How do human activities affect water quality?

Lesson Plan

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Institution: Ang Mo Kio Secondary School, Singapore

Introduction:

This lesson plan aims to sensitize students about the strategies used in Singapore to increase water supply. Water catchment areas amount to 66 per cent of Singapore's total land area. Through investigative enquiry and collaborative methods, students develop positive social skills and deepen their understanding on the topic.

Eco-Schools

12 to14 Years old

Objectives or Learning Outcomes

Students will be able to:

- demonstrate leadership and decision-making skills.
- collaborate and communicate effectively.
- test and evaluate water quality through fieldwork.
- explain the importance of having clean drinking water and how that is achieved in Singapore.
- demonstrate commitment towardsthe importance of environmental conservation.

4 QUALITY EDUCATION

6 CLEAN WATER AND SANITATION

14 LIFE BELOW WATER

17 PARTNERSHIPS FOR THE GOALS

Time required:

Session 1 (60 minutes): Introduction and pre-fieldwork tasks

Session 2 (120 minutes): Conducting fieldwork and fieldwork tasks

Session 3 (60 minutes): Post-fieldwork tasks

Assessment: Presentations preparation and delivery

Resources required:

- Worksheets: Pre-fieldwork, Fieldwork and Post-fieldwork ; camera or smartphone (one in each group)

- Chemistry materials: turbidity testing equipment (Jars, Sacchi disk icon sticker and turbidity chart); dissolved oxygen equipment (jars, small vial 125, dissolved oxygen test labs -3976, dissolved oxygen colour chart); pH testing equipment (Test-tube 0106, pH wide range test tab 6459, pH Colour Chart); Temperature Testing equipment (Thermometers, jars)

Activity

Session 1

- The teacher divides students in groups of 5 and brief students on the tasks to be carried out.

- The teacher asks each group to complete the pre-fieldwork worksheet.

Session 2

- The teacher explains how fieldwork will be conducted. First, students will take photographs as they walk along the trail to the fieldwork area. Then, they will then conduct tests regarding water quality – turbidity, dissolved oxygen, pH testing and temperature testing of the water at the nearby park.

- The teacher requests students to record the readings of the tests. Students are also to record their observations on how human activities impact the water quality.

- The teacher asks students to record a sound map to as a way to create awareness of the environment and to sketch a section of the park.

- The teacher asks students to complete the fieldwork worksheet.

Session 3

- The teacher and students hold a discussion about the environmental impact they have witnessed in waterways and strategies to reduce the impact of human activities on water quality.

- The teacher asks students to complete the post-fieldwork worksheet.

Assessment

The teacher request groups to present data collected, sketches, impact and management strategies to mitigate impact of human activities on water quality to the rest of the group. Groups have one hour to prepare their 5-10 minutes presentations. Then, students present in front of the rest of the class.

Suggestions of variation or further reading

The fieldwork activity can be simplified and adapted to the context of each school. Moreover, the fieldwork activity can be replicated in other water bodies in or outside Singapore. Finally, a collaboration network with other schools can be created in order to have a better perspective of water quality of water bodies in Singapore.

References

Singapore government websites:

https://www.pub.gov.sg/abcwaters/explore/bishanangmokiopark

https://www.pub.gov.sg/Documents/KRBAMKParkStudentTrail.pdf

This lesson plan was selected from the 2019 Eco-Schools competition in which teachers were invited to develop and submit lesson plans that promote action oriented pedagogy about specific Sustainable Development Goals (SDGs).

Annexe 1 - Pre-fieldwork worksheet

WATER SUPPLY:

HOW DO HUMAN ACTIVITIES AFFECT THE QUALITY OF WATER IN A WATERWAY OR WATER BODY?

GEOGRAPHICAL INVESTIGATION PRE FIELDWORK LOG

This Log belongs to:

Name:	
Class:	

My group is:

Group Name:	
Group Members:	1.
	2.
	3.
	4.
	5.

My Marks for this PRE FIELDWORK Geographical Investigation

Total	/5

Stage 1: Analyse the Geographical Investigation (GI) questions

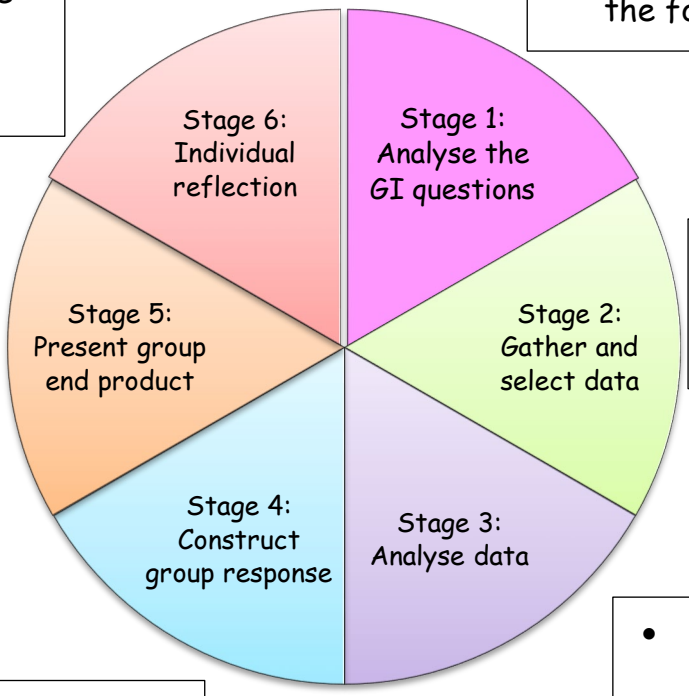
1.1 Introduction to GI: How do human activities affect the quality of water in a waterway or water body?

In Singapore, various strategies are used to increase our water supply. Currently, our water catchment areas constitute two-thirds of Singapore's total land area. Waterways (e.g., rivers and canals) and water bodies (e.g., lakes, reservoirs and ponds) are inter-connected and form part of the catchment area. They are often found close to where people live and work. Human activities can affect the quality of water in the waterways and water bodies. Good water quality is necessary to support aquatic fishes and cater to the needs of people.

a) What are the tasks to be completed for GI?

- Reflect on the learning and experience
- Identify strengths, limitations and possible ways of improving the investigation

- Ask questions to understand the focus of the GI



- Conduct secondary research
- Conduct fieldwork

- Present and communicate conclusion

- Interpret, analyse and represent data gathered

- Construct group response to the GI questions

1.2 Grouping and Group Contribution Feedback

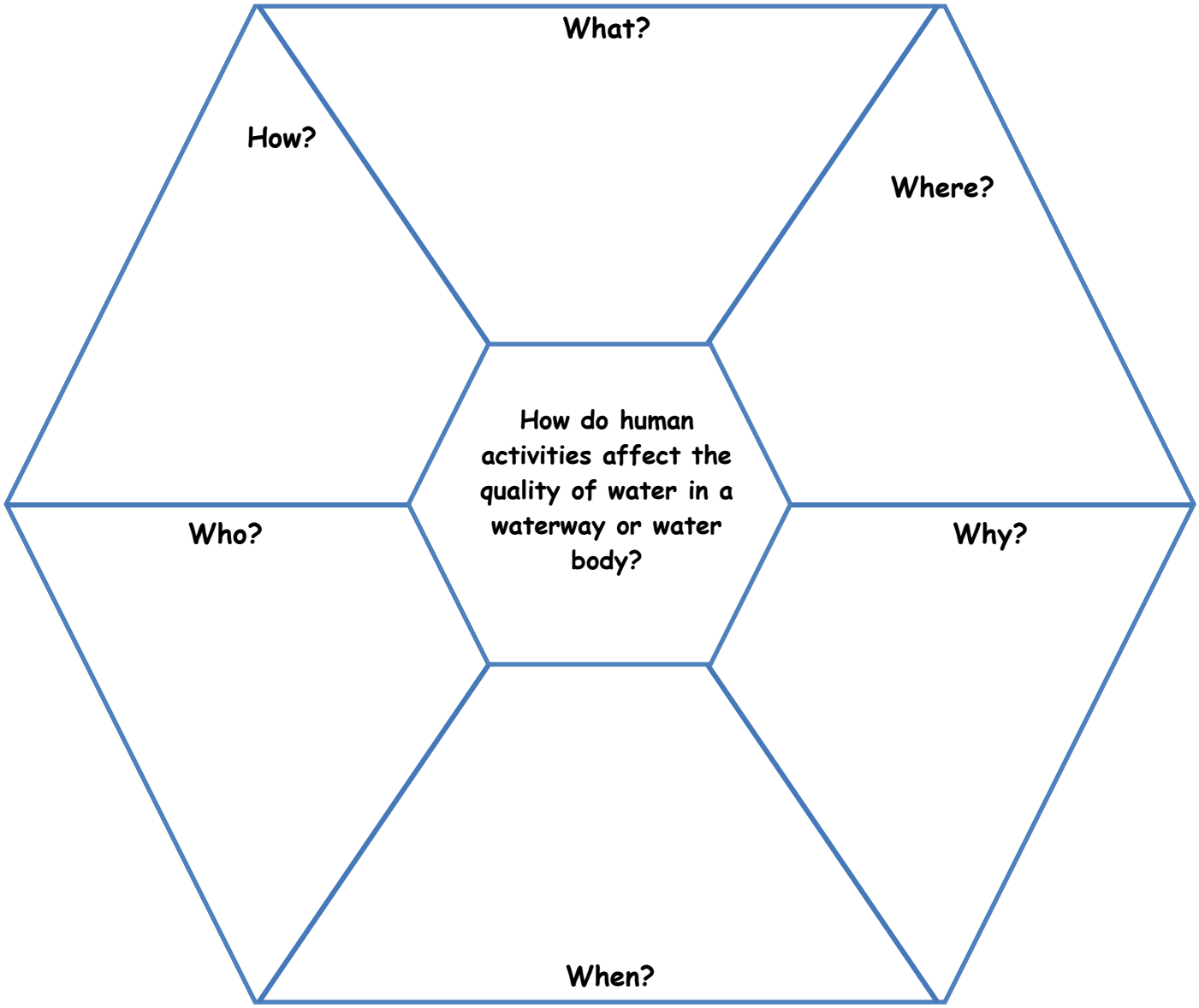
Your groups have been assigned. Fill in their names on the left column according to the role.

Role	Duty
LEADER Name of member: _____	✓ Ensures every member ✓ Maintains peace and harmony within the group ✓ Reduces tension and conflicts within the group ✓ Reconcile differences and conflicts between members to ensure harmony throughout the IBL journey
SAFETY MANAGER & TIMEKEEPER Name of member: _____	*As Safety Manager (during Fieldwork):* ✓ Conducts headcount and be responsible for group members' whereabouts and safety at all times *As Timekeeper:* ✓ Ensures that the group meets the submission deadline ✓ Ensures that the group is on-task for every lesson/period ✓ Reminds group what should be done and by when
RECORDER & RESEARCHER Name of member: _____	*As Recorder (during Fieldwork):* ✓ Records data and take notes *As Researcher:* ✓ In charge of collating the research from all members ✓ Informs members what research they should be doing ✓ Guides members in researching
PHOTOGRAPHER & EDITOR Name of member: _____	*As Photographer (during Fieldwork):* ✓ Brings camera with sufficient battery ✓ Take photographs of group's fieldwork procedures *As Editor:* ✓ Organises collated research in a logical sequence or format ✓ Revises and edits the representation of data with help from the rest of the members ✓ Makes the final changes on graded tasks based on everyone's feedback

1.3 Understand the GI Questions (1 mark)

Before you begin your investigation, let's examine carefully the GI question: **How do human activities affect the quality of water in a waterway or water body?'** We can better understand the focus of the GI questions by first identifying the keywords and phrases in the question. Secondly, we can also generate some guiding questions to break down the task into smaller parts.

Keeping in mind the GI questions, some guiding questions my group thought of using the 5W1H question frame to guide our investigation are:



MARKS	
	1

2a) Gathering secondary data

Amelia wants to find the quality of water in Bishan Park and after conducting some research, Amelia found the following data. Help her look through the data and choose the ones that she should use. Give reasons for your choices.

Source A shows a picture taken by a park user, Mr Chan on his facebook.

Facebook user Alphonso Chan posted picture which showed the river covered in a coat of oily substance. He wrote: "I am upset. Who on earth poured kerosene in the Bishan-Ang Mo Kio Park? Fishes are leaping out of the water for air."

Source B shows an article in Channel NewAsia.

> Bishan Park water quality normal despite mass fish deaths: PUB
>
> Despite the death of up to 900 fish in the river running through Bishan-Ang Mo Kio Park, laboratory tests show the raw water quality, including dissolved oxygen levels, is within normal range, PUB says.
>
> Channel NewsAsia 21 Jul 15

Source C shows the results of student's finding of human activities during fieldwork on one Friday Morning.

Site	Observation of human activities
1	People throwing litters in the river
2	People jogging and cycling
3	Construction near the park
4	People feeding the fishes with bread

1. Discuss the reliability of the sources. Based on your opinion, which source is the most reliable? Explain on a piece of foolscap paper. Staple your answers together with your individual research.

Use the REAL approach to evaluate websites.

- **R**ead the URL
- **E**xamine the content, facts, coverage
- **A**sk about the author and objective
- **L**ook at the links and date

Task 1

Name: _____ ( )
Class: _____ Date: _____

2b) Individual research (4 marks)

Choose 1 key question to research on. You may refer to the next few pages for the guiding questions and worksheet.

1. What are the key indicators to test for water quality?
2. What are the human activities that affect water quality?
3. Which location is suitable to conduct water testing?
4. How can government, private sector or public help in maintaining the water way?
5. How does Singapore manage water shortage?

Task 1A

Name: _____ ( )
Class: _____ Date: _____
Group: _____

Choose 1 Key Question

Key Question 1: What are key indicators to test for water quality?

1. Name two indicators to test for water quality
   _____
2. The factor that I am researching is _____

a. Definition of factor:

_____

_____

_____

b. List the acceptable range of this factor:

_____

_____

c. Explain the importance of this factor in determining water quality:

_____

_____

_____

_____

_____

_____

References:
Google: Key indicators for water quality
or
http://www.fondriest.com/environmental-measurements/parameters/water-quality/

MARKS FOR INDIVIDUAL RESEARCH	
	4

Task 1B

Name: _____ ( )
Class: _____ Date: _____
Group: _____

Choose 1 Key Question

Key Question 2: What are the human activities that affect water quality?

1. State one human activity that may affect water quality in a specific country.

_____

2. Describe the human activity that may affect water quality in the country.

_____

_____

_____

_____

_____

_____

_____

3. Explain how the human activity stated affect water quality.

_____

_____

_____

_____

_____

_____

_____

References:
Google: Human activity that affects water quality at _____ (a specific country) OR http://www.umgeni.co.za/water_education/wpwq.asp

MARKS FOR INDIVIDUAL RESEARCH	
	4

Task 1C

Name: _____ ( )
Class: _____ Date: _____
Group:_____

Choose 1 Key Question

Key Question 3: Which location is suitable to conduct water testing?

Figure 1

1. With reference to Figure 1, which location 'A, B or C' is a suitable location to conduct water testing?

Think: Where do we collect water from the river to ensure it is accurate? How many times do we need to measure to ensure accuracy?

2. Explain one reason for your choice.

_____

_____

_____

_____

3. Describe one precaution to ensure accuracy of data.

_____

_____

_____

_____

MARKS FOR INDIVIDUAL RESEARCH	
	4

Task 1D

Name: _____ ( )
Class: _____ Date: _____
Group:_____

Choose 1 Key Question

Key Question 4: How can government, private sector or public help in maintaining the water way?

1. List one strategy that the government/ private sector/ public uses to help in maintaining the water way in a specific country.

2. Describe how this strategy helps in maintaining the waterway.

3. Explain one reason to maintain the waterway.

References:
Google: management strategies in maintaining waterway or

https://www.pub.gov.sg/savewater

MARKS FOR INDIVIDUAL RESEARCH	**4**

Task 1E

Name: _____ ( )
Class: _____ **Date:** _____
Group:_____

Choose 1 Key Question

Key Question 5: How does Singapore manage water shortage?

1. Name one tap of Singapore to increase water supply.

_____

_____

2. List and explain one advantage and disadvantage of this tap.

_____

_____

_____

_____

_____

_____

3. Describe how Singapore obtain this water source.

_____

_____

_____

References:
Google: Taps of Singapore
Or
https://www.pub.gov.sg/watersupply/fournationaltaps

(Refer to TB Pg 160 to 171)

MARKS FOR INDIVIDUAL RESEARCH	
	4

Annexe 2 - Fieldwork worksheet

WATER SUPPLY:

HOW DO HUMAN ACTIVITIES AFFECT THE QUALITY OF WATER IN A WATERWAY OR WATER BODY?

GEOGRAPHICAL INVESTIGATION FIELDWORK LOG

This Log belongs to:

Name:	
Class:	

My group is:

Group Name:	
Group Members:	1.
	2.
	3.
	4.
	5.

My Marks for this Fieldwork Geographical Investigation

Total	/15

Task 2

Stage 3: Gather Data

Field site observations- SEE THINK WONDER (Human impact on river and environment)

As you conduct your field investigation, take note of the sights and sounds you encounter.

1a Sight- Narrating the journey (1 mark)

As a pair, take photos and list the human activities that you see along the way here (from school to the water way). The photographs will be used for your presentation.

Type of human activities	
Example: people walking/ people driving on roads	

Table 1

b. Hear- Sound mapping (1 mark)

Find a comfortable spot at site chosen. Close your eyes and listen for a minute. Identify sounds around you.

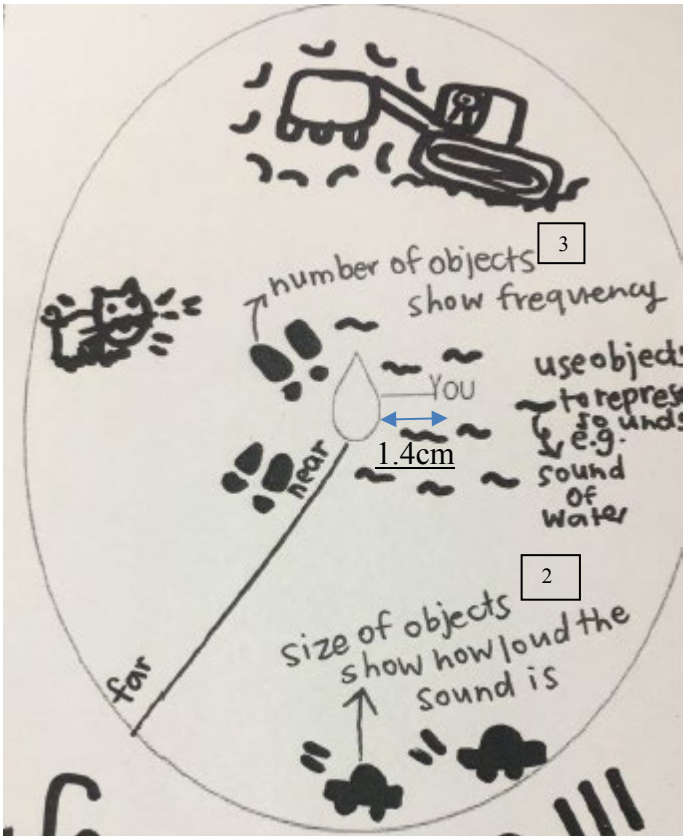
Figure 2 shows a sample.

Create a legend[1] to indicate type of sound.
In your sound map, indicate direction and volume of sound[2], frequency[3]. Take photos of the source of the sound. The photographs will be used for your presentation.

Site: At Mac Donald

Legend [1]

~ - sound of water

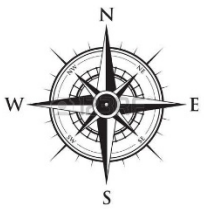


Scale

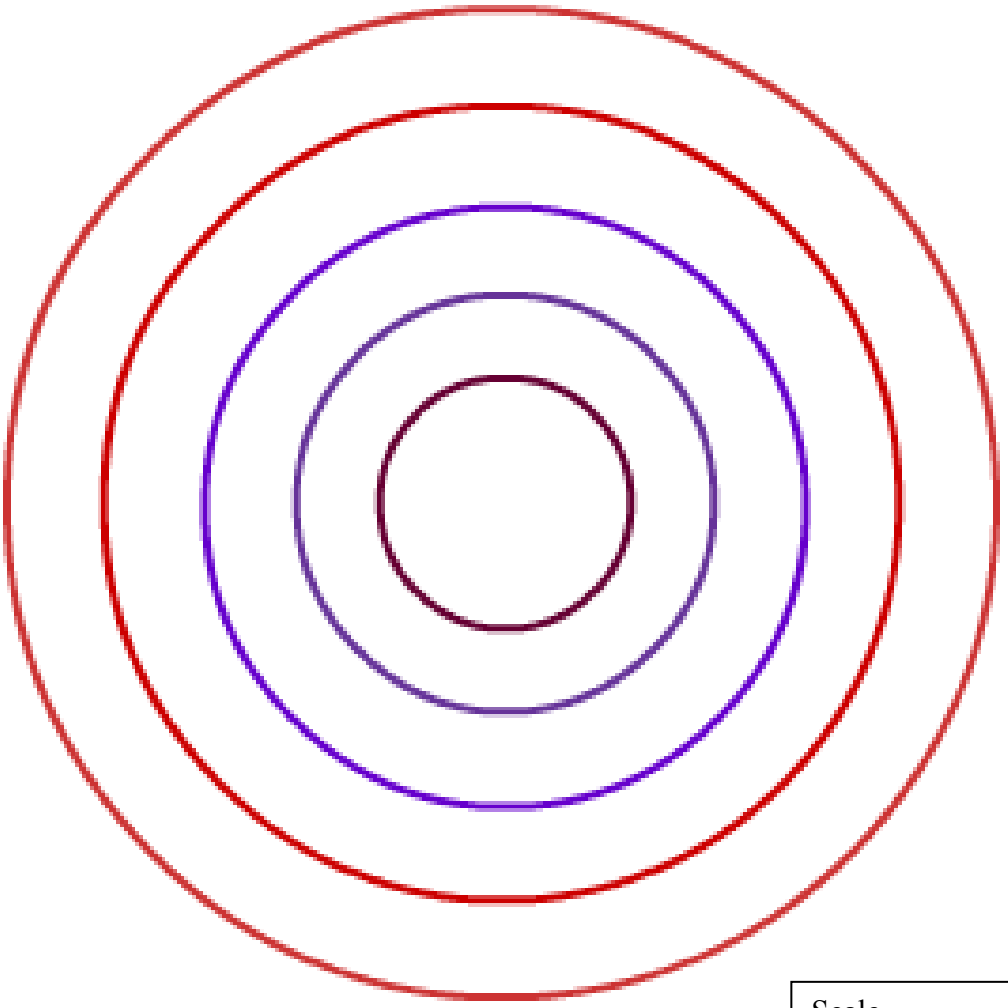
1cm: 50m

River from Mac Donald is 70m, therefore if you want to indicate a sound at the river, you need to measure
= 70/50
=1.4cm

Figure 2



Site: _____ (example: Mc Donald/ Recycle Hill)



Legend

Scale

1cm: 50m

Figure 3

*Remember to include photos of the source of sound.

2. Based on what you observed and heard, (8 marks)

List the human activity that affects water quality that you observed in Table 1 and Figure 3	**Describe how the human activity affects water quality/ biodiversity/ safety of park users**	**Describe how individuals and government help to ensure the good quality of water/ safety of park users**	
Activity (Causes)	*Impact*	*Management*	
		Individuals	*Government*

Biodiversity: the variety of plant and animal life in the world or in a particular habitat

Task 3

3. Field Sketching (4 marks)

Draw a field sketch of your group's field site in the box below.

Please check against the checklist on the right.

Checklist (please tick those that you have completed):

1. Water body □
2. Residential area □
3. Human activities □
4. Annotations □
5. Title □

Water Quality Indicators (1 mark)

Task 4A

i) Turbidity

Turbidity

Turbidity is the measure of the relative clarity of water. Turbid water is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter, and microscopic organisms. Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid.

Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances which can be caused by boat traffic and abundant bottom feeding fish.

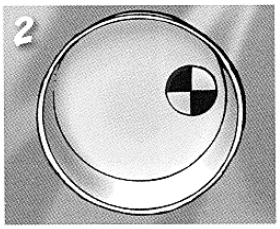
Note: This test has limited utility in pristine, clear waters. For more precision in measuring turbidity in standing waters such as lakes, reservoirs and estuaries you could obtain and use a Secchi disk.

For information on how to make your own Secchi disk and how to take the measurement, go to http://www.secchidipin.org/makedisk.htm. In addition, transparency tubes can be used for more precision in measuring the turbidity of flowing waters such as streams and rivers.

Turbidity procedure

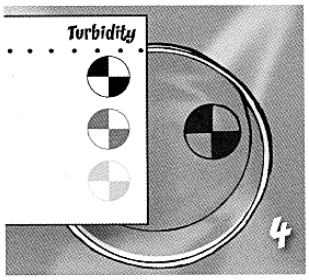
The white jar is used to perform the turbidity test. If possible, adhere the Secchi disk icon sticker to the jar 8-24 hours before use to allow the adhesive to cure.

1. Remove the backing from the Secchi disk icon sticker.



2. Adhere sticker on the inside bottom of the white jar. Position the sticker slightly off center.

3. Fill the jar to the turbidity line located on the label.



4. Hold the turbidity chart on the top edge of the jar. Looking down into the jar, compare the appearance of the Secchi disk icon in the jar to the chart. Record the result as turbidity in JTU.

9

Data Collection

1st Reading	2nd Reading	3rd Reading	Average
			JTU

Analysis

Based on your data collection, what does this indicate about the water's turbidity. Circle your answer.

The water collected has (high or low) turbidity, which is within the (acceptable/ non acceptable) range.

Task 4B

ii) Dissolved Oxygen

Dissolved oxygen

Dissolved oxygen (DO) is important to the health of aquatic ecosystems. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved oxygen levels are most likely healthy and stable environments and are capable of supporting a diversity of aquatic organisms. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen.

The saturation percentage of dissolved oxygen (% saturation) is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28°C will be 100% saturated with 8 ppm dissolved oxygen. However, water at 8°C can hold up to 12 ppm of oxygen before it is 100% saturated.

High levels of bacteria or large amounts of rotting plants can cause the % saturation to decrease. This can cause large fluctuations in dissolved oxygen levels throughout the day, which can affect the ability of plants and animals to thrive.

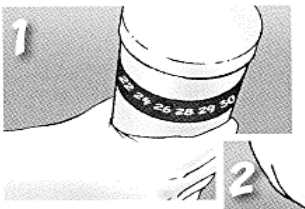
Note: This test is a screening test and will only give ballpark indications of poor, fair and good water quality. If you want more accurate measurements or need a higher range, you could use a Winkler titration kit that would be more expensive and require more careful handling.

PPM
(parts per million)
PPT
(parts per thousand)

Units of measure for very dilute solutions. These units are very similar to percent. 1% is one part per hundred. 1 ppt is one part per thousand. 1 ppm is one part per million. In water testing, ppm is also called milligrams per liter (mg/L).

13

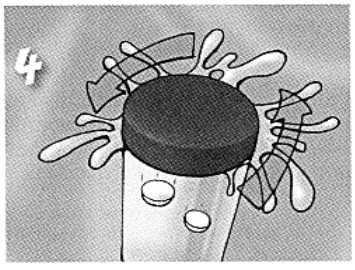
Dissolved oxygen procedure



1. Record the temperature of the water sample.

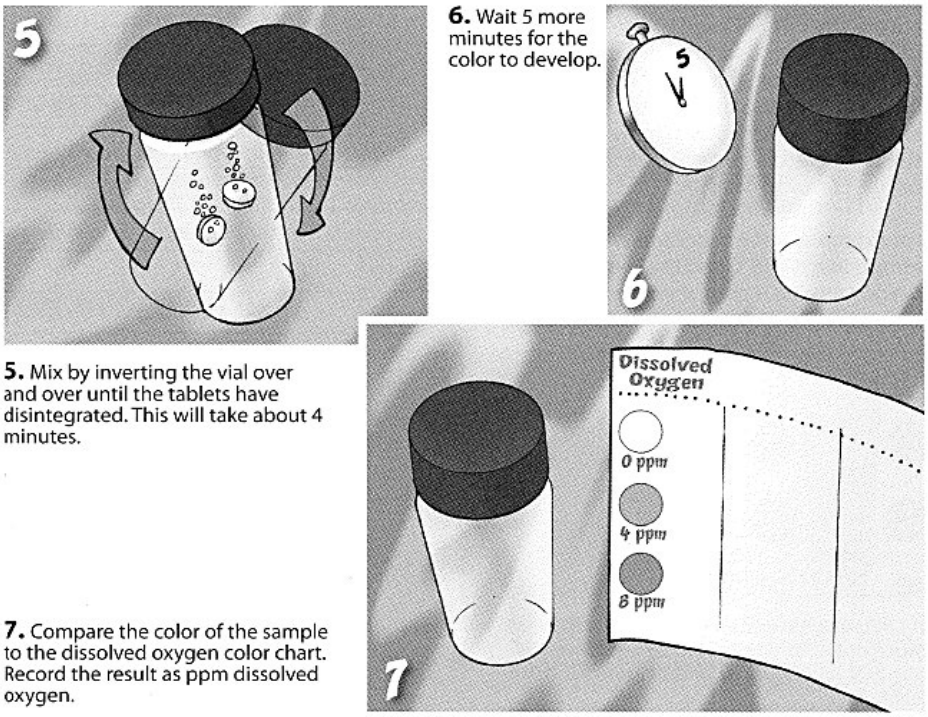
2. Submerge the small vial (0125) into the water sample. Carefully remove the vial from the water sample, keeping the vial full to the top.

3. Drop two Dissolved Oxygen TesTabs® (3976) into the vial. Water will overflow when the tablets are added.



4. Screw the cap on the vial. More water will overflow as the cap is tightened. Make sure no bubbles are present in the sample.

14



Data Collection

1st Reading	2nd Reading	3rd Reading	Average
			ppm

Analysis

Based on your data collection, what does this indicate about the water's dissolved oxygen? Circle your answer.

The water collected has (high or low) dissolved oxygen, which is within the (acceptable/ non acceptable) range.

iii) pH

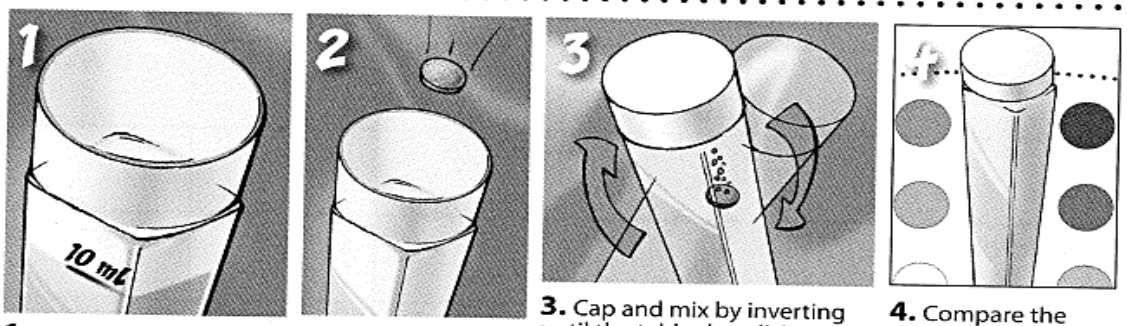
Task 4C

pH

pH is a measurement of the acidic or basic quality of water. The pH scale ranges from a value of 0 (very acidic) to 14 (very basic), with 7 being neutral. Most aquatic animals prefer a range of 6.5 to 8.0 They are adapted to a specific pH level and may die, stop reproducing, or move away if the pH of the water varies beyond this range.

Low pH can also allow toxic compounds to become more available to aquatic plants and animals. This can produce conditions that hurt aquatic life. pH can be affected by atmospheric deposition (or acid rain), wastewater discharges, drainage from mines, and the type of rock naturally found in the area.

pH procedure



1. Fill the test tube (0106) to the 10 ml line with the water sample.

2. Add one pH Wide Range TesTab (6459).

3. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.

4. Compare the color of the sample to the pH color chart. Record the result as pH.

17

Data Collection

1st Reading	2nd Reading	3rd Reading	Average
			pH

Analysis

Based on your data collection, what does this indicate about the water's pH? Circle your answer.

The water collected has (high or low) pH level, therefore it is (acidic/alkaline). It is within the (acceptable/ non acceptable) range.

Task 4D

iv) Temperature

Use of thermometers

The two thermometers have an adhesive back. Adhere them to the sampling jar or another object to make grasping them easier. The temperature is indicated by a liquid crystal number on the low-range thermometer and a green display on the high-range thermometer.

Temperature

Aquatic animals (e.g. stream insects, trout and salmon) are sensitive to changes in water temperature and require a certain temperature range to survive and thrive. If water temperature is outside that range for a long time, organisms can be stressed and die.

Temperature affects the amount of oxygen water can hold. Cold water holds more oxygen than warm water, and all aquatic animals need oxygen to survive.

Temperature also affects the rate of photosynthesis by aquatic plants, and the sensitivity of organisms to toxic wastes, parasites and disease. Warm water discharged from factories, the removal of trees and vegetation that shade streams, and water that runs off city streets can cause temperature changes that threaten the balance of aquatic systems.

Data Collection

1st Reading	2nd Reading	3rd Reading	Average

Analysis

Based on your data collection, what does this indicate about the water's temperature? Circle your answer.

The water collected has (high or low) temperature, which is within the (acceptable/ non acceptable) range.

Annexe 3- Post-fieldwork worksheet

WATER SUPPLY:

HOW DO HUMAN ACTIVITIES AFFECT THE QUALITY OF WATER IN A WATERWAY OR WATER BODY?

GEOGRAPHICAL INVESTIGATION POST FIELDWORK LOG

This Log belongs to:

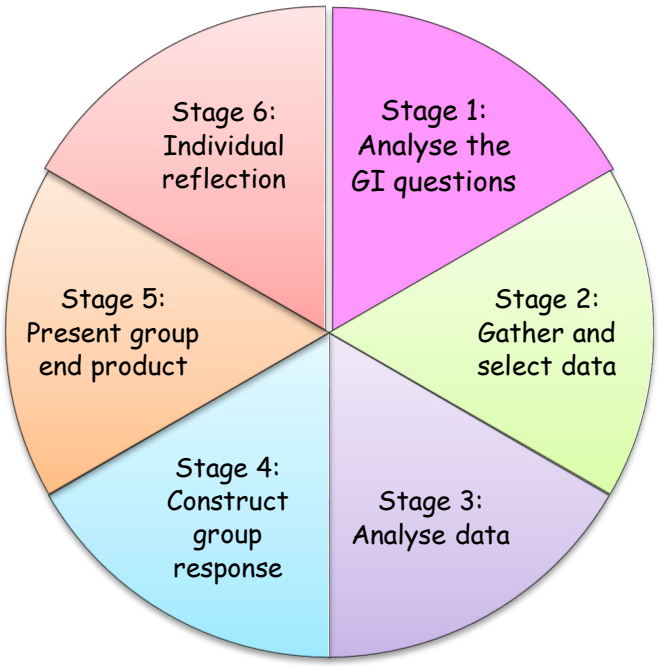
Name:	
Class:	

My group is:

Group Name:	
Group Members:	1.
	2.
	3.
	4.
	5.

My Marks for this Post Geographical Investigation

Total	/ 10



Student Power Point Presentation Rubric

	3	2	1	0
CATEGORY	Exceeds standards	Meets standards	Approaches standards	Below standards
Oral Presentation	Students are well prepared. Volume is loud enough. Establish eye contact always. Team cooperation always smooth.	Students are fairly prepared. Volume is loud enough. Establish eye contact most of the time. Team cooperation most of the time smooth.	Students are somewhat prepared. Volume is loud enough. Establish eye contact sometimes. Team cooperation sometimes smooth.	Students do not seem prepared. Volume is too soft to be heard. Establish no eye contact. Partners do not seem cooperative.
Content - Accuracy	All content on slides is accurate. There are no factual errors.	Most of the content is accurate. There are 1 or 2 factual errors.	There are many inaccuracies in the content.	Content is confusing on many of the slides.
Use of Graphics	All slides have graphics to support all information.	At least 10 of the slides have graphics to support all information	Some of the slides have graphics but don't support the information.	Many of the slides have no graphics.

1 mark for participation (asking other groups questions)

Task 5

Stage 3, 4, 5 and 6: Data Representation and Analysis (10 marks)

Include the following in your presentation

Check list

Contents	Tick when this is in the slide	
1. **Introduction** Objectives of Geographical Investigation		
2. **Recording of data collection and observations**. Refer to fieldwork package		
- State location, include photos and sketch of place (Pg 1 and Pg 5)		
- Picture of sound mapping drawing and photographs to indicate the human activities near the water way (Pg 1 and Pg 3)		
- Describe how the human activities affects water quality/ biodiversity and safety of park users using the sketch (Pg 5) and Table (Pg 4)		
3. **Data Representation and analysis** Each student create their own graphs on one indicator - Turbidity - Student 1 - Dissolved oxygen - Student 2 - Temperature - Student 3 - pH - Student 4 and analyse whether results are at the		

acceptable range		
4. Conclusion a) Is the water in Bishan Park high/ low quality? Explain using data to support? **b)** How do human activities affect quality of water in a waterway?		
5. Reflection Identify strengths, limitations and possible ways of improving the investigation		