally good)

Pg 15

- Can you drink the water from this reservoir? Why? (Expected answers: No. Even though the water is generally of good quality and is able to support a rich community of aquatic life, the water still has to go through a series of treatment processes before it is suitable for drinking to remove bacteria and other microorganisms.)

- Where does the water in MacRitchie Reservoir come from? How do these parameters affect the water quality in the reservoir? (Expected answers: MacRitchie is surrounded by the forests (Central Catchment Nature Reserve). As such, the water may be slightly acidic as it is fed from forest streams which have dissolved tannins (from leaf litter).)

- What are the limitations of this water testing activity? (Only one measurement was taken at the water's surface at one time of the day. For more comprehensive testing, we need to test water from different depths, at different times of the day and from many locations throughout the year. Also, the water testing kit is limited in terms of accuracy.)

- Other properties of water: The measurements taken for the water during this session is not exhaustive. Briefly discuss the following properties of water that can be measured and their relative importance.

    - Electrical conductivity: A measure to the capacity of water to conduct electrical current due to positively or negatively charged ions in the water. Such ions form as salts dissolved in the water hence this is directly related to the concentration of salts dissolved in the water (Total Dissolved Solids – TDS). Measurement is taken in ppm (parts per million) or in mg/l.

    - Hardness of water: Hard water is the result of the presence of metal ions (Ca^{2+}, Mg^{2+}) accumulated in the water as it follows through rock. There are no regulatory limits for water hardness, which is also not shown to be harmful. Measurement is taken in ppm (parts per million). One can estimate the hardness of water by observing the amount of soap you need for soap suds to form in the water – the more soap needed, the higher the degree of water hardness.

    - Total Dissolved Solids (e.g.nitrates, phosphates): TDS measures the amount of charged mobile ions in the water, including minerals, salts or metals dissolved. It is directly related to the purity of water and affects everything that uses the water. Such solids end up in the water from a number of sources – both natural and as a result of human activities. Some examples of such TDS are as follows:

      Nitrates – Nitrates are a form of nitrogen and is harmful for both animals and humans. They often appear in aquatic and terrestrial ecosystems as a result of human activities.

	Phosphates – Phosphates are essential nutrients for plants and animals, hence they are often found in high amounts in fertilisers. Agricultural runoff can carry off excess phosphates into water sources which can set off a whole chain of negative events due to algae blooms (eutrophication). Ammonia – Ammonium is a natural product produced when organic matter breaks down. Together with nitrates, they form parts of the Nitrogen Cycle. Ammonia is formed in a type of balance with natural Ammonium. However, when the balance is typed towards harmful ammonia, it has undesirable consequences on aquatic ecosystems as it is harmful to fish.	

Station 5: The Meeting of the Habitats and Human Impact

Duration: 35min
Location: From Spillway to Prunus Trail (second platform) and back
Learning Points:

- Recognise that MacRitchie Reservoir and the surrounding forests have a rich biodiversity
- Recap, spot and record plants and animals around the reservoir (park area, forest edge, over the water) and in the water
- Recognise that MacRitchie Reservoir/park/trail is an important community space that promotes social bonds, healthy lifestyle and water sports
- Recognise that usage by the community results in human impact. Recap, spot and record human activities and human impact at the reservoir
- How to minimise human impact at MacRitchie reservoir and help enhance the biodiversity in the area

Trainer's Notes	Cross Reference/ Materials
1. Introduce the **theme of biodiversity**: • Recap that the Central Catchment Nature Reserve (CCNR) is located to the north of MacRitchie Reservoir. • Ask students which habitats are represented along the boardwalk? (Freshwater habitat and lowland tropical rainforests).	
2. Explain the **significance of MacRitchie reservoir** - with a nature reserve in the vicinity, one can expect a higher biodiversity than most other reservoirs. The biodiversity is expected to be high as two major habitats meet - the forest and the reservoir. Recap some of the animals students had spotted so far on the learning trail. Ask students to turn to pages 16 and 17 of their booklet and list them down.	Pg 16,17
3. Refer to page 18 and introduce **Human Impact**. While the area is an ABC Waters site which encourages the community to visit the place as a community space, a place for recreation and sports, there is human impact that comes with a greater number of people using the area. Ask students: • What can visitors do at MacRitchie? (Expected answers: walking, hiking, jogging, kayaking, exercising, fishing, bird watching, etc.) • To recap who are some of the users they had observed so far in the Learning Trail (people they had passed by). They can record these down in the table on page 18.	Pg 18
4. Explain that for the next part of the Learning Trail they will be walking to part of the Prunus Trail boardwalk and back. Along the way, students are to **spot and record:** • Plants and animals (pages 16,17) • Human activities and human impact (page 18)	Pg 16,17 Pg18

5. **Distribute the nature guide books/cards**. Reiterate that: • Students should make as little noise as possible. • Safety with monkeys (Long Tailed Macaques) – they should keep their food and drink bottles in their bags and not eat or drink. If there are monkeys about, be very careful – do not go near them nor provoke them. 6. Bring students to the **Fishing Area**. Ask students to observe the fishing area (any fishermen) and read the rules for fishing. Go through some of these guidelines and ask students why the guideline has to be adhered to (e.g. fishing there is only "catch and release" – so as not to decrease the biodiversity in the reservoir). 7. Continue to the Prunus Trail (Boardwalk) and walk to the second platform. Turn around retrace your steps back. You may **return to the Amenities Centre** for the debrief or a shelter/shaded area on the route back.	Optional: nature guide cards/books, binoculars

Debrief and Reflection

Duration: 20min
Location: Amenities Centre, Reservoir Deck, or a shelter /shaded area on route between the Kayak Shed and Amenities Centre
Learning Points:

- Recap of learning points of the trail
- Debrief the Biodiversity and Human Impact 'survey'
- Reflection questions

<table>
<tr><th>Trainer's Notes</th><th>Cross Reference/ Materials</th></tr>
<tr><td>
1. Recap the main points of the Learning Trail starting from the front of the book:
• MacRitchie Reservoir is one of our 17 reservoirs, all part of the First National Tap – Local Catchment Water.
• MacRitchie Reservoir is also an ABC Waters site and illustrates all the aspects of urban sustainable environment – hydrology, ecology and community.
• It is significant for water supply/catchment, recreational, environmental conservation (biodiversity); it is a historical, education and research site.
• Many ABC Waters features have been built at MacRitchie Reservoir – including the Green Car Park, Landscape Pond, Landscape Retention Pond, Green Roof of the Amenities Centre, Submerged Boardwalk, gravel swales, etc.
• The water quality of the water in MacRitchie Reservoir is generally good.

2. Debrief the Biodiversity and Human Impact 'survey':
• MacRitchie Reservoir supports a rich biodiversity. We have seen a few of these plants and animals during trail. Recap the animals and plants recorded. Highlight a few if there is time.
• Recap the human activities and impact observed:
Ask students to rate human impact at MacRitchie Reservoir. Here are some possible answers/observations:
<table>
<tr><th>Activity</th><th>Potential impacts</th><th>Solutions</th></tr>
<tr><td>Nature walks
Joggers</td><td>Littering
Noise pollution (scaring animals away)</td><td>• Educate users on consequences of their actions
• Enforcement of laws</td></tr>
<tr><td>Water sports: kayak</td><td>Negative
pollution of water, scaring or harming of</td><td>• Impose restriction on where kayaks can go (not to kayak into the</td></tr>
</table>
</td><td>Pg 8,9

Pg 10

Pg 12, 13

Pg 14, 15

Pg 16,17

Pg 18</td></tr>
</table>

	aquatic life	inlets of MacRitchie Reservoir) • Educate kayakers not to pollute waters
Fishing	Disturbance of native fish species 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 animals - monkeys or fishes	Change of behaviour, become aggressive towards humans – chase, snatch, scratch or bite humans	• Educate users on consequences of their impact • Enforcement of laws
Bringing in domestic animals e.g. dogs	Pets may get bitten or they may attack native forest species	

Discuss these questions:

- How would human activities at MacRitchie Reservoir affect the water quality of the reservoir and the biodiversity? (Suggested answers: pollution can affect the water quality, also affecting the aquatic plants and animals; harming/scaring of animals; destruction of plants can lower the biodiversity around and in MacRitchie Reservoir.)
- Your conclusion about having the community at MacRitchie Reservoir. (Suggested answer: The community can continue to be encouraged to visit and use MacRitchie, but users should take responsibility to keep their water resource and nature reserve clean; and minimise their impact on plants and animals here.)

Pg 18

3. Ask students to turn to page 19 and **write their reflections**. Ask a few students to share. Here are some expected answers:
    - Water sustainability involves the conservation of water resources and prevention of water pollution. What can you personally do to help ensure water sustainability in Singapore?
        - Keep our waterways clean – not dispose any waste, solid or liquids, into our waterways.
        - Explaining to people the consequence of their actions if you encounter them.
        - Report to NParks or PUB if you encounter such undesirable activities.

Pg 19

• What is your understanding of the ABC Waters programme?
  ○ Active, Beautiful, Clean Waters (ABC Waters) programme will transform our drains, canals and reservoirs into beautiful and vibrant water ways; encourage people to enjoy water activities and bring water closer to the population; increase appreciation for this precious resource; use it wisely and nurture stewardship and advocacy for our waters.
 	
• How can you encourage other visitors to care for MacRitchie Reservoir and other reservoirs and waterways? Suggested answers:
  ○ By setting a good example.
  ○ Conduct talks, educational walks and events.
  ○ Through banners and campaigns, etc.
 	
• How does MacRitchie Reservoir and its surroundings enrich the lives of Singaporeans? Suggested answers:
  ○ It supplies us with water.
  ○ It is a place for recreation and a nature retreat/sanctuary.
  ○ It conserves our country's native life (biodiversity).
  ○ It is a significant historical site.
 	
• How will you spread the water conservation message to others? Suggested answers:
  ○ Write it on my Facebook or blog.
  ○ Bring them to MacRitchie Reservoir or any reservoir/ABC Waters site.
  ○ Do a project and make a presentation on it.	

Extension Activity: A Problem-based Learning Activity

Duration: 1.5 – 2hours

This can be conducted as a post trip activity or a wet weather programme at the Amenities Centre.

Trainer's Notes	Cross Reference/ Materials
1. Divide the class into 2 or 4 teams. 2. Let each team develop their 10-year plan for MacRitchie Reservoir for 20-45 minutes. Guide them as they answer the scaffold questions provided on page 19. 3. Gather the class and let each team make their presentations (5 min), followed by a 1-2 minute question and answer session. 4. Give your comments after each presentation and summarise the points raised after all teams have presented.	 Pg 19 Flipchart paper, markers (for each team)

References

- Water for All. Conserve, Value, Enjoy. 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.
- Guide to the Prunus Trail at the MacRitchie Boardwalks. Available www.nparks.gov.sg/cms/docs/diy_guide/prunus_trail_macritchie.pdf

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:**	MacRitchie Reservoir
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: o 2 hours before LT o 1 hour before LT o 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	History and background of MacRitchie Reservoir	Setting up of water supply for Singapore Reservoirs - one of the 4 taps in Singapore WATER FOR ALL	**History** • Growth and development of Singapore under the British – setting up water supply in Singapore. • Nation-building years (1965-1971) **Geography** • Understanding the environment (environments through maps) • Managing the changing environment (water resources)
2	Water properties – link with flora, fauna, biodiversity and vegetation	Understanding the need for clean water (not taking it for granted)	**Science** • Process skills (observing, comparing, using apparatus, inferring) • Solutions (chemicals/minerals) and suspensions (turbidity) • Importance of various physical factors to the life of the organisms **Geography** • Inter relationships of components of the environment • Managing the changing environment (pollution)
3	ABC Waters Design Features and other features at MacRitchie Reservoir	VALUE and ENJOY	**Science** • Process skills: observing, inferring **Geography** • Understanding the environment (physical and human environments) • The physical environment (natural vegetation)
4	Life at MacRitchie Reservoir	Water supports life CONSERVE and VALUE	**Science** • Biodiversity of plant and animal life (classification) • Identifying habitats and some of the organisms associated with the habitats • Importance of conserving the environment **Geography** • Protecting and conserving the environment at different levels (individual, national, international)

No	Theme	PUB's Educational Objectives	Lower Secondary School Curricula
5	Human activities and impact	CONSERVE, VALUE and ENJOY	**Science** • Importance of conserving the environment **Geography** • Managing the changing environment (water resources, pollution) • Protecting and conserving the environment at different levels (individual, national, international)
6	Water supply and treatment	Water technology Local Catchment Water – The first of our 4 National Taps WATER FOR ALL	**Science** • Basis of Biology and Chemistry **Geography** • Managing the changing environment (water resources, pollution) • Case study of water supply in Singapore

Annex 4: “Journey of Water” Cards

RAIN
NATURAL BIOFILTRATION
PUMPING STATION
TAPS
DRAW-OFF TOWER

COLLECTION AT ACTIVE, BEAUTIFUL, CLEAN WATERS (ABC WATERS) SITES

Annex 5: Suggested Packing List (of Resources) – for Trainers

1. First Aid Kit
2. Insect repellent
3. 4-5 Compasses
4. 4-5 sets of ‘Journey of Water’ Cards (Annex 4)
5. 4-5 pails with rope attached (for collection of water)
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

Optional:

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

Acknowledgements

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

Hwa Chong Institution

National Parks Board

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