

Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Chencharu (Site 2)

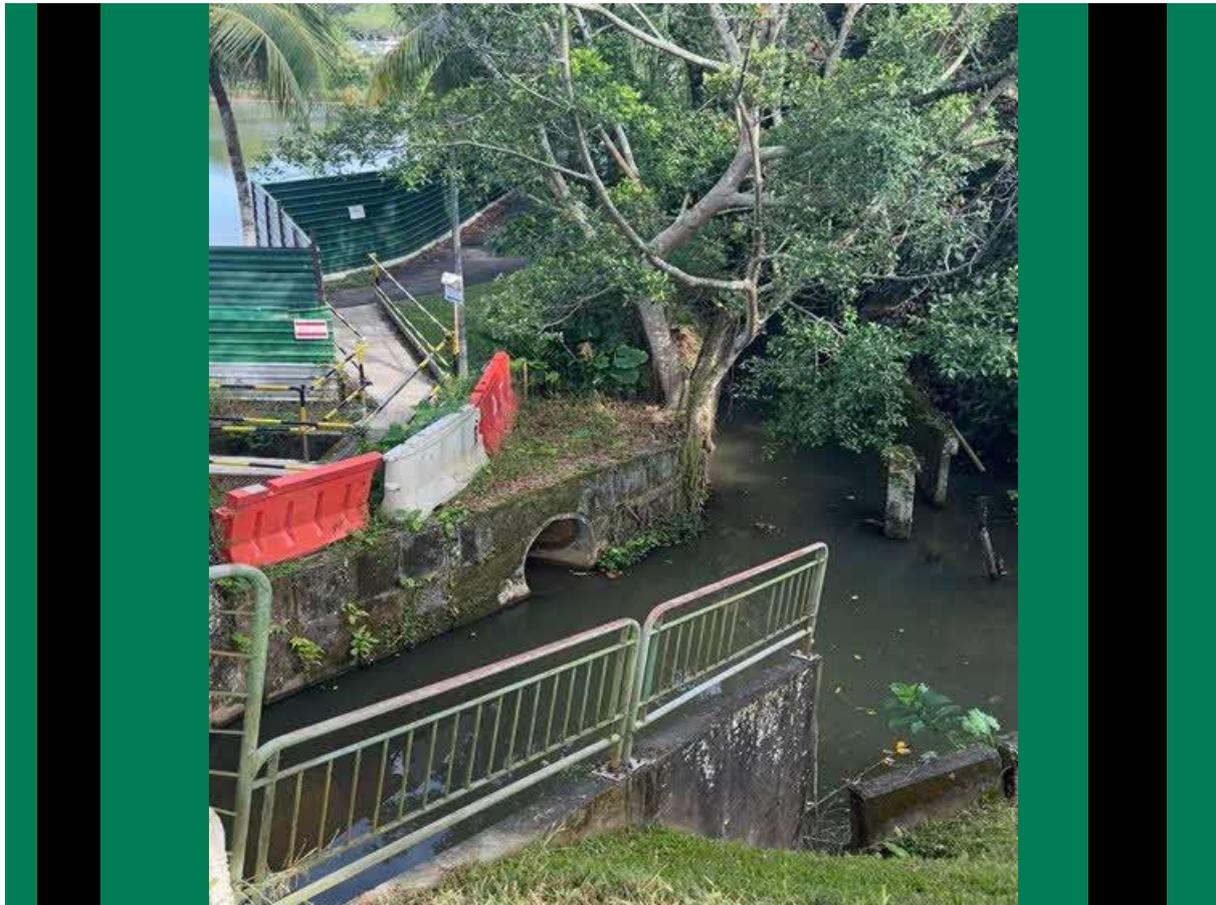
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Report for Site 2



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Acronyms and Abbreviations

>	Greater than
≤	Less than or equal to
≥	Greater than or equal to
APHA	American Public Health Association
BIA	Biodiversity Impact Assessment
BOD	Biological Oxygen Demand
BS	British Standards
COD	Chemical Oxygen Demand
COP	Code of Practice
dB	decibels
DIV	Dutch Intervention Values
DO	Dissolved Oxygen
e.g.	exempli gratia
EIA	Environmental Impact Assessment
EPHA	Environmental Public Health Act
EPMA	Environmental Protection and Management Act
ES	Environmental Score
ESA	Environmental Site Assessment
ESRI	Environmental Systems Research Institute
GLS	Government Land Sales
ha	Hectare
HDB	Housing & Development Board
HK EPD	Hong Kong Environmental Protection Department
i.e.	id est
km	kilometer
LTA	Land Transport Authority
m	meter
MND	Ministry of National Development
MRT	Mass Rapid Transit system
NAS	National Archives of Singapore

NEA	National Environment Agency
NSC	North-South Corridor
NParks	National Parks Board
NSR	Noise Sensitive Receiver
NTU	Nephelometric Turbidity Unit
NUS	National University of Singapore
PUB	Public Utilities Board
QGIS	Quantum Geographic Information System
RIAM	Rapid Impact Assessment Matrix
SGBA	Singapore Biodiversity Accounting Tool
SLA	Singapore Land Authority
SRDB3	Singapore Red Data Book
TDS	Total Dissolved Solids
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TSS	Total Suspended Solids
URA	Urban Redevelopment Authority

1. Introduction

1.1 Overview

The National Parks Board (NParks) has appointed Jacobs (under the contracting entity of CH2M Hill Singapore Pte Ltd) on behalf of the Housing & Development Board (HDB) on 29 July 2024 to conduct Specialist Consultancy Services for an Environmental Impact Assessment (EIA) at Yishun (“hereinafter referred as “the EIA Study”).

This Report for Site 2 has been prepared as one of the deliverables of the EIA Study for the proposed upcoming public housing developments and related drainage works at Chencharu in Yishun (referred to as the “Project”). The area of these proposed developments (hereinafter referred to as the “Subject Site”) is bounded by Sembawang Road, Yishun Avenue 1 / 2, Yishun Walk, and ongoing construction works for the first phase of public housing developments in Chencharu and spans an approximate area of thirty-three hectares (33 ha), as shown in **Figure 1-1**. Site 2 consists of an earth drain of approximately 869 meters (m) with a width of 18 m running from Sembawang Road to Yishun Avenue 2, which will be the focus of this report. The EIA Study also contains a separate report for Site 1, a forested patch with an approximate area of seven hectares (7 ha) along Yishun Avenue 1, which is not contiguous with Site 2. Baseline surveys are currently ongoing for Site 1 at the time of writing, and a separate report will be published when ready.

The Developing Agency for the proposed developments at Chencharu is the Housing & Development Board (HDB), while NParks is the Agency managing the conduct of the EIA.

The purpose of this Report for Site 2 is to document the current environmental conditions of Site 2 via a baseline study and field surveys, evaluate the potential environmental impact arising from the proposed drain diversion works at Site 2, and recommend mitigation measures to manage the potential impact. The Report for Site 2 will contain the following:

- Project Introduction and Project Description.
- EIA Approach and Methodology.
- Documentation of all baseline results from field surveys and data sourced from the literature review for Site 2.
- Impact assessment of various environmental aspects scoped for the study.
- Mitigation measures to be proposed according to the impact assessment.
- Appendices containing maps and supporting documents.

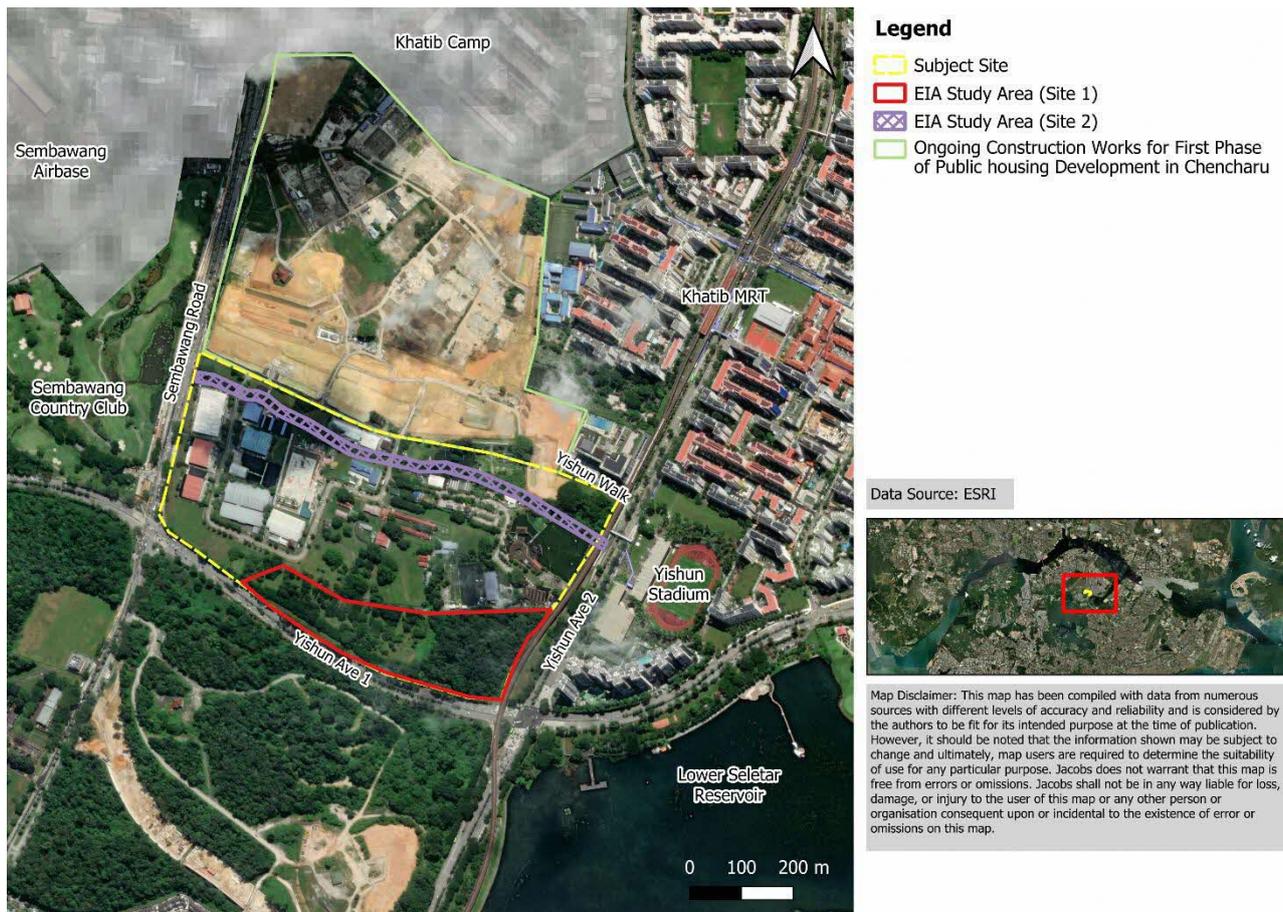


Figure 1-1: Overview of EIA Study Area for Site 2 and Subject Site Boundary

1.2 EIA Requirement for the Project

An EIA has been commissioned to assess the environmental impact of the construction and operational phases of the Project's proposed drain diversion works at Site 2. The results of the EIA aim to guide decision making for the following:

- Any environmental impact on Site 2 that are likely to arise from the Project.
- The conditions and requirements for the Project's proposed works at Site 2 to mitigate the anticipated environmental impact, wherever practicable.
- Residual environmental impact after the proposed mitigation measures is implemented.

1.2.1 Objectives for Site 2 Impact Assessment

The objectives of this impact assessment are to:

- Identify and describe the elements of the community and environment likely to be affected by the Project and/or likely to cause impact to the Project, including both the natural and man-made environment and the associated environmental constraints to and by the Project.
- Describe the baseline conditions of Site 2 and the environmental constraints.
- Identify, quantify, and assess the potential impact and determine the significance of these impact areas on sensitive receptors in the vicinity of Site 2.

- Propose and justify effective mitigation measures (if any) to minimise the environmental impact (e.g. pollution, environmental disturbance, and nuisance) during the construction and operational phases of the Project.
- Identify, predict, and evaluate the residual environmental impact (i.e., after practicable mitigation) expected to arise during the development of the Project in relation to the sensitive receptors.
- Investigate the extent of the secondary environmental impact that may arise from the proposed mitigation measures and to identify constraints associated with the mitigation measures (if any) recommended in the EIA, as well as the provision of any necessary modifications.

1.2.2 Applicable Environmental Legislation, Regulations, and Guidelines

The EIA will adopt and refer to applicable standards and references that are relevant to the Project, the establishment of baseline conditions, environmental impact assessment, and mitigation measures, as follows:

- Singapore's laws, acts, rules, and regulations listed in **Appendix 1A**.
- Other relevant Codes of Practice and Guidelines listed in **Appendix 1A**.

1.3 Limitations

In preparing this Report, we have utilised information related to the development provided by the client and third parties. The findings and conclusions outlined in this Report are compiled on a best-effort basis and are based on the data and information available at the time of writing.

Regarding the fauna surveys, it is important to note that the surveys may not have recorded all species present within Site 2 due to various factors, such as the limited duration of the study, activity patterns of fauna, weather conditions, seasonal variations, and other environmental considerations. To address this limitation, species identified through literature reviews were also taken into consideration for the baseline and impact assessment. These surveys were conducted by experienced field biologists with extensive knowledge of local fauna.

The assessment outlined in this Report reflects an approximation of the environmental conditions within the Study Area at the time of reporting based on available literature, expert observations, and professional judgement.

This Report has been prepared for the sole use of HDB and NParks and is not intended for distribution, disclosure, or reliance by any third party without prior written consent. Such consent may be granted or withheld at our discretion.

2. Project Description

2.1 Project Location

Site 2 consists of an approximately 18-meter wide earth drain within the Subject Site, bounded by Yishun Avenue 2 to the east, Yishun Avenue 1 to the south, Sembawang Road to the west, and Yishun Walk and ongoing construction works for the first phase of public housing developments in Chencharu to the north (Figure 2-1). The western portion of the Subject Site is currently occupied by mostly ornamental/aquarium fish farms and temporary worksites etc. ORTO Leisure Park and SingHealth’s National Large Animal Research Facility once occupied the eastern and central portions of the Subject Site respectively but has since vacated in 2024. Ground-Up Initiative and the Live Turtle and Tortoise Museum, which occupy a small part of the northern portion, will be relocating to a nearby location north of Site 2.

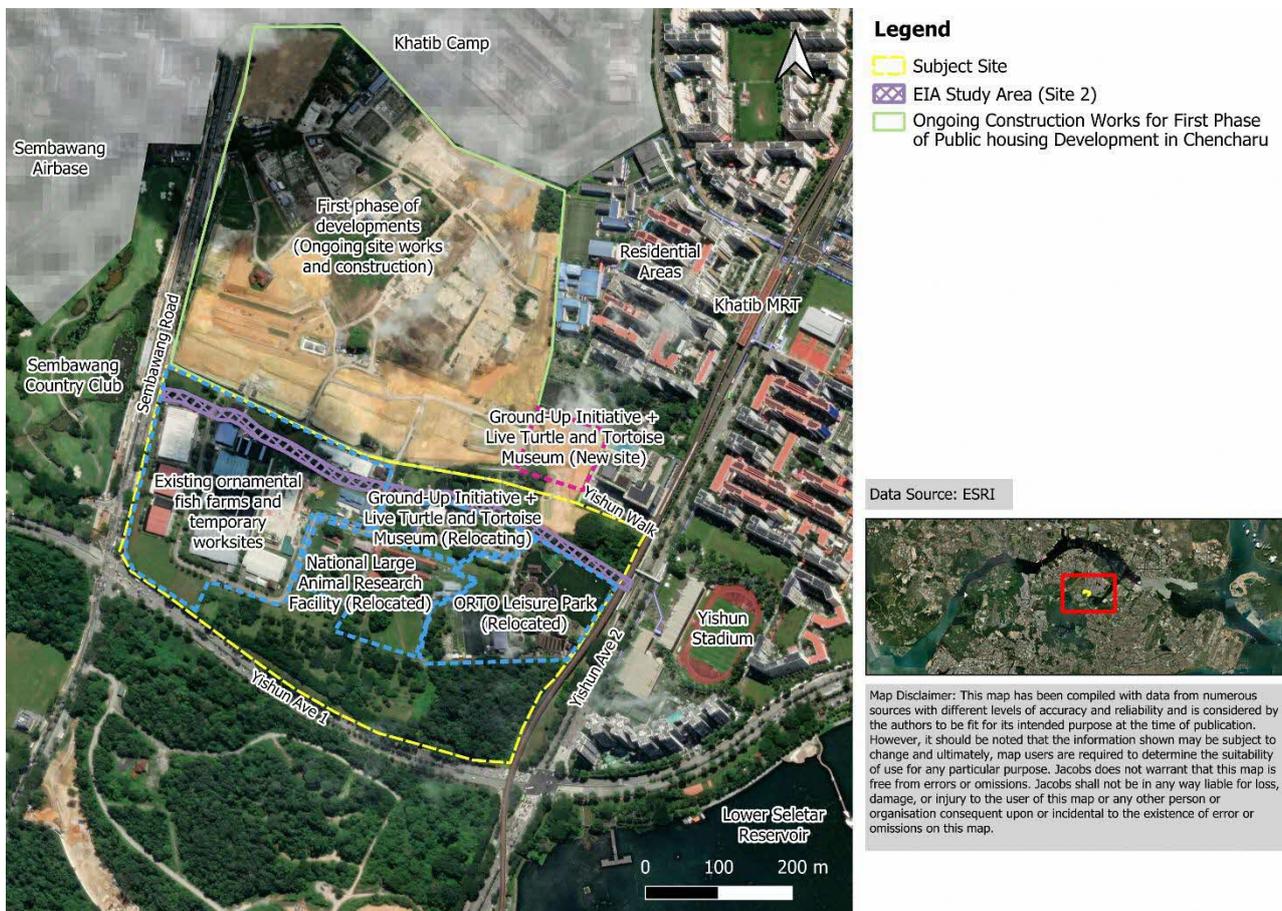


Figure 2-1: Project Location and Land Uses

2.2 Land Use Intent

The land use within the Subject Site is predominantly zoned “Residential (Subject to Detailed Planning)” in URA’s gazetted Master Plan 2019 (Figure 2-2). This area has also been announced in 2024 for housing developments and accompanying amenities as part of the larger Chencharu housing area within Yishun Town, given its proximity to Khatib MRT and the existing town fabric of Yishun.

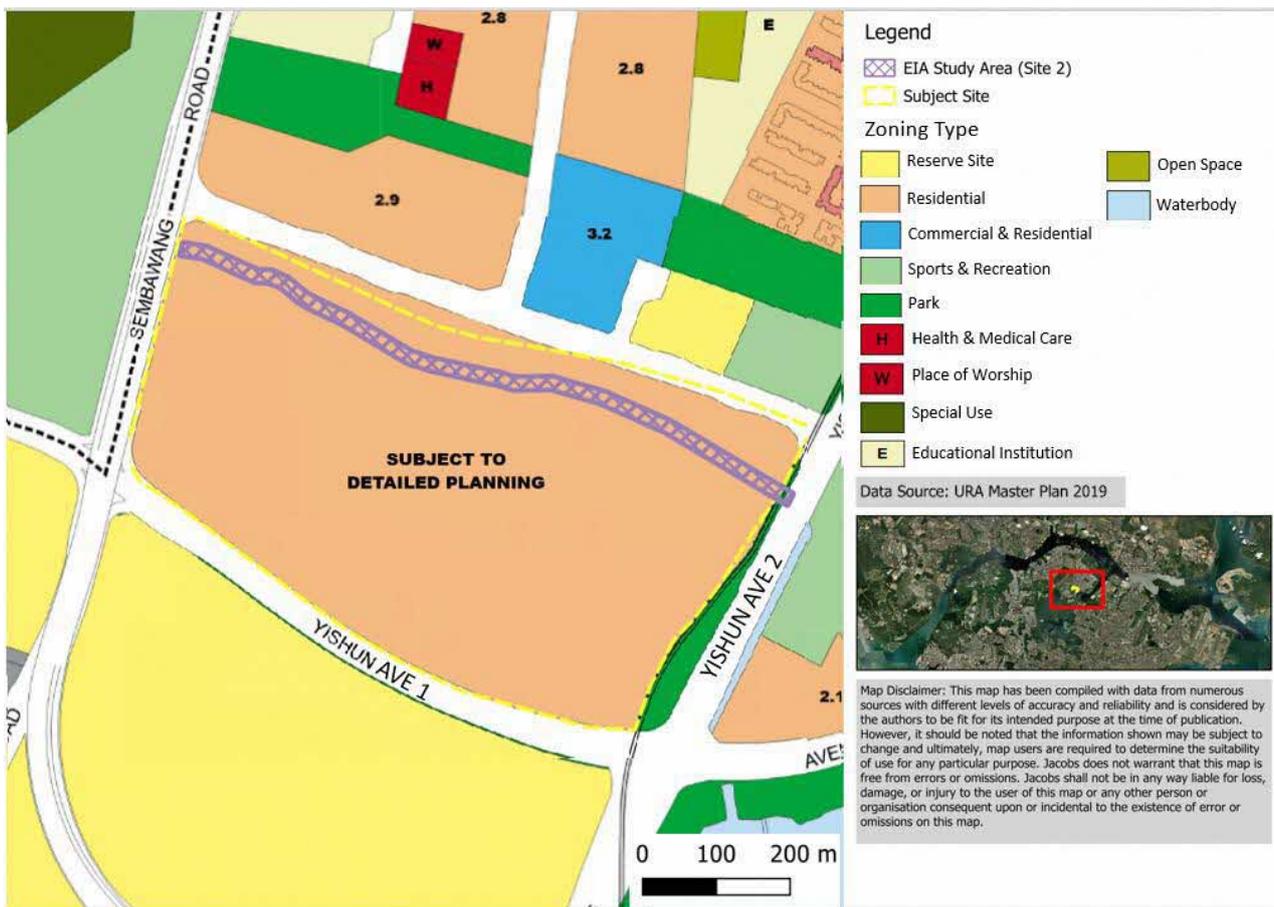


Figure 2-2: Land Use Intent

2.3 Land Use History

Historical and present-day land uses at the Subject Site were reviewed to obtain an understanding of the habitat and areas surrounding Site 2. Information on land use history was primarily gathered from published literature and historical maps in the online collections of the National University of Singapore Libraries (National University of Singapore Libraries, 2024) and National Archives of Singapore (NAS) (National Archives of Singapore, 2024).

Before British colonization in 1819, Singapore's primeval vegetation consisted largely of lowland dipterocarp forest, freshwater swamp forest inland, and mangrove forest fringing much of the coast (Corlett, 1991). By 1900, 90% of the existing forest was cleared for various uses such as agriculture (Yee et al., 2011). Site 2, which was previously known as Sungei Chik Abu and situated northeast of the Chan Chu Kang Forest reserve boundary, was originally a narrow estuary leading to Sungei Seletar (Figure 2-3A). It is likely that the primeval vegetation surrounding Site 2 had been cleared by then.

Subsequently, in the mid-1800s and early 1900s, the surrounding land around Site 2 was used for gambier and pepper plantations and farms in the Sembawang Estate, which were later replaced by pineapple and rubber plantations (Thulaja, 2005; Roots, 2021). As of 1943, Site 2 was surrounded by rubber plantations, but its eastern end remained connected to primeval tidal swamps and Sungei Seletar (Figure 2-3B). Subsequently, Sembawang Field Experiment Station was established north of Site 2 at Bah Soon Pah Road between 1955-1959, which later gave rise to the Sembawang Farm School in 1966, focusing on animal husbandry, freshwater fisheries, and horticulture (Remember Singapore, 2022). A rural field station providing veterinary services to livestock farmers was also established in the area in the 1960s. After which, in 1974-1975, a pig farm and hydroponics farm were set up along Lorong Chencharu (Remember Singapore, 2022). Following this period, the area surrounding Site 2 saw the construction of roads, such as Lorong Chencharu and Chencharu Link along

and across Sungei Chik Abu respectively, and the conversion of adjacent rubber plantations into built-up areas, minor sundry cultivation, and ponds (**Figure 2-3C**).

In the early 1980s, Sungei Chik Abu was separated from Sungei Seletar (**Figure 2-3D**), which was later dammed to form Lower Seletar Reservoir, converting the surrounding natural vegetation from tidal swamps into freshwater swamp forest (**Figure 2-3E**; PUB, 2012). During this period, an earth drain (Site 2) was constructed to serve the drainage needs of the area. (**Figure 2-3E**). The surrounding brownfield land use around Site 2 remained largely unchanged, mostly occupied by farms and nurseries. Discharge from these surrounding farms and nurseries was drained into Site 2, given its primary function as a drain.

Subsequently in 2006, Bottle Tree Park Pte. Ltd. occupied the land south of Site 2 and developed the area into Bottle Tree Park for recreational and commercial purposes, including a fishing pond, restaurants, and other commercial activities. It was later renamed ORTO Leisure Park in 2014, which remained on-site until its lease expiry in 2023 (The Straits Times, 2024). During this period, other farms, and community facilities, such as Ground-Up Initiative and the Live Turtle & Tortoise Museum, also occupied the areas north and south of Site 2. The plant nurseries that occupied the area north of Site 2 vacated the area after their leases expired, and site works for the area commenced in January 2022 to facilitate upcoming residential plans. HDB announced the master plan for the first phase of Chencharu's housing developments in June 2024 on the area previously occupied by the plant nurseries, along with the sales launch of the first BTO project (Chencharu Hills), where construction works have commenced (**Figure 2-3F**).

In its present state, there is a thin strip of riparian vegetation lining Site 2 that likely persisted from old sundry cultivation with some spontaneous secondary vegetation growth.

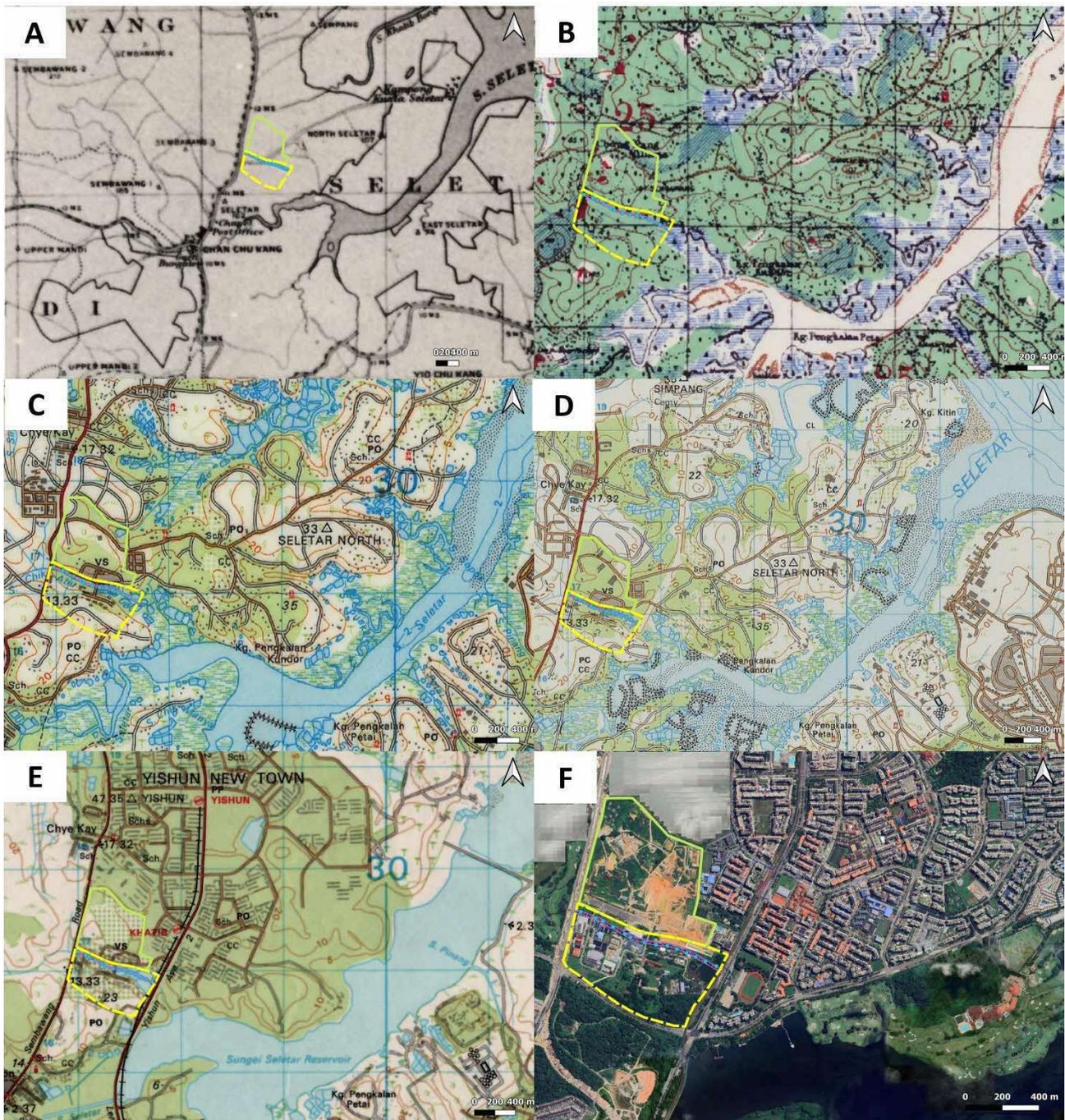


Figure 2-3: Historical and Present Land Use Changes of Chencharu (NUS Historical Maps of Singapore). A) 1911, B) 1943, C) 1978, D) 1983, E) 1987, and F) 2024.

2.4 Site Conditions

The area around Site 2 is relatively flat with some mild undulations. It is part of the Yishun Planning Area, which is generally low-lying and historically characterised by swamps and mangroves. Over time, the land was drained and utilised for plantations and agriculture, and subsequently for urban development, thus significantly altering the hydrology and drainage of the area. Currently, the land use includes a mix of residential developments, recreational and commercial uses.

The earth drain was constructed as part of a broader network of waterways in the area to enhance drainage capacity, which allowed for better stormwater management and flood risk mitigation, particularly given Singapore's tropical climate with periods of high rainfall.

2.5 Proposed Works at Site 2

Originally constructed in the 1980s to handle drainage from surrounding agricultural and recreational uses, the earth drain flows from the west through Sembawang Country Club to the east towards Yishun Avenue 2, before discharging into Lower Seletar Reservoir. The surrounding Chencharu area was announced for housing developments, with plans for around 10,000 public and private units along with accompanying amenities. Due to evolving land use needs and the limited drainage capacity of the current earth drain, upgrading and diversion works are required to support the future drainage needs of upcoming residential developments and ensure compliance with updated drainage standards. These works will be conducted in phases, where the eastern half (outlined in orange) will be diverted to a new 4-meter-wide box drain (outlined in green) and backfilled in the near-term, while the remaining western half will be diverted and backfilled in later years (Figure 2-4).

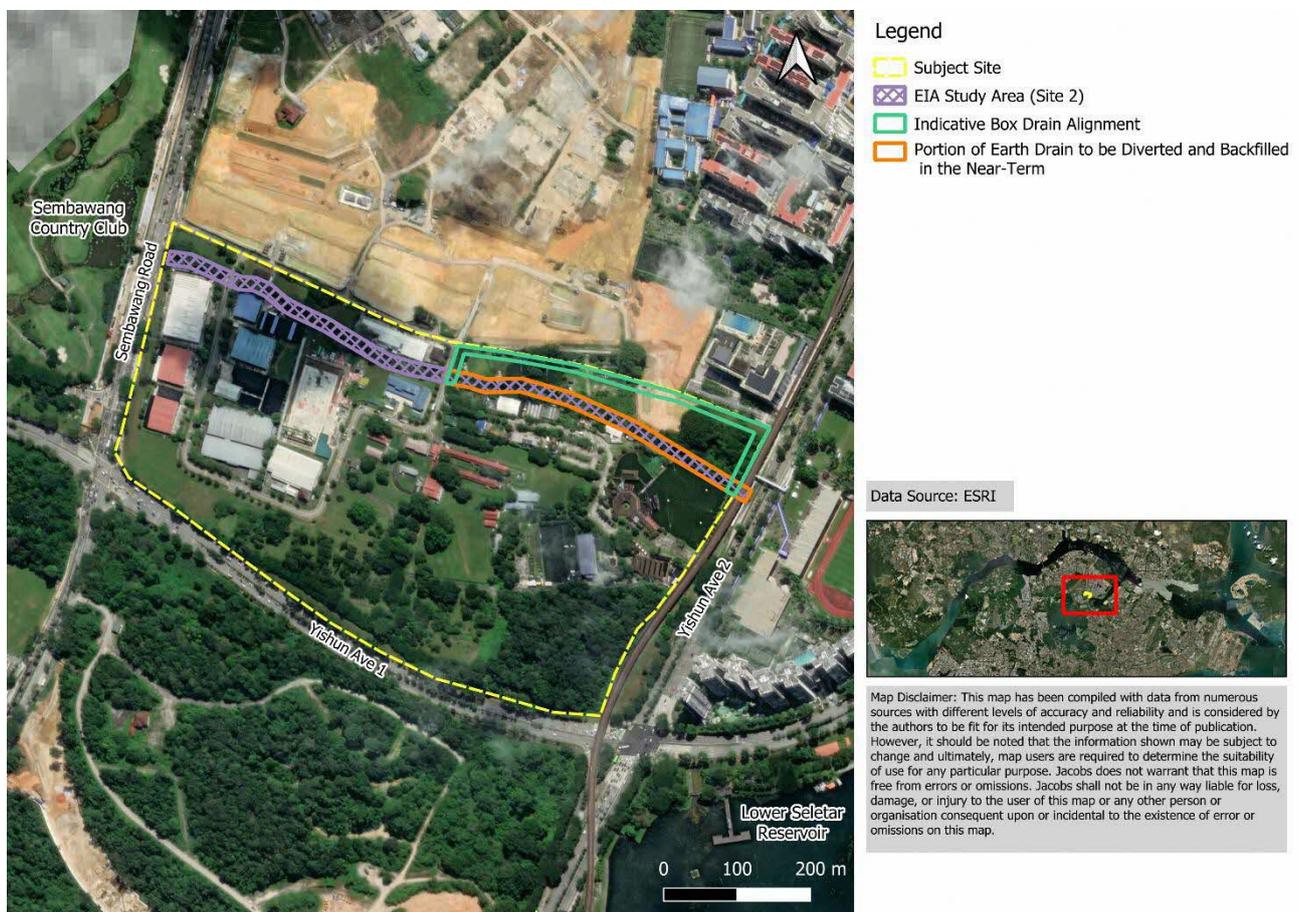


Figure 2-4: Indicative Location for Earth Drain Diversion and Box Drain Alignment

The proposed works for Site 2 include a sequence of diversion and backfilling processes. A new 4-meter-wide box drain with a higher drainage capacity will be constructed to replace the earth drain, and water flow will be redirected into the new box drain before the existing earth drain is isolated and backfilled. The new drainage system will support efficient stormwater management and reduce erosion risks for the future developments. The detailed steps of the proposed diversion and backfilling works for Site 2 are outlined below:

a) Site Preparation and Initial Setup:

- i. Silt fencing will be installed along the edges of the existing earth drain to control sediment and protect surrounding areas.
 - ii. Vegetation (where necessary) and debris will be cleared from the construction zone while ensuring minimal disruption to surrounding areas.
- b) Box Drain Construction:
- i. The new 4-meter-wide box drain will be constructed parallel to the existing earth drain.
- c) Water Diversion:
- i. A localised temporary diversion drain surrounding the proposed sump areas will be constructed.
 - ii. The earth drain will be diverted to the temporary diversion drain to make space for the sump construction. Temporary barriers will be installed to safely guide water flow from the earth drain to the temporary diversion drain during the initial phases of the drain diversion.
 - iii. Close monitoring of water flow and quality checks will be performed to ensure that the temporary diversion drain contains the diverted water without leaks or overflow.
- d) Sump Construction and connection of the existing earth drain to the newly constructed box drain:
- i. Sheet piles will be installed around the newly established drain path as a temporary earth retaining structure to prevent soil erosion and stabilise the work area prior to sump construction.
 - ii. A sump within the sheet-piled section will be constructed to collect and manage the flow of water downstream.
 - iii. Water in the earth drain will be diverted to the sump, which is connected to the newly constructed box drain, prior to any backfilling works.
- e) Backfilling of the Earth Drain:
- i. After diversion and stabilization, the original earth drain will be backfilled with suitable materials, ensuring that the layers are compacted to prevent future subsidence.
 - ii. Final grading and landscaping will be conducted, including turfing, and installing erosion control blankets where necessary to stabilise the area.
 - iii. All temporary structures will be removed to ensure that the site meets environmental and development standards.

These steps outlined above will be implemented in two phases. The eastern half of the earth drain is planned to be diverted to the new box drain and backfilled in the near-term (as illustrated in **Figure 2-4**), while the western half of the earth drain will be diverted to an extension of the box drain planned for construction in later years and backfilled subsequently.

2.6 Environmental Sensitive Receptors

Environmental sensitive receptors include the current habitat conditions and water quality of the earth drain. They may be affected by potential sedimentation, contamination, and removal due to the proposed diversion and backfilling works. This EIA scope focuses on these receptors to assess and mitigate the potential impact arising from the proposed activities.

Ecological sensitive receptors in the study area encompass a range of fauna, including odonates, herpetofauna, and aquatic species, which are classified by their sensitivity levels from high to low. High-sensitivity species

include those of conservation significance, while moderate and low-sensitivity groups consist primarily of native and exotic fauna which are not of conservation significance.

The earth drain at Site 2 was identified as the only waterbody on-site. The water quality of this drain is also considered a sensitive receptor in the environmental assessment.

2.7 Project Implementation Schedule

The proposed diversion and backfilling works at Site 2 are expected to commence in 2Q 2025, after the relevant approvals have been obtained. The works will require approximately 8 months to be completed. There will be no night works expected for these works.

2.8 Concurrent Developments (Ongoing and Upcoming Projects)

There are several ongoing developments within the vicinity of the Subject Site. A summary of the ongoing and upcoming developments located within a 2 km radius of the Subject Site is tabulated in **Table 2-1**.

Table 2-1: Concurrent Developments

Development	Description	Tentative Development Timeline
North-South Corridor (LTA)	The North-South Corridor (NSC) is a multi-modal transportation corridor that will enhance connectivity from the northern region to the city, serving towns such as Sembawang, Yishun, Ang Mo Kio, Toa Payoh, Novena and Rochor. It will help to relieve traffic along Singapore's north-south transportation axis and support new developments along the corridor.	Ongoing. The NSC is expected to be completed in phases from 2027. The EIA for this development was completed and published in 2021.
Public housing developments at Chencharu, Yishun (HDB)	HDB unveiled the master plan for the first phase of public housing developments in Chencharu in June 2024. Chencharu will also feature a range of new amenities such as a bus interchange, hawker centre, neighbourhood park, and shops to serve new and existing residents of Yishun Town. The first BTO project (Chencharu Hills) was launched for sale in June 2024.	Earthworks and construction works are ongoing. The first BTO Project (Chencharu Hills) is estimated to be completed in December 2028.
	Detailed plans for subsequent phases of public housing developments in Chencharu are currently under study within the Subject Site.	Demolition works and earthworks of vacated or relocated brownfield uses in the eastern half of the Project site are ongoing.
Chong Pang City (SLA)	Chong Pang City is a 0.9ha integrated development that will rejuvenate the Chong Pang City neighbourhood centre with a community club, market and hawker centre, and facilities such as swimming pools, a gym, and a variety of shops including a supermarket.	Ongoing and expected to complete in 2027.

Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Chencharu (Site 2)

Development	Description	Tentative Development Timeline
Springleaf Precinct (URA)	Bounded by Seletar Expressway, Mandai Road, and Upper Thomson Road, the Springleaf site has been planned to utilise the site for about 2,000 new dwelling units and more nature-based recreation opportunities to the public.	Ongoing. One Government Land Sales (GLS) site has been awarded in 2024. The EIA for this development was completed and published in 2022.

Source: Chong Pang Integrated Development, URA, 2022; 2024; LTA, 2024; HDB, 2024.

3. EIA Approach and Methodology

3.1 EIA Baseline Components

The baseline study aims to establish the existing environmental conditions at Site 2 prior to the proposed diversion works and provide a benchmark against which the potential impact of the proposed project development can be assessed to determine its significance.

The environmental aspects for the baseline study associated with the proposed diversion works will comprise the following:

- Surface water quality – information relating to the drainage along the EIA Study Area
- Ecology and Biodiversity – species recorded, focusing specifically on species and taxonomic groups that are rare and threatened, have significant ecological or keystone functions, or are otherwise of public interest.

3.2 Assessment of Potential Environmental Impact

3.2.1 Assessment Criterion

The Modified Rapid Impact Assessment Matrix (RIAM) will be used as the impact assessment methodology to assess the overall impact on the key environmental aspects from the development of this Project in the pre-construction, construction, and post-construction phases. RIAM is a semi-quantitative impact assessment method modified/ adopted from Pastakia (1998) and Ijas et al. (2009). This modified RIAM approach applies a scoring matrix (quantitative indicators) for impact evaluation in the form of Environmental Scores (ES), which range from an extreme positive impact to critically negative impact for each specific project activity, with consideration of the sensitivity level of the existing baseline environmental conditions.

The criteria used for the assessment fall into two groups, Group A and Group B, with their respective factors of assessment indicated in Figure 3-1.

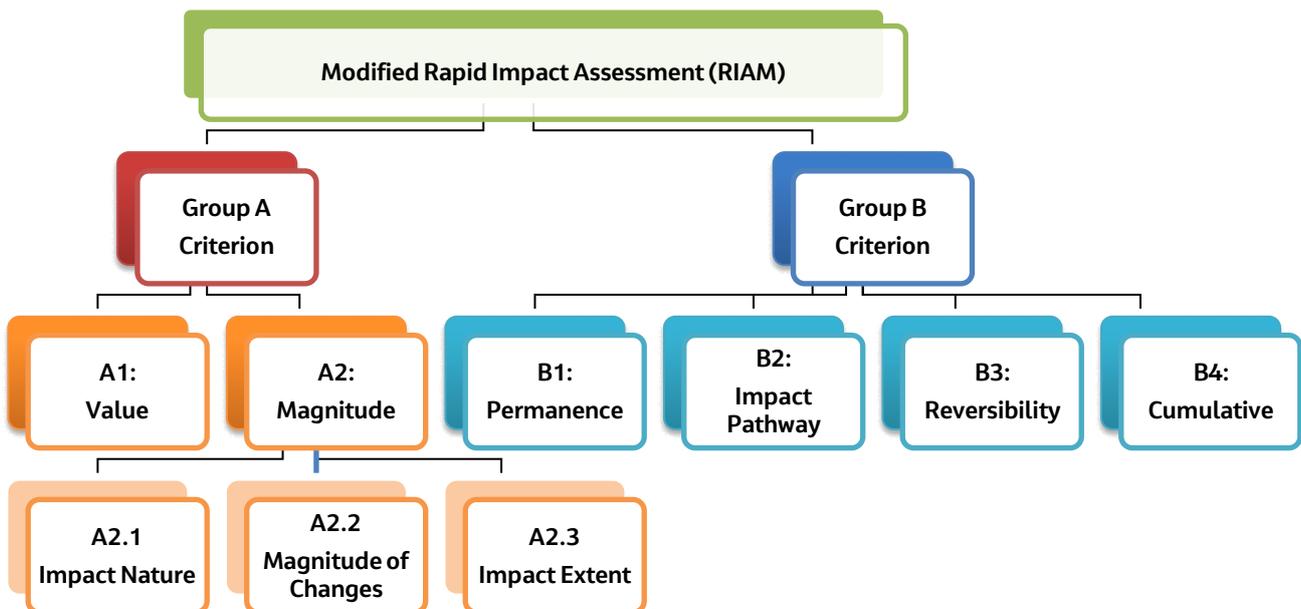


Figure 3-1: Assessment Criteria for Impact Significance following the RIAM Method

3.2.1.1 Group A Criteria

Group A Criteria are measures of importance of the existing sensitive receiver characteristics with value levels (A1) against the magnitude (scale) of the changes regardless of whether the impact nature is a beneficial or dis-beneficial impact (A2). The score for Group A will be calculated using multiplication, i.e. $(A1) \times (A2.1) \times (A2.2) \times (A2.3) = AT$, where (A1) to (A2.3) are the individual criteria scores in Group A and (AT) is the result of multiplication of all Group A scores. The definition and score general criteria considered for Group A is given in Table 3-1.

Table 3-1: Definition and Score Criteria for Group A Criterion

Group A Criterion	Score/ General Criteria Considered
A1 – Value Sensitive Receiver Characteristic	4: Important to international interests (beyond Singapore) (Very High)
	3: Important to national/ regional interests (within Singapore) (High)
	2: Important to the area immediately outside local conditions (i.e., 100m buffer around Site 2) (Medium)
	1: Important to local conditions (within Site 2) (Low)
	0: No importance, i.e., value does not carry important role of local interest (Not Important)
A2 – Magnitude Measure of the scale of benefit/dis-benefit (impact nature) of an impact or a condition	A2.1 – Impact Nature (Benefit or Dis-benefit)
	+1: Positive impact
	-1: Negative impact
	0: Negligible impact/ no change/ status quo
	A2.2 – Magnitude of Changes*
	3: High impact/ changes
	2: Medium impact/ changes
	1: Low impact/ changes
	0: No change/ status quo/ negligible
	A2.3 – Impact Extent (Geographical Extent of the Induced Change)
	4: Transboundary (Impact extends beyond Singapore's boundary)
	3: Impact extends up to national boundary
	2: Impact extends immediately beyond Site 2, i.e., Buffer area
	1: Impact within local area, i.e., within Site 2
	0: No change/ status quo

Note: *Magnitude of changes – there will be specific definitions of magnitude for each environmental component/ aspect given in their respective evaluation sections.

3.2.1.2 Group B Criteria

Group B Criteria are measures of value to the situation but should not individually be capable of changing the overall score obtained. Each of the Group B criteria collectively contributes to the assessment, without allowing any single criterion to disproportionately influence the overall score. The criteria definitions are shown in **Table 3-2**.

The score for the criteria in Group B will be calculated using summation, i.e. $(B1) + (B2) + (B3) + (B4) = BT$, where (B1) to (B4) are the individual criteria scores in Group B and (BT) is the result of summation of all Group B scores.

Table 3-2: Definition and Score Criteria for Group B Criterion

Group B Criterion	Scores/ Definition	
B1 – Permanence Whether a condition is temporary or permanent and should be seen only as a measure of the temporal status of the condition (i.e. the time period over which a resource/ receptor is affected)	4:	Long term effects, i.e., > 10 years (over the lifetime of the Project)
	3:	Medium term, i.e., ≥ 3 years ≤ 10 years
	2:	Short term, i.e., less than 3 years
	1:	Temporary, i.e., less than one month
B2 – Impact Pathway Whether the receivers are directly or indirectly impacted	3:	Direct impact
	2:	Indirect impact
	1:	No change/ not applicable
B3 – Reversibility Whether a condition can be changed and is a measure of the control over the effect of the conditions	3:	Irreversible
	2:	Reversible
	1:	No change/ not applicable
B4 – Cumulative Whether the effect will have a single direct impact or whether there will be a cumulative effect over time or synergistic effect with other conditions	3:	Cumulative/ synergistic
	2:	Non-cumulative/ single
	1:	No change/ not applicable

3.2.1.3 Impact Severity/ Significance

The impact severity/ significance is evaluated against the impact criteria (Group A and Group B) and a score is determined for each criterion, which provides a measure of the impact severity expected for the potential impact area identified.

The total environmental score (ES) will be calculated using the equation $(AT) \times (BT) = ES$.

The severity of impact for each of the evaluated potential impact identified has been categorised using a qualitative scale of severity with range bands as indicated in **Table 3-3**.

Table 3-3: Range Bands of Environmental Score (ES) and the Corresponding Level of Impact Significance

Environmental Score (ES)	Impact Severity/ Significance	Definition
481 to 624	Extreme Positive Effect	Impact which causes great improvement or benefit to the existing environment
313 to 480	Major Positive Effect	Impact which causes major improvement or benefit to the existing environment
121 to 312	Moderate Positive Impact	Impact which causes noticeable improvement or benefit to the existing environment
53 to 120	Minor Positive Impact	Impact which causes minor improvement or benefit to the existing environment
1 to 52	Slight Positive Impact	Impact which causes slight improvement or benefit to the existing environment
0	No Change/ Status Quo	No discernible deterioration or improvement to the existing environment
-1 to -52	Slight Negative Impact	Impact which causes slight deterioration or dis-benefit to the existing environment
-53 to -120	Minor Negative Impact	Impact which causes minor deterioration or dis-benefit to the existing environment
-121 to -312	Moderate Negative Impact	Impact which causes a noticeable deterioration or dis-benefit to the existing environment
-313 to -480	Major Negative Impact	Impact which causes major deterioration or dis-benefit to the existing environment
-480 to -624	Critically Negative Impact	Impact which causes critical deterioration or dis-benefit to the existing environment

3.2.2 Identification and Recommendation of Applicable Mitigation/ Enhancement Measures

As the impact significance is evaluated, preventative measures and/or mitigation measures are determined. The mitigation hierarchy is shown in **Figure 3-2**.



Figure 3-2: Mitigation Hierarchy

The priority of the Mitigation Hierarchy is to first apply feasible prevention/ mitigation/ control measures to the source of impact, i.e., avoid or reduce the magnitude of impact or alleviate the significance of any negative impact identified from the associated design initiatives, construction method approach, construction and

operation activities to as low as reasonably practicable (ALARP) using the following types of control methods as shown in **Figure 3-3**.

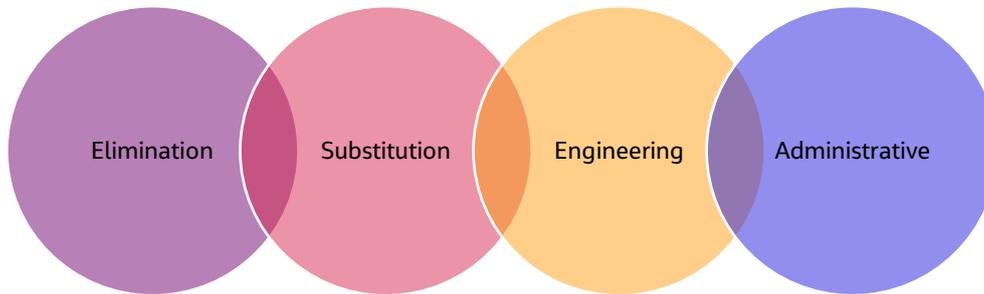


Figure 3-3: Control Method

The mitigation measures proposed will consider their effectiveness, embedded measures, safety, practicality, and suitability for implementation for the proposed project design initiatives, construction methodology, timeline, and site space. Any resultant effects to the specific environmental aspects/ resources/ receptors will be addressed via abatement or compensatory measures or offset.

Physical or procedural controls (embedded control measures or minimum control measures) that are planned as part of the Project design in complying with applicable statutory legislation but not added solely based on mitigation measures identified by the impact assessment process, are distinguished from mitigation measures in the impact significance assigned for the potential impact of the Project.

Once embedded mitigation measures are declared, the next step will be to evaluate the residual impact significance. Any subsequent residual impact following the implementation of the proposed mitigation measures from the study and their significance, will also be assessed.

The RIAM method impact assessment approach has considered the cumulative impact/ effects to which the Project may contribute to. The approach for assessing the cumulative impact and effects resulting from the Project and its associated facilities with another activity affecting the same resource/ receptor is based on consideration of the approval/ existence status of the other activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

4. Assessment of Water Quality

This section describes the applicable legislation and standards in evaluating the potential water quality impact associated with the proposed development activities of the proposed Project. It includes a discussion of the existing water quality conditions within the EIA Study Area, methodology, and criteria used for the assessment. Appropriate mitigation measures are recommended, where necessary.

4.1 Applicable Legislation Standards

NEA administers the *Environmental Protection and Management Act (EPMA)* and the *Environmental Protection and Management (EPM) (Trade Effluent) Regulations* which regulates the discharge of wastewater into open drains, canals, and rivers, and specifies the allowable limits for trade effluent discharge to various types of watercourses. The nature or type of trade effluent discharge must be approved by NEA prior to discharge into any watercourse. The effluent must be treated before discharge and comply with the water quality limits specified in the regulations.

The earth drain at Site 2 drains downstream into Lower Seletar Reservoir, one of the 17 reservoirs in Singapore. As Lower Seletar Reservoir is a watercourse from which potable water supplied by PUB under the Public Utilities Act is obtained, it is classified as a controlled watercourse. Although the earth drain (Site 2) is not strictly trade effluent but rather a controlled watercourse that existing brownfield users may discharge trade effluent into, the report will be using the EPM Trade Effluent guidelines and allowable limits (**Table 4-1**) as a proxy for the water quality assessment. In addition, the following guideline levels are adopted for parameters not listed in the EPM Trade Effluent:

- *NEA's Water Quality Guidelines for Popular Recreational Beaches* for Enterococcus
- *PUB Internal Guidelines for Water Treatment* for Total Organic Carbon
- *PUB Internal Guidelines for Reservoir Water Quality* for Ammoniacal Nitrogen

Table 4-1: In-situ and Ex-situ Parameters Analysed for Water Quality Sampling and Relevant Discharge Limit referenced to EPM (Trade Effluent) Regulations

	Item of Analysis	Units	Test Method	Discharge Limit Controlled Watercourse, mg/L
In-situ Parameters	Temperature	°C	MLS-SOP-ES-004 using multi-parameter	45°C
	pH	-	MLS-SOP-ES-004 using multi-parameter	6-9
	Conductivity	µS/cm	MLS-SOP-ES-004 using multi-parameter	-
	Salinity	ppt	MLS-SOP-ES-004 using multi-parameter	-
	Dissolved Oxygen	mg/l	MLS-SOP-ES-004 using multi-parameter	-
	Turbidity	NTU	MLS-SOP-ES-004 using multi-parameter	-

Specialist Consultancy Services for Environmental Impact Assessment (EIA) at Chencharu (Site 2)

	Item of Analysis	Units	Test Method	Discharge Limit Controlled Watercourse, mg/L
Ex-situ Parameters	Biochemical Oxygen Demand (BOD)	mg/l	APHA 5210B	20
	Chemical Oxygen Demand (COD)	mg/l	HACH Method 8000 (Jul 2021)	60
	Total alkalinity	mg/L CaCO ₃	APHA 2320B	-
	Total Phosphorus (TP)	mg/l	APHA 4500-P (J)	-
	Total Nitrogen (TN)	mg/l	APHA 4500-P (J)	-
	Total Organic Carbon (TOC)	mg/l	APHA 5310B	10
	Nitrate (NO ₃ -N)	mg/l	APHA 4500- NO ₃ (I)	20
	Ammonical Nitrogen (NH ₄ -N)	mg/l	APHA 4500- NH ₃ (H)	0.5
	Orthophosphate (PO ₄ -P)	mg/l	APHA 4500-P (G)	2
	Total Dissolved Solids (TDS)	mg/l	APHA 2540C	1,000
	Total Suspended Solids (TSS)	mg/l	APHA 2540D	30
	Arsenic as As	µg/l	APHA 3500B	10
	Barium as B	µg/l	APHA 3500B	1000
	Tin as Sn	µg/l	APHA 3500B	5000
	Beryllium as Be	µg/l	APHA 3500B	500
	Boron as B	µg/l	APHA 3500B	500
	Manganese as Mn	µg/l	APHA 3500B	500
	Iron as Fe	µg/l	APHA 3500B	1000
	*Lead	µg/l	APHA 3500B	100
	*Zinc	µg/l	APHA 3500B	500
	*Mercury	µg/l	USEPA 245.1 (FIMS) (1994)	1
	*Cadmium	µg/l	APHA 3500B	3
	*Chromium	µg/l	APHA 3500B	50
	*Copper	µg/l	APHA 3500B	100
*Nickel	µg/l	APHA 3500B	100	
*Selenium	µg/l	APHA 3500B	10	

	Item of Analysis	Units	Test Method	Discharge Limit Controlled Watercourse, mg/L
	*Silver	µg/l	APHA 3500B	100
	*Metals in Total	µg/l	By Calculation	500
	Oil and grease [total]	mg/l	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	1
	Oil and grease (hydrocarbon)	mg/l	APHA 5520F	-
	Bacteria (Enterococcus, etc)	cfu/100ml	APHA 9230C	-

The *Sewerage and Drainage Act (SDA)* authorises PUB to construct, maintain and improve sewerage and drainage systems, to regulate the discharge into these systems, and to issue codes of practice or specifications. It mandates the supervision of works requiring a clearance certificate under this Act by a Qualified Person. The Act also confers PUB with enforcement powers.

The Codes of Practice (COPs) and guidelines that are relevant to discharges into waterbodies are listed below:

- COP for Environmental Control Officer (ECO) issued by NEA
- COP on Surface Water Drainage (revised 2007) issued by PUB
- Guidebook on Erosion and Sediment Control at Construction Sites, issued by PUB
- Guidebook for Qualified Erosion Control Professional (QECP), issued by PUB

4.2 Methodology for Water Quality Assessment

This EIA focuses on the assessment of potential water quality impact during the construction and operational phase activities of the proposed Project. The methodology for water quality impact assessment has been developed based on best practices and guidelines. Thus, this report adopted the *Technical Memorandum Annex 14: Guidelines for Assessment of Water Pollution* published by Hong Kong's Environmental Protection Division (HK EPD), adapted to the Singapore context. The Technical Memorandum Annex 14: Guidelines for Assessment of Water Pollution was chosen as it provides guidance on the identification of potential water pollution sources associated with the Project development, prediction, and assessment of potential water pollution impact.

The potential impact from the construction and operational phases of the Project on water quality was undertaken in a qualitative manner, as specific discharge quantities and discharge points were not known at the time of writing. The assessment of the potential water quality impact involved the following steps:

- Identifying the watercourse within Site 2
- Establishing existing conditions for water quality in the receiving watercourse based on the listed specifications and methodology
- Specifying construction activities with the potential to affect water quality and assessing their anticipated impact
- Recommending mitigation measures to minimise any identified adverse impact on the water quality by the proposed construction activities and identifying appropriate monitoring requirements during the construction phase

4.3 Existing Pre-Construction Conditions

4.3.1 Climate and Meteorological Data

4.3.1.1 General Climate in Singapore

Singapore, situated near the equator, has a tropical climate with abundant rainfall and high humidity and temperatures all year long. The climate is characterised by two monsoon seasons and separated by two inter-monsoon periods:

- **Northeast Monsoon** (December to early March) – The early part of the Northeast monsoon (December to early January) is the wetter period with monsoon surges and heavy rain. The later part (Late January to early March) is usually drier.
- **Inter-monsoon** (late March to May) – Afternoon thunderstorms are common.
- **Southwest Monsoon** (June to September) – Heavy rain and gusty winds associated with Sumatra squalls occur occasionally.
- **Inter-monsoon** (October to November) – Afternoon thunderstorms are common.

The average number of rainy days in a year (where total rainfall in a day is at least 0.2 mm) in Singapore is 167 days. The 1981-2010 long-term average annual rainfall was 2,166 mm.

The minimum daily temperature in Singapore does not usually fall below 23-25°C during the night and the maximum does not rise above 31-33°C during the day. May and June are the hottest months with a mean monthly temperature of 27.8°C. December and January are the coolest months with a mean monthly temperature of 26.0°C. Due to the proximity of the sea, Singapore has a coastal climate that moderately influences its climate. During the afternoons, conditions at the coast are often relieved by sea breezes.

Relative humidity in Singapore is fairly uniform throughout the year and does not vary much from month to month. On days where there is no rain, the daily relative humidity varies from more than 90% in the morning just before sunrise and falls to around 60% in the mid-afternoon. The mean annual relative humidity is 83.9%. Relative humidity frequently reaches 100% during prolonged periods of rain.

4.3.1.2 Site-Specific Rainfall during Water Quality Study

There are no rain stations in the immediate vicinity of the EIA Study Area (**Figure 4-1**). Hence, two of the closest rain stations were selected to indicate approximate rainfall during the study (i.e., S25 Seletar, and S80 Sembawang). Sembawang Weather Station is approximately 1.1 km northwest of Site 2, while Seletar Weather Station is approximately 3.8 km northeast of Site 2. Data on the total daily rainfall collected at these two rain stations in September 2024 were obtained from publicly available platforms hosted by NEA's Meteorological Service Singapore (MSS) division and presented in **Figure 4-2**.

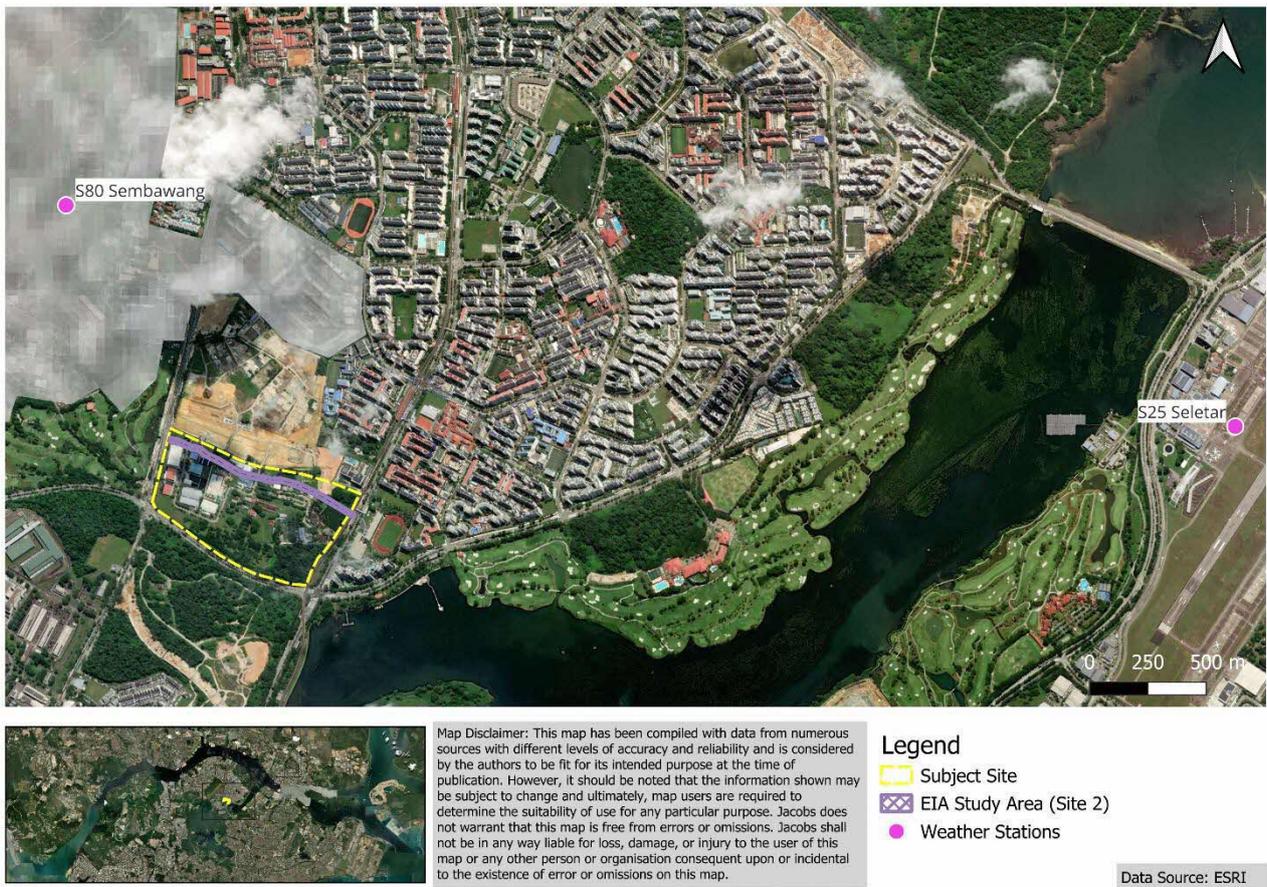


Figure 4-1: Locations of Rainfall Data Stations Closest to the EIA Study Area

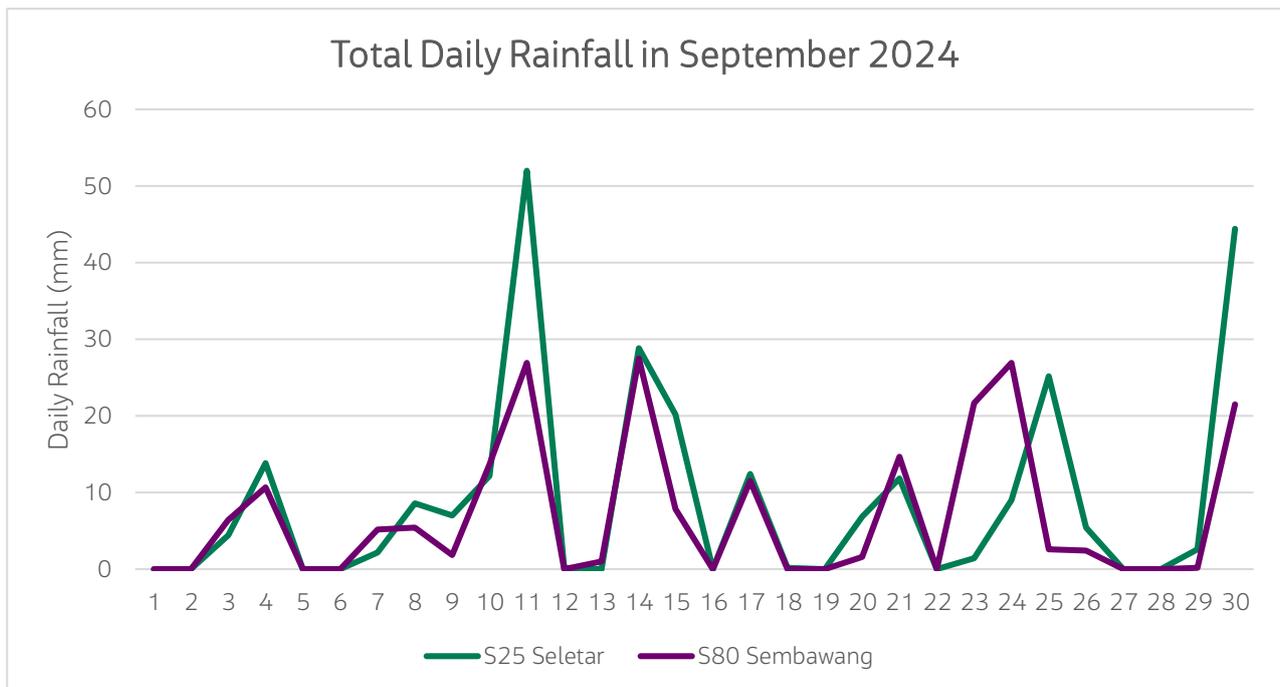


Figure 4-2: Daily Total Rainfall in September 2024

4.3.2 Locations of Water Quality Monitoring

Water samples were sampled across the start, mid, and end portions of the drain, with additional points fixed at outfall points. Water quality samples were collected at ten (10) locations as shown in **Figure 4-3**.

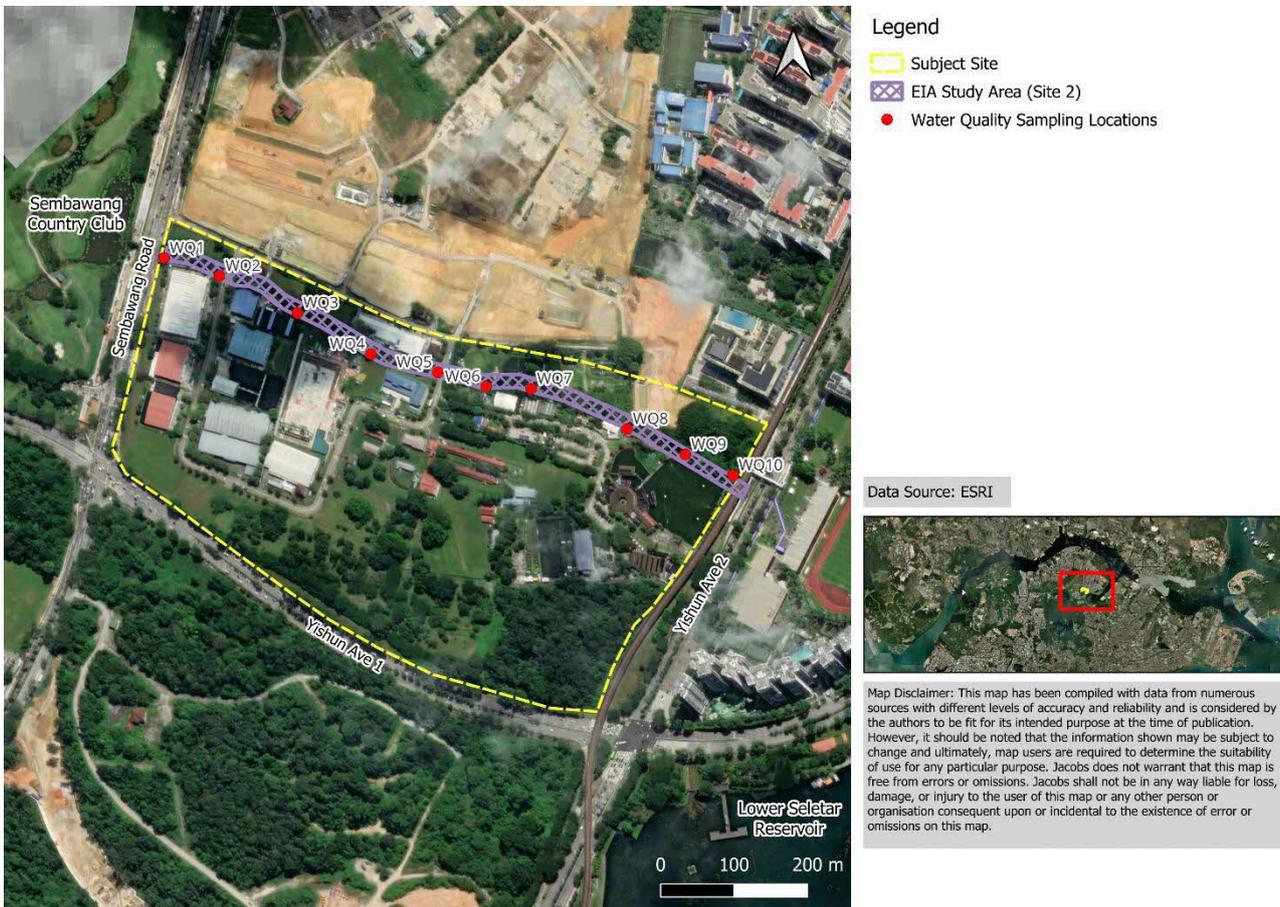


Figure 4-3: Water Quality Sampling Locations

The waterbody features observed during the survey are presented in Table 4-2. The photographs were taken during the dry weather sampling on 16 September 2024. Other sampling observations are listed in **Appendix 4A**.

Table 4-2: Waterbody Features and Photographs with Coordinates

WQ1 (1.416050, 103.823870)	WQ2 (1.415794, 103.824610)	WQ3 (1.415288, 103.825582)
		
WQ4 (1.414805, 103.826496)	WQ5 (1.414522, 103.827263)	WQ6 (1.414387, 103.828366)
		

WQ7 (1.414381, 103.828392)	WQ8 (1.413768, 103.829819)	WQ9 (1.413465, 103.830250)
		
WQ10 (1.413195, 103.830954)		
		

4.3.3 Water Quality Sampling

Water samples were collected in both dry (no rain event in the preceding 48 hours) and wet weather (more than 10 mm of rainfall/hour, sampling conducted within 3 hours after rainfall event). There were two (2) rounds of dry weather sampling and one (1) round of wet weather sampling. A total of 30 water samples (10 sampling points for each of the 3 sampling rounds) were collected and submitted for laboratory analysis. Water analytical results are compared against the EPM Limits and relevant criteria for ecological uses. The proposed locations are based on a reasonable sampling interval which meets the assessment requirement. Details on the sampling date, location, and activity are summarised in **Table 4-3**.

Table 4-3: Details of Surface Water Quality Sampling

Monitoring Point	Dry Weather Event 1		Dry Weather Event 2		Wet Weather Event	
	Sampling Date	Weather Condition	Sampling Date	Weather Condition	Sampling Date	Weather Condition
WQ1	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ2	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ3	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ4	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ5	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ6	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ7	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ8	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ9	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling
WQ10	16-Sept-24	No rain 48 hours before sampling	23-Sept-24	No rain 48 hours before sampling	23-Sept-24	Up to 13.7 mm within 3 hours of sampling

4.3.4 Results of Water Quality Survey

With reference to the limits of EPM (Trade Effluent) Regulations listed in **Table 4-1**, the water analytical results show that most metrics did not exceed the limits listed in the EPM. However, the results showed that arsenic had exceeded the limit for discharge into a controlled watercourse ($>10 \mu\text{g/l}$) at each sampling station during the wet weather event and one dry weather event, with an average level of $15.31 \mu\text{g/l}$ recorded across all samples (see full results in **Appendix 4B**). PUB conducts water quality monitoring at a location close to WQ7, which had typically recorded at or near non-detect levels of arsenic. However, in September 2024, coinciding with the sampling timeline of this Study, PUB's water samples had also recorded elevated levels of arsenic. The recent increase suggests that the detection of arsenic in the drain may be linked to an isolated discharge

occurrence possibly from surrounding brownfield uses along the catchment or upstream uses outside the Subject Site. Additionally, during the wet weather sampling, analytical results reported exceedances for both pH (10.7) and oil and grease (1.29 mg/L) at WQ2, iron at WQ2 (1,871 µg/l) and WQ7 (1,028 µg/l), and TSS at WQ2 (315 mg/l) and WQ3 (36.2 mg/l), though these exceedances were not observed at other locations along the earth drain or during dry weather sampling.

These findings have been shared with PUB for their reference as the earth drain discharges into Lower Seletar Reservoir. PUB conducts regular monitoring of the water quality at Lower Seletar Reservoir and has informed that the water quality of Lower Seletar Reservoir and treated water had not been adversely impacted following the arsenic exceedances observed in the earth drain in September 2024. PUB's sampling results showed that arsenic levels in the following months were well below the 10 µg/l threshold and there are no associated public health concerns. A complete summary of the water analytical results (detects and non-detects) and comparison with the water quality criteria are presented in **Appendix 4B** while the laboratory reports are presented in **Appendix 4C**.

4.3.5 Evaluation of Results against Soil and Groundwater Quality

Surface water quality is closely linked to soil and groundwater quality as any water pollution from runoff, construction activities, or wastewater discharge can contaminate soil, and subsequently groundwater, with harmful chemicals and heavy metals.

Dutch Intervention Values (DIV) are environmental standards used to estimate the extent of remediation required from soil or groundwater contamination. The values are part of the Dutch Soil Protection Act and is published in documents such as the Soil Remediation Circular 2013. Soil and groundwater are considered to be seriously contaminated when the contamination levels exceed specific thresholds i.e., more than 25 m³ of soil and more than 100 m³ of groundwater is contaminated above the intervention value. Comparing the concentration of corresponding metals analysed for the Study against DIV, the results indicate that surface water quality of the earth drain did not exceed groundwater and soil quality thresholds listed in the DIV, suggesting no adverse impact to groundwater or soil quality.

4.4 Impact Assessment

4.4.1 Potential Impact on Water Quality

The proposed diversion and backfilling works at Site 2 listed in **Section 2** may have a potential impact on water quality from the release of silt, nutrients, or other chemicals into the waterway, potentially leading to water pollution. The impact assessment for water quality was conducted based on the assumption that the entire drain will eventually be backfilled, where the proposed diversion and backfilling works at Site 2 will be carried out on the eastern portion in the near term, while similar works will be conducted for the western portion in later years. The assessment indicates that the potential impact on water quality is likely to remain consistent whether considering only the near-term works on the eastern side or the combined effects of future works on the western side. Potential areas of impact include:

- Increased sedimentation of the earth drain due to soil loss/ disturbance of topsoil.
- Surface runoff from construction activities.
- Accidental spillage of diesel, oil, and other pollutants.

The qualitative assessment of the potential water quality impact considers the diversion and backfilling of the earth drain, and distinguishes between those that are positive or negative, direct or indirect, and whether they are long or short-term. Impact areas that are cumulative, unavoidable, or irreversible are also identified. The potential water quality impact areas identified are also assessed to determine the significance of these areas of impact. The evaluation of the above identified areas of impact are discussed below.

4.4.2 Impact Magnitude Definition

Criterion A2 of the assessment criteria for impact significance following the RIAM method (see **Section 3.2.1**) is a measure of the magnitude/ scale of the changes and whether the nature of impact is beneficial or dis-beneficial. Criterion A2.2 in particular assesses whether the magnitude of changes contributing to environmental deterioration attributed to the proposed works is high (3), medium (2), low (1), or negligible/ no change (0). The impact magnitude definition for water quality is outlined in **Table 4-4**.

Table 4-4: Impact Magnitude Definition for Water Quality

Criterion A2.2	Magnitude of Changes
3: High	A significant level of proposed activities contributing to environmental deterioration.
2: Medium	A moderate level of proposed activities contributing to environmental deterioration.
1: Low	A relatively minor level of proposed activities contributing to environmental deterioration.
0: Negligible	A negligible level of proposed activities contributing to environmental deterioration

4.4.3 Impact Evaluation

4.4.3.1 Degradation of Water Quality due to Soil Erosion and Surface Runoff from Construction Activities

Sediment introduced into waterways from diversion and backfilling activities through surface runoff may cause water pollution and potentially affect the water quality of the receiving watercourse (i.e., Site 2). Surface runoff from the diversion and backfilling activities may occur during rainfall events at areas with exposed earth, disturbed soils, and unprotected soil stockpiles. These exposed surfaces (from vegetation clearance, diversion, backfilling, excavation, and stockpiles of soil) may be eroded and contribute silt and sediment to the receiving watercourse.

Table 4-5: Impact Assessment for Soil Erosion and Surface Runoff During Construction Phase

Assessment Criterion	Score Rating	Rating Justification/ Definition
A1: Value	3: National	The Value is rated as National as the earth drain flows downstream into Lower Seletar Reservoir, one of Singapore's water supply reservoirs
A2.1: Impact Nature	-1: Negative	Increased sedimentation due to surface runoff from diversion and backfilling activities is expected to have a negative impact
A2.2: Magnitude of Changes	2: Medium	The diversion and backfilling works are anticipated to generate surface runoff and sedimentation which may moderately alter water quality parameters if released into the watercourse
A2.3: Impact Extent	2: Outside Local	Impact can extend outside the EIA Study Area
B1: Permanence	2: Short-term	Impact will occur during the construction phase and will last less than 3 years

Assessment Criterion	Score Rating	Rating Justification/ Definition
B2: Impact Pathway	3: Direct	Soil erosion and surface runoff have a direct impact on the water quality
B3: Reversibility	2: Reversible	The water quality impact due to surface runoff is reversible when diversion and backfilling works are completed. The impacted surface water (i.e. the newly constructed box drain that the water flow will be diverted to) may revert to the current conditions by natural water flow and surface water dilution.
B4: Cumulative	3: Cumulative	Presence of existing brownfield uses, active construction sites, as well as future developments located within the vicinity of Site 2, can cumulatively generate soil-driven runoffs to the same receiving watercourse.
Environmental Score (ES)	(-12) x 10 = -120	
Range Bands ES/ Impact Significance	Minor Negative Impact	

4.4.3.2 Degradation of Water Quality due to Trade Effluent Discharge

The Project development is expected to generate trade effluent from land/ vegetation clearance and excavation works. The trade effluent includes wastewater and wheel wash wastewater. The resultant wastewater is likely alkaline (with pH of around 12) and would likely consist of fine particles and may contain heavy metals, and oil and grease.

Discharge of untreated trade effluent into the watercourse could either directly or indirectly negatively impact the water quality of the receiving watercourse, as it potentially increases the pH, COD, TSS, turbidity, and metals in the water.

This trade effluent must not be discharged to any receiving watercourse without prior treatment and must be treated separately from surface runoff before being discharged. The development of Site 2, being in the vicinity of Lower Seletar Reservoir, is also prohibited from discharging treated trade effluent without authorisation. The impact sources are expected to be short term, reversible and exist for the duration of the construction phase activities only. Trade effluent from other construction sites located near the Site 2 development will potentially have a cumulative effect if the discharge flows into the same network of watercourse.

Table 4-6: Impact Assessment for Trade Effluent Discharge

Assessment Criterion	Score Rating	Rating Justification/ Definition
A1: Value	3: National	The Value is rated as National as the earth drain flows downstream into Lower Seletar Reservoir, one of Singapore's water supply reservoirs
A2.1: Impact Nature	-1: Negative	Trade effluent discharge from diversion and backfilling activities is expected to have a negative impact
A2.2: Magnitude of Changes	2: Medium	The diversion and backfilling works are anticipated to generate trade effluent which

Assessment Criterion	Score Rating	Rating Justification/ Definition
		may moderately alter water quality parameters if released into the receiving watercourse
A2.3: Impact Extent	2: Outside Local	Impact can extend outside the EIA Study Area
B1: Permanence	2: Short-term	Impact will occur during the construction phase and will last less than 3 years
B2: Impact Pathway	3: Direct	Trade effluent discharge has a direct impact on water quality
B3: Reversibility	2: Reversible	The water quality impact due to trade effluent discharge is reversible when diversion and backfilling activities are completed. The impacted surface water (i.e. the newly constructed box drain that the water flow will be diverted to) may revert to the current conditions by natural water flow and surface water dilution.
B4: Cumulative	3: Cumulative	Presence of existing brownfield uses, active construction sites, as well as future developments located within the vicinity of Site 2, can cumulatively generate trade effluent discharge into the same receiving watercourse.
Environmental Score (ES)	$(-12) \times 10 = -120$	
Range Bands ES/ Impact Significance	Minor Negative Impact	

4.4.3.3 Degradation of Water Quality due to Potential Accidental Leak or Spillage of Diesel, Oil, and other Pollutive Substances

The construction phase activities are anticipated to require on-site storage and handling of diesel for lubrication oil to maintain the equipment used on-site, along with other pollutive substances. If these substances are not properly stored or handled (i.e., accidental spillage, poor handling practices, leaks or insufficient safeguards provided), they could spill and be directly or indirectly washed into the surrounding watercourses, causing an adverse impact to the water quality of the receiving watercourse.

Diesel and lubrication oil will have significant effects on pH, COD, DO and other water quality parameters, though diesel can be readily and completely broken down by naturally occurring microbes over a period of time.

Table 4-7: Impact Assessment for Potential Accidental Leak or Spillage of Diesel, Oil, and other Pollutive Substances

Assessment Criterion	Score Rating	Rating Justification/ Definition
A1: Value	3: National	The Value is rated as National as the earth drain flows downstream into Lower Seletar Reservoir, one of Singapore's water supply reservoirs

Assessment Criterion	Score Rating	Rating Justification/ Definition
A2.1: Impact Nature	-1: Negative	Potential accidental leak or spillage of diesel, oil, and other pollutive substances from construction activities is expected to have a negative impact
A2.2: Magnitude of Changes	2: Medium	Diversion and backfilling works may require on-site storage and usage of pollutive substances that may moderately alter water quality parameters if accidentally released into the watercourse
A2.3: Impact Extent	2: Outside Local	Impact can extend outside the EIA Study Area
B1: Permanence	2: Short-term	Impact will occur during the construction phase and will last less than 3 years
B2: Impact Pathway	3: Direct	Potential accidental leak or spillage of diesel, oil, and other pollutive substances would have a direct impact on the water quality
B3: Reversibility	2: Reversible	The water quality impact due to leak or spillage of diesel, oil, and other pollutive substances is reversible when diversion and backfilling works are completed. The impacted surface water (i.e. the newly constructed box drain that the water flow will be diverted to) may be reversed to the baseline condition by natural water flow and surface water dilution
B4: Cumulative	3: Cumulative	Presence of active construction sites, as well as future development located within the vicinity of Site 2, can cumulatively generate leak/spills to the same receiving waterbodies (i.e. existing earth drain and its downstream area)
Environmental Score (ES)	(-12) x 10 = -120	
Range Bands ES/ Impact Significance	Minor Negative Impact	

4.5 Recommendation of Prevention and Mitigation Measures

A number of mitigation measures may be adopted to eliminate, minimise, or reduce the potential impact on water quality during the construction activities of the Project development.

The primary emphasis for water pollution control is to control the potential harmful impact from construction works on water quality, adhering to the COP on Surface Water Drainage and using good practices for construction sites. No obstruction of the drain is allowed.

The overall approach to mitigating the water quality impact of surface runoff from construction sites will involve the following approaches:

- **Erosion Control:** The objective is to reduce the volume of sediments that could be generated or are available to be washed off during rainfall events. The key strategies involve minimising the extent of bare earth areas (erodible surfaces) on-site and protecting any unavoidable bare earth surfaces.
- **Sediment Control:** The objective is to capture the sediments washed down from the site and reduce TSS in surface water discharges. The key strategies involve containing and treating the surface runoff before it is discharged into the watercourse.
- **Trade Effluent Management:** The objective is to control and treat discharge of wastewater on-site before it is discharged into the watercourse.
- **Management of Pollutive Substances:** The objective is to control the storage, use and disposal of hazardous substances used on-site.

4.5.1 Minimum Control Measures

This section lists surface water-specific minimum controls commonly implemented in Singapore for similar construction activities. These include the basis for developing, implementing and monitoring earth control measures (ECM) at the construction sites as required by Regulation 4 of the *Sewerage and Drainage (Surface Water Drainage) Regulations*, Code of Practice (COP) for Environmental Control Officer (ECO) issued by NEA, COP on Surface Water Drainage issued by PUB as well as Guidebook on Erosion and Sediment Control at Construction Sites and the Guidebook for Qualified Erosion Control Professional (QECP).

These measures are assumed to be implemented by HDB as embedded measures or minimum control measures required by the applicable regulations and COPs (Table 4-8).

Table 4-8: Minimum Controls of Surface Water Pollution Implemented at Construction Phase Applicable to Site 2 Development

Impact	Minimum Controls Adhered to Applicable Regulations and COP
Sedimentation/ Soil Erosion	<ul style="list-style-type: none"> ▪ Before work commences, submit a detailed ECM proposal duly endorsed by a Qualified Erosion Control Professional (QECP) to PUB and copied to HDB indicating: <ul style="list-style-type: none"> - Plans to minimise exposed surfaces for the proposed diversion and backfilling activities. - Implementation of effective sediment control facilities (including storage and treatment facilities). - ECM systems that will be put in place prior to the commencement of physical works. - A Clearance Certificate that is obtained prior to the commencement of physical works. - Revisions or updates to the ECM systems during construction to control silty discharge, where necessary. - ECM shall not be removed prior to the completion of physical works. Relevant approvals from PUB shall be obtained for removal of ECM upon the completion of physical works. - Condition of ECM shall be inspected regularly and during/after every rain event. - QECP shall carry out regular audit/reviews for every stage of the construction works and revise the ECM on-site accordingly. ▪ Earth surfaces or slopes adjacent to any drain shall be close turfed, paved or covered with appropriate materials.

Impact	Minimum Controls Adhered to Applicable Regulations and COP
	<ul style="list-style-type: none"> ▪ Bare surfaces shall be covered up with appropriate materials before rain and daily works should be halted to reduce the volume of silty water to be contained and treated. ▪ The treatment of silty water shall be closely monitored, and the treatment shall be halted immediately if silty water is being discharged to the public drain.
Water Pollution/ Trade Effluent Discharge	<ul style="list-style-type: none"> ▪ Discharge from the site into public drains shall not contain TSS in concentrations greater than the prescribed legal limits for a controlled watercourse, i.e., 30 mg/L. ▪ All wastewater generated at the site must be properly treated and disposed of. No discharge of untreated wastewater into public drains or land is allowed. ▪ Oil and chemicals in drums, carboys, containers, etc. shall be stored in a designated storage area within a building or covered shed with concrete floors and facilities to contain any accidental leak or spillage. ▪ Waste oil and chemicals generated from site activities, as well as all leaks and spillage, shall only be sent to a licensed toxic industrial waste collector for proper disposal. ▪ Bunds of stockpiled materials such as earth from trench work shall not be longer than 10 m. Gaps of at least 1 m width shall be provided between the bunds to allow the free flow of surface runoff. ▪ Material from any stockpile shall not be allowed to fall or be washed into the drain. Adequate preventive measures, including the provision of proper and stable barricades or screens where necessary, shall be provided. ▪ All used water discharged from temporary toilets, sanitary appliances and washing facilities at the site must be collected and disposed of via temporary sanitary facilities. The design shall be in accordance with the General Requirements for temporary sanitary facilities for Construction Site and obtain NEA's Clearance Certificate on Environmental Health.

4.5.2 Recommended Mitigation Measures

The following recommended mitigation measures for each potential impact on water quality are assumed to be additional mitigation measures apart from applicable embedded control measures in the COPs outlined in **Section 4.5.1** that need to be adhered to prior to applying these additional measures.

a) Mitigation measures recommended to control soil erosion and sediment-laden runoff:

- Drain diversion works (i.e., ground preparation, vegetation clearing, topsoil removal, excavation, and concreting) should be done in a phased manner to minimise the area disturbed at any given time. Given the length of the drain, the alignment may be subdivided into segments for which drain construction works can be scheduled and completed before moving on to the next segment.
- Install hoarding along the site boundary with embedded silt fences at the bottom to ensure an enclosed construction working space, to contain any silty runoff generated from construction activities.
- Lay sandbags beside the earth drain and proposed drain diversion to prevent soil and silt from entering the existing earth drain.

- All exposed earth created should be covered with fully biodegradable Earth Control Blankets (ECB) or other methods.
- Cleared vegetation, particularly at sloped areas, will be covered with fully biodegradable ECB to control erosion of exposed soil. Re-vegetate exposed ground as soon as possible to stabilise surfaces and minimise erosion of soil to watercourses.

b) Mitigation measures recommended to control trade effluent discharge:

- Wheel wash wastewater should be diverted into ECM facilities for reuse as wheel washing.
- Appropriate concrete washout water containers should be provided and stored away from any streams for offsite disposal through licensed waste treatment contractors.
- Temporary sanitary facilities should be provided for on-site workers during the construction phase. Workers should be trained on the necessity of portable sanitary facilities.
- Regular clearance of domestic waste generated in the temporary sanitary facilities should be conducted to avoid wastewater spillage. Locations of temporary sanitary facilities must be accessible by NEA-licensed portable toilet companies for servicing (e.g., collection and disposal of sewage)

c) Mitigation measures recommended to control accidental leaks or spills:

- Spill containment shall be provided at all discharge points.
- A response plan should be formulated to cater for accidental spillages into any watercourse. This plan shall be communicated to all on-site personnel. Training shall be provided for all staff in spill response measures.
- All spill containment facilities and spill trays shall be regularly maintained to prevent rain from washing out the pollutive substances.
- All spills must be cleaned within the same day or immediately under wet weather conditions.
- A Safety Data Sheet (SDS) for all hazardous materials shall be compiled and stored on site and available for viewing.
- Spill management kits shall be provided at worksites (in accordance with the type of hazardous materials to be used, included but not limited to rags, sands, eyewash, protective gloves etc.) at locations where hazardous materials, equipment and machinery will be stored and used.
- Hazardous materials shall be stored in bunded and covered areas in accordance with the manufacturer's safety requirements. Storage of hazardous materials on-site should be limited to the minimum necessary to reduce the impact of any spillage or mitigation failure.

4.6 Evaluation of Residual Impact

The implementation of requirements or standard practices of controls commonly applied in Singapore for similar activities and the recommended mitigation measures in **Section 4.5** will reduce the magnitude and permanence of the water quality impact by regulating the potential adverse impact and reducing the likelihood and/or extent of such hazards polluting the watercourses. It also provides remedial measures for recovery should the impact occur notwithstanding the implementation of best practices. Consequently, it is expected that water quality should only be impacted to a minor extent during this Project after the recommended mitigation measures are adopted as described in **Table 4-9**.

Table 4-9: Summary of Evaluation of Residual Impact

Impact Register	Before Mitigation Measures		Post Mitigation Measures (Residual Impact Significance)	
	Environmental Score (ES)	Range Band of ES / Impact Significance	Environmental Score (ES)	Range Band of ES / Impact Significance
Degradation of water quality due to soil erosion and surface runoff from construction activities	-120	Minor negative impact	-60	Minor negative impact
Degradation of water quality due to trade effluent discharge	-120	Minor negative impact	-60	Minor negative impact
Degradation of water quality due to potential accidental leak or spillage of diesel, oil, and other pollutive substances	-120	Minor negative impact	-60	Minor negative impact

5. Assessment of Ecology and Biodiversity

5.1 Applicable Legislation Standards

NParks administers the Parks and Trees Act which regulates the planting, maintenance and conservation of trees and plants within national parks, nature reserves, tree conservation areas, heritage road green buffers and other specified areas, and the Wildlife Act which enacts protection, preservation, and management of wildlife for the purposes of maintaining healthy ecosystems.

NParks has released the Biodiversity Impact Assessment (BIA) Guidelines (latest revision in May 2024) as a non-prescriptive guide and reference to recognise the basic requirements for the biodiversity component of an EIA.

5.2 Methodology for Ecological Assessment

The EIA focuses on the assessment of the potential impact on habitats and fauna observed and documented during ecology field surveys arising from the proposed diversion works at Site 2. It includes a description of guidelines and methodology used for the assessment.

Ecology field investigations within the EIA Study Area were carried out to establish baseline biodiversity information on the EIA Study Area. Baseline information was first gathered through reviews of past and present biodiversity records, published literature, and in consultation with taxonomic experts. Actual field surveys were then carried out to verify and supplement the data. Specific details of the ecology baseline survey are detailed in the sections below.

5.2.1 Desktop Assessment

5.2.1.1 Taxonomy and Nomenclature

Past and present faunistic species compositions were examined using key references that included books, scientific publications, unpublished literature, and online databases. Sources of databases include *The Biodiversity of Singapore* by the Lee Kong Chian Natural History Museum (LKCNHM) (Lee Kong Chian Natural History Museum, 2024a), *Flora and Fauna Web* by NParks (National Parks Board, 2024b) and iNaturalist. Other key references included the Singapore Red Data Book (National Parks Board, 2024c), Singapore Biodiversity Records (Lee Kong Chian Natural History Museum, 2024b), and the database of fauna records compiled by our biodiversity specialists. Key local and/ or regional references for the various taxonomic groups are listed in Table 5-1.

Table 5-1: Key References for the Nomenclature and Taxonomy for each Taxonomic Group

Taxon	Key References
Odonates	National Parks Board, 2024b
Herpetofauna (amphibians and reptiles)	Figueroa et al., 2023
Freshwater decapod crustaceans	Cai et al., 2007; Ng, 1997
Freshwater fish	Ho et al., 2016; Kottelat, 2013; Suzuki et al., 2016

5.2.1.2 Species of Conservation Significance

The assessment of whether certain species are of conservation significance is important for highlighting the needs and priorities for conservation. Faunal species of conservation significance include threatened species listed as nationally or globally Vulnerable, Endangered, Critically Endangered, or Extinct, that are considered

native to Singapore. The national conservation statuses reference the Singapore Red Data Book list (SRDB3) published by NParks (National Parks Board, 2024b). The global conservation status references the Red List of Threatened Species published by the International Union for Conservation of Nature (IUCN) (IUCN, 2024).

5.3 Ecology Field Assessment

Ecology field assessments for the EIA Study Area was conducted between 24 September and 3 October 2024.

Faunistic field surveys were carried out within Site 2 for the following taxa: (1) odonates (damselflies and dragonflies), (2) herpetofauna (amphibians and reptiles), (3) freshwater decapod crustaceans and (4) freshwater fish. These four taxa would be herein collectively referred to as aquatic taxa while all other opportunistic taxa observed will be referred to as terrestrial taxa for the purposes of this assessment. Each aquatic transect was conducted twice (i.e. two cycles), where possible. Due to the potential presence of stingrays, locations observed with high water levels and low visibility during sampling were not accessed for safety reasons. However, at least one nocturnal survey was carried out at all locations. Minnow trapping was conducted once per location at locations with suitable water levels, except for AQ10 due to the presence of a honeybee nest in close proximity to the sampling location. All observations of species of conservation significance from the aforementioned taxa was recorded if seen outside the stated survey times. A checklist of all fauna species observed from the surveys was compiled.

Figure 5-1 shows the locations of the aquatic transects. **Table 5-2** summarises all the surveys that were carried out for fauna. Each survey was performed by at least two surveyors. All fauna encountered were identified to species, or to the next lowest taxonomic level possible, and the location of each sighting was recorded using a handheld GPS (Garmin GPSMAP 64s). The number of individuals observed was also documented.

While the focus was on aquatic fauna, an opportunistic floristic survey was conducted along the banks to identify any potential flora species of conservation significance. Opportunistic sightings of terrestrial faunal species were also recorded.

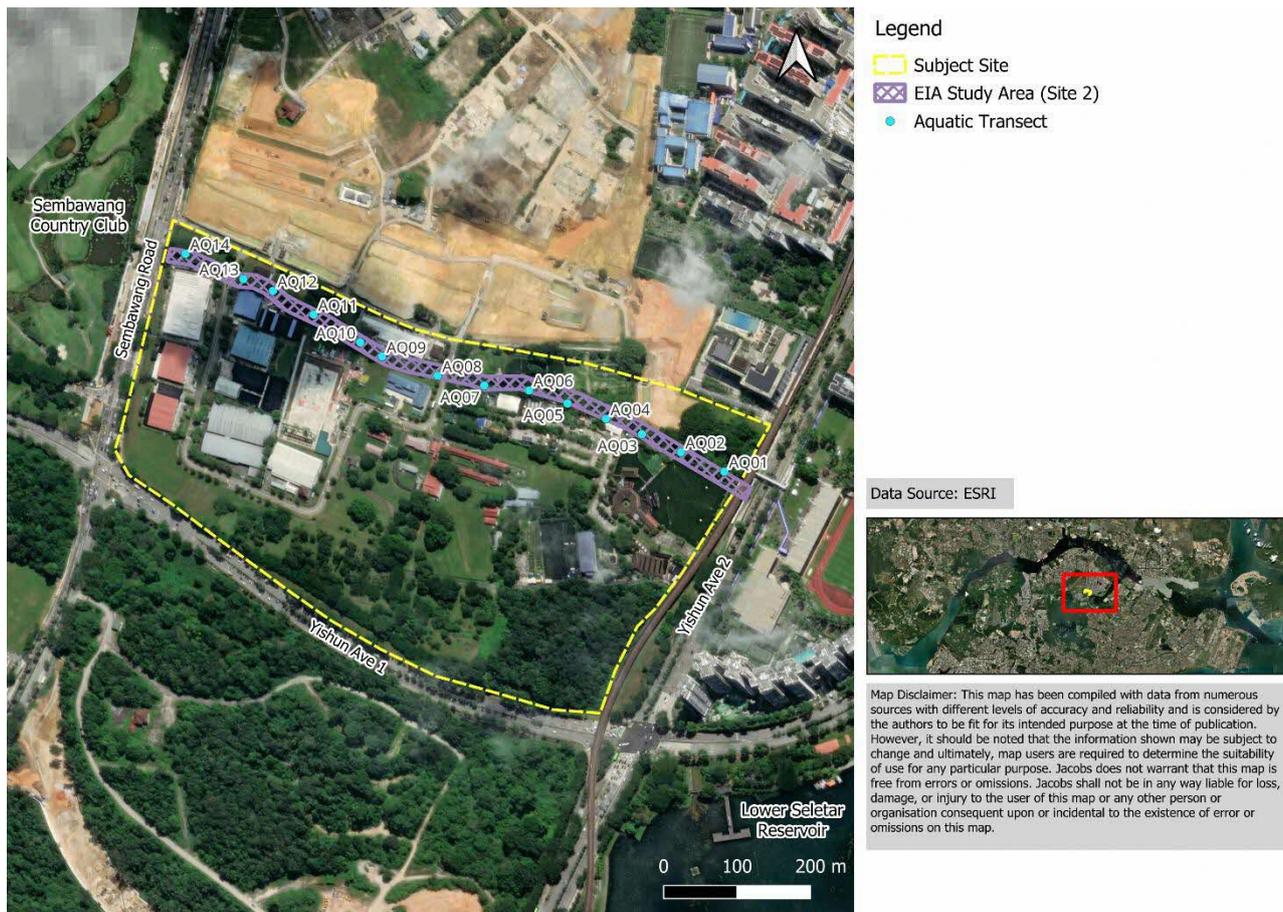


Figure 5-1: Locations of Aquatic Transects

Table 5-2: Summary of Fauna Surveys

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	No. of sampling units	Technique	Data Collected
Diurnal aquatic transects	Odonates (damselflies and dragonflies)	0900–1600	Up to 20 min per transect with two surveyors; two cycles	10 m long transects, spaced approximately 50 m (excluding the transect)	14	Visual	Location, species, quantity, date, time
Diurnal and nocturnal aquatic transects	Herpetofauna (amphibians and reptiles)	0900–1600; 2000–2300	Up to 20 min per transect with two surveyors; two cycles	10 m long transects, spaced approximately 50 m (excluding the transect)	14	Visual and auditory detection and capture via push/scoop netting	Location, species, quantity, date, time
	Freshwater aquatic fauna (fish, decapod crustaceans)	0900–1600; 2000–2300	Up to 20 min per transect with two surveyors; two cycles	10 m long transects, spaced approximately 50 m (excluding the transect)	14	Visual detection and capture via push/scoop netting	Location, species, quantity, date, time

Survey Type	Taxon	Timing (h)	Duration	Sampling Unit*	No. of sampling units	Technique	Data Collected
Minnow trapping[#]	Aquatic fauna (fish and decapod crustaceans)	Overnight	Overnight; once per location	Traps inside waterbodies (at 50 m intervals for streams, where suitable for trapping)	13 [^]	Baited traps	Location, species, quantity, date
<p><i>*A sampling unit is the building block of the dataset that will be used for statistical analyses. For transect surveys, one sampling unit is defined as a 200-m long transect. Hence, a sampling route may consist of several 200 m transects.</i></p> <p><i>[#]Minnow trapping was carried out at all locations, except for one (i.e., AQ10) due to presence of an active honeybee nest.</i></p>							

5.3.1 Odonates (Dragonflies and Damselflies)

Odonates were surveyed along diurnal 10-m aquatic transects at 50-m intervals along the earth drain, together with herpetofauna and aquatic fauna. Owing to difficulties in sampling and identification, aquatic larvae and exuviae were not surveyed. Adult odonates were identified visually (with binoculars where necessary), photographed, or caught using insect nets, if required. Captured individuals were released immediately after identification. Two cycles of surveys were conducted.

5.3.2 Herpetofauna (Amphibians and Reptiles)

Herpetofauna were surveyed along diurnal (0700 h–1000 h) and nocturnal (2000 h–2300 h) 10-m aquatic transects at 50-m intervals along the earth drain, together with odonates and aquatic fauna. Both diurnal and nocturnal surveys also involved active searches along the earth drain banks. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys. Vocalising fauna were also located or identified by call recognition, whenever possible. Two cycles of surveys were conducted.

5.3.3 Freshwater Fauna

Freshwater fauna surveyed included freshwater fish and decapod crustaceans. Freshwater fauna were surveyed along diurnal (0700 h–1000 h) and nocturnal (2000 h–2300 h) 10-m aquatic transects at 50-m intervals, together with odonates and herpetofauna. Two cycles of surveys were conducted.

Push and/or scoop netting were carried out to capture freshwater aquatic fauna that may be difficult to spot or identify from the water surface. Push netting was carried out, mostly in deeper waters, using a rigid-frame tray net (61 × 49 cm; 5 mm mesh) to catch specimens along the banks or the streambed (**Figure 5-2A**). Scoop netting was carried out, mostly in shallower waters, using hand nets (net size 25 × 18 cm; 2 mm mesh) to catch specimens within the earth drain column. Captured individuals were released immediately after identification. Torches and/or headlamps were used to elicit eyeshine during nocturnal surveys.

Minnow traps baited with halal meat (e.g., sausage or liver) was deployed at suitable locations within the earth drain (**Figure 5-2B**). The traps were left overnight, then checked and removed the following morning. All caught individuals were released immediately upon identification. Minnow trapping was conducted once per location, at locations with suitable water levels, except for AQ10 due to the presence of a honeybee nest in proximity to the sampling location.

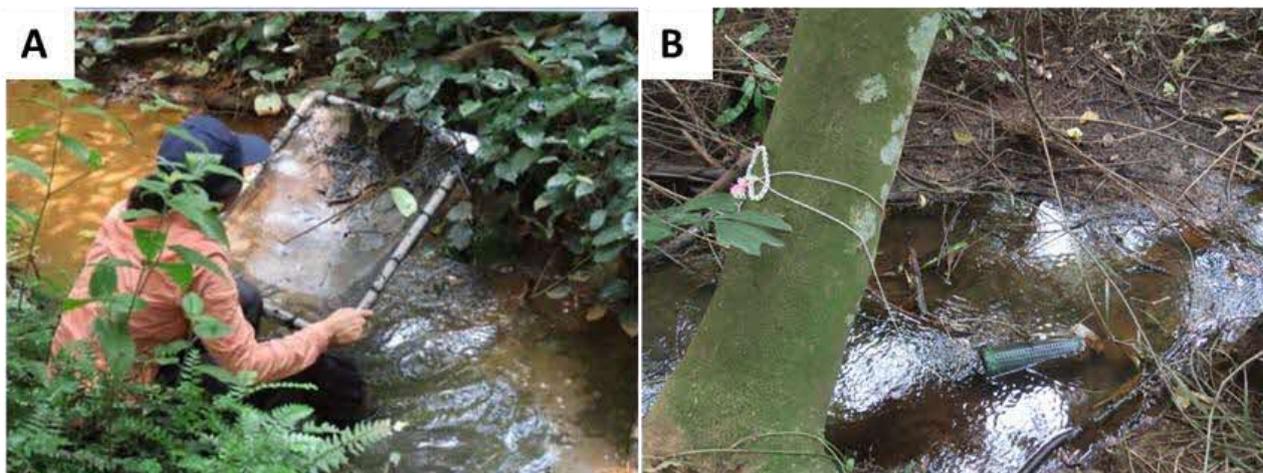


Figure 5-2: Photo of (A) Push Netting and (B) Minnow Trap

5.4 Pre-construction Baseline

5.4.1 Habitat Description

As established in earlier sections, the EIA Study Area (Site 2) consists of a single earth drain receiving water from Sembawang Country Club and flows downstream towards Yishun Avenue 2, and subsequently Lower Seletar Reservoir. Most of the earth drain was soft-bottomed, with common native and exotic flora species, both spontaneous and cultivated, growing along the riparian banks along the whole earth drain. There was scarce aquatic vegetation growing only at AQ08 and AQ13. There was a mix of habitat conditions observed along the earth drain where shady forested areas with steeper banks were observed at AQ01–AQ06, AQ09–AQ10 and AQ14, open sunny areas with more gradual banks at AQ07–08, and debris/litter and concrete structures at AQ05. Stronger currents were also observed upstream. The depth of the earth drain varied with some downstream (AQ02–AQ05) and upstream (AQ08) points being deeper, while the remaining points were generally shallower.

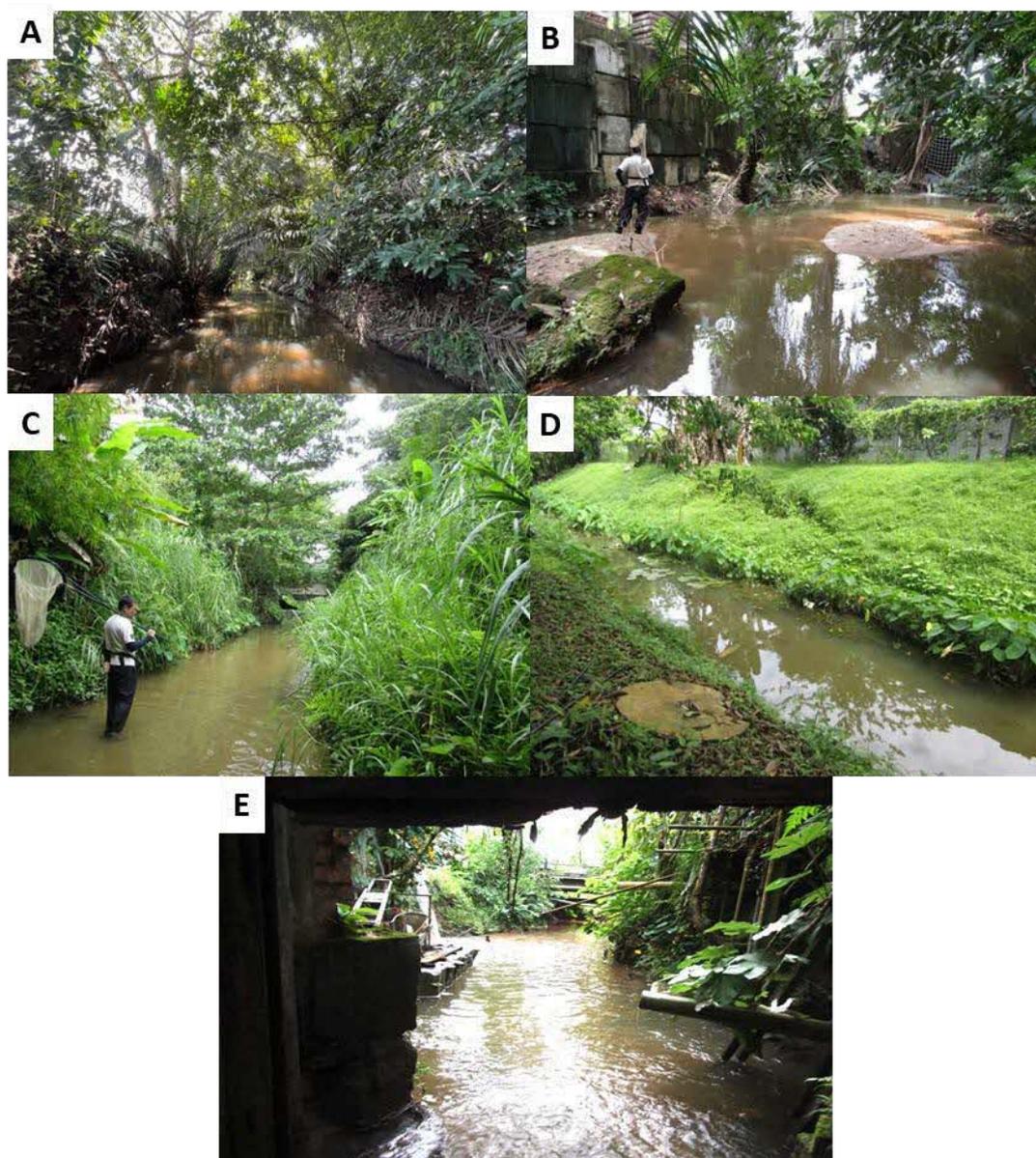


Figure 5-3: Photos of (A) AQ01, AQ02, (B) AQ14, (C) AQ07, (D) AQ08, (E) AQ05.

5.4.2 Fauna Baseline Results

5.4.2.1 Overall Faunistic Findings

The aquatic assessment recorded 38 species, comprising 9 odonate, 8 amphibian, 2 reptile, 2 decapod, and 17 fish species (Table 5-3). No aquatic fauna species of conservation significance were recorded at Site 2. The aquatic fauna assemblage in the EIA Study Area was exotic dominated, with more than 70% of the fish recorded being exotic species that were likely introduced via the ornamental pet trade. The native species observed were mostly widespread and common species which are found in disturbed habitats.

Additionally, there were incidental records of terrestrial species outside the 4 target taxa surveyed, i.e., 1 butterfly and 2 mammal species - hieroglyphic flat (*Odina hieroglyphica ortina*), Sumatran palm civet (*Paradoxurus musangus*), and long-tailed macaque (*Macaca fascicularis*). The long-tailed macaque opportunistically recorded on-site is considered a terrestrial species of conservation significance (globally Endangered) but is considered nationally Least Concern. Three individuals were observed around the existing

hoarding next to the earth drain. The Sumatran palm civet, considered globally and nationally Least Concern, was observed atop a tree in a vegetated and shady area near AQ05.

The total species count across both aquatic and terrestrial species for Site 2 is 41. The full list of faunal survey data and recorded species is provided in **Appendix 5A** and **Appendix 5B** respectively. A summary of recorded faunal species is given in **Table 5-3**.

Table 5-3: Summary of Recorded Faunal Species

Faunal Group	All species	Native Species	Species of Conservation Significance
Odonate	9	9 (100.0%)	0
Dragonfly	7	2 (100.0%)	0
Damselfly	2	2 (100.0%)	0
Herpetofauna	10	6 (60.0%)	0
Amphibian	8	5 (62.5%)	0
Reptile	2	1 (50.0%)	0
Freshwater Decapod Crustacean	2	1 (50.0%)	0
Freshwater Fish	17	5 (29.4%)	0
Butterfly*	1	1 (100.0%)	0
Mammal*	2	2 (100.0%)	1

Note: *Opportunistic records of terrestrial species

5.4.2.2 Taxon Sampling Curve

Sample coverage was generated for the following target taxa: 1) odonates, 2) amphibians and 3) freshwater fish. Reptiles and freshwater decapod crustaceans were excluded from analysis due to its small sample size.

Both odonates and fish achieved a sample coverage of above 90%, while amphibians achieved a sample coverage of 77.4% (Table 5-4 and Figure 5-4). With the observed richness obtained via sampling, the estimated richness for each taxon was derived for the EIA Study Area (Table 5-4).

Table 5-4: Result Summary of Taxon Sampling Analysis

Faunal Group	Sample coverage (%)	Observed Richness	Estimated Richness	95% Confidence Interval
Amphibian	77.4%	5	7.9	5.4 – 28.9
Fish	96.9%	16	18.6	16.4 – 34.5
Odonate	92.2%	9	13.4	9.5 – 49.1

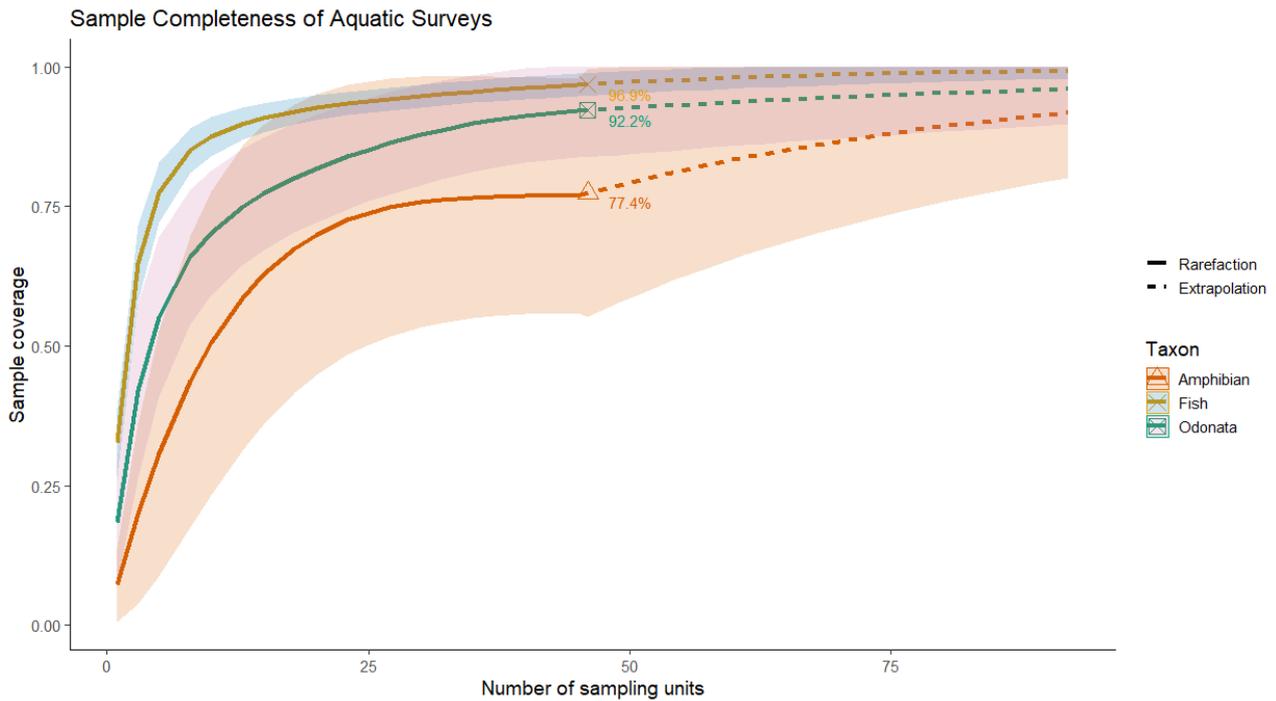


Figure 5-4: Sample Coverage Curves for Amphibian, Freshwater Fish and Odonata.

5.4.2.3 Odonates

The survey recorded a total of nine (9) odonate species, with seven (7) dragonfly species and two (2) damselfly species. None of these species are of conservation significance. All of these species are widespread and common. Majority of the records were observed in the midstream (AQ07-AQ09) to upstream (AQ11-AQ14) portions. Most of the species recorded were species that prefer open, sunny habitats and are tolerant to disturbed habitats, such as the blue sprite (*Pseudagrion microcephalum*) (Ngiam & Ng, 2022) which was the most abundantly recorded species. Another regularly observed species on-site was the common parasol (*Neurothemis fluctuans*), which can be commonly found in urban habitats (Ngiam & Ng, 2022).

5.4.2.4 Herpetofauna

A total of eight (8) amphibian species were recorded, with none of conservation significance. All 8 species were frogs, with five (5) native species. Records were few and distributed across the earth drain.

All of these species were widespread and common, except for the green paddy frog (*Hylarana erythraea*) that was heard once at midstream (AQ09). This species has been dwindling in numbers (Figuroa et al., 2023). The green paddy frog is commensal with humans and typically observed in freshwater habitats (Baker & Lim, 2012).

The non-native Guenther's frog (*Sylvirana guentheri*) was the most commonly observed species, followed by the Malayan giant frog (*Limnonectes blythii*). The Malayan giant frog was previously known to prefer forest streams with flowing water (Baker & Lim, 2012). However, recent records suggests that this species seems to be more widespread, inhabiting areas that are open, disturbed and lacking suitable streams such as Bishan-Ang Mo Kio Park (Figuroa et al., 2023). It was recorded at several locations along the earth drain (AQ1, AQ8, AQ10 and AQ11). Two species of frogs; the native crab-eating frog (*Fejervarya cancrivora*), and the non-native Mukhlesur's chorus frog (*Microhyla mukhlesuri*), were recorded outside the earth drain in adjacent areas.

There were only two species of reptiles recorded: the non-native red-eared slider (*Trachemys scripta*) and the widespread and common painted bronzeback (*Dendrelaphis pictus*). Both species are not of conservation significance. The red-eared slider was observed in the water and on the bank edge downstream once at AQ01 and AQ07 respectively. The painted bronzeback is an arboreal forest-edge species that has adapted to

disturbed and man-made habitats (Baker & Lim, 2012). It was observed within the riparian vegetation several times between downstream to midstream areas (AQ03–AQ11).

5.4.2.5 Freshwater Fish

A total of 17 freshwater fish species were recorded from the EIA Study Area. None of the species recorded were of conservation significance. Of the 17 species, 12 (70.59%) were exotic.

Among the 17 species, the native Sunda pygmy halfbeak (*Dermogenys collettei*; **Figure 5-5A**) and non-native red-tailed rasbora (*Rasbora borapetensis*; **Figure 5-5B**) were recorded in large numbers throughout the earth drain. Other commonly recorded species included the Indochinese spotted barb (*Barbodes rhombeus*; **Figure 5-5C**), guppy (*Poecilia reticulata*; **Figure 5-5D**) and mosquitofish (*Gambusia affinis*), all of which are non-native. Only four other native species were recorded, which were the common snakehead (*Channa striata*), greater glass-goby (*Gobiopterus brachypterus*), Sunda swamp eel (*Monopterus javanensis*) and whitespot (*Aplocheilichthys armatus*). The common snakehead and greater glass-goby were recorded at multiple points throughout the earth drain, while the oriental swamp eel and whitespot were only recorded at AQ02.

Due to decades of agricultural and other adjacent brownfield uses, including the ornamental fish farms as well as interim uses such as recreational spaces (e.g. ORTO) that are currently on-site or have recently vacated, the EIA study area is disturbed and not pristine, receiving discharge from surrounding brownfield uses. It is likely that some of the non-native species were introduced to the earth drain either via the ornamental pet trade or were previously introduced in Singapore as a vector control measure for mosquitoes, such as the guppy (*Poecilia reticulata*) and mosquitofish (*Gambusia affinis*) (Lim & Ng, 1990). Several of the fish species belonging to the *Cichlidae* family such as the Mozambique tilapia (*Oreochromis mossambicus*) and Nile tilapia (*Oreochromis niloticus*), and *Cyprinidae* family such as the Hasselt's bony-lipped barb (*Osteochilus vittatus*) have been recorded in reservoirs such as Lower Seletar Reservoir and Upper Seletar Reservoir. These fish are likely to have been introduced through the ornamental pet trade (Tan et al., 2020).

The highest number of fish was recorded midstream at AQ07 with 11 species, followed by AQ14 with 9 species located upstream. The habitat conditions in these areas were shady and forested, with weaker currents. The lowest diversity of fish was recorded from AQ11–AQ13, ranging from one to four species of fish present. This included the guppy (*Poecilia reticulata*), which is a disturbance-tolerant species that can be found in concrete drains, typical of the habitat conditions observed in AQ12 and AQ13.

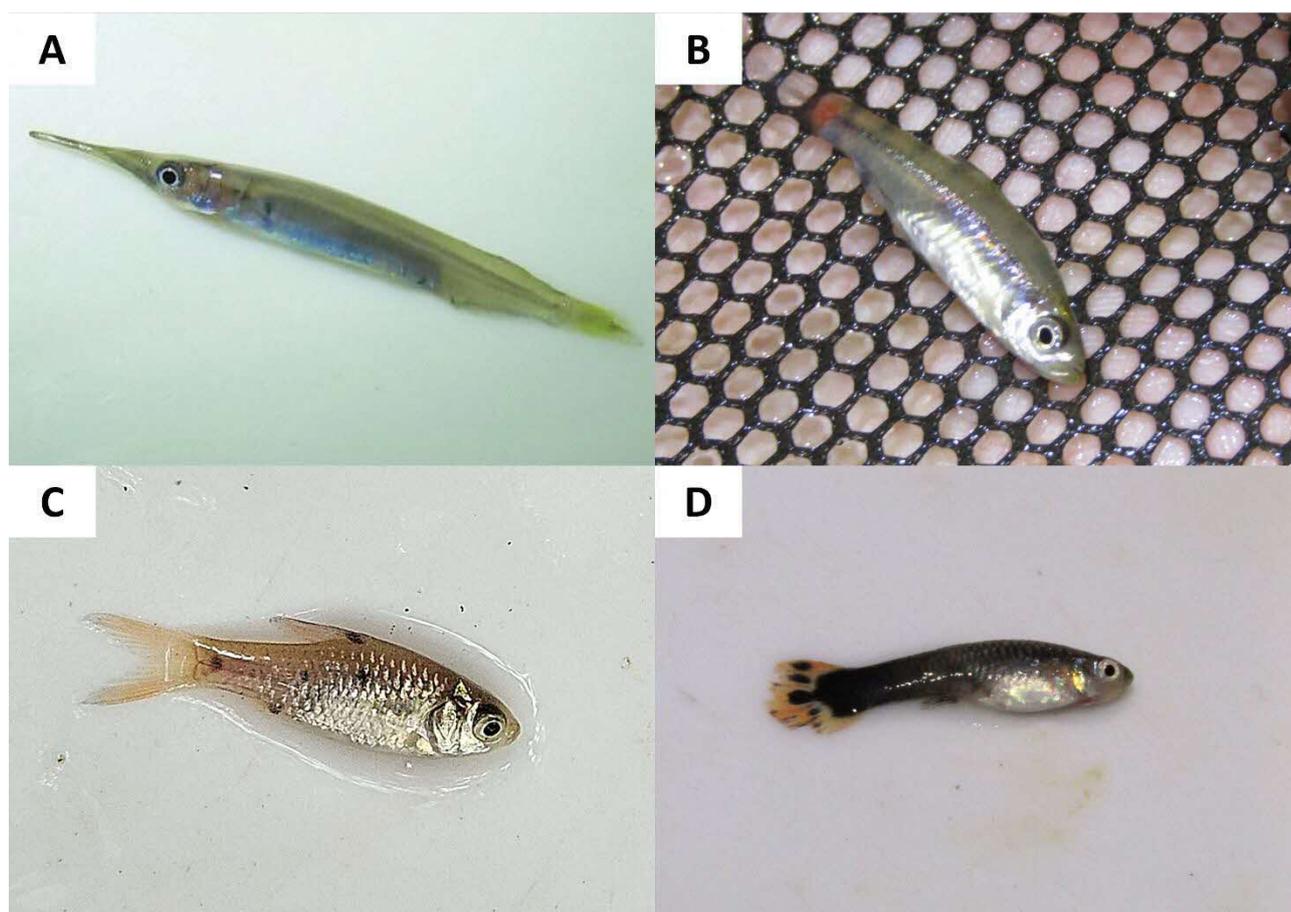


Figure 5-5: Fish Species Collected via Tray Netting. A) Sunda Pygmy Halfbeak (*Dermogenys collettei*), B) Red-Tail Rasbora (*Rasbora borapetensis*), C) IndoChinese Spotted Barb (*Barbodes rhombeus*), D) Guppy (*Poecilia reticulata*)

5.4.2.6 Freshwater Decapod Crustaceans

Two decapod crustacean species were recorded within the EIA Study Area. None of the species recorded were of conservation significance. Of the two shrimps, only the Johnson's shrimp (*Caridina johnsoni*) is native. *Caridina* sp. was observed at AQ01, AQ03, and AQ12. The identity of the *Caridina* sp. collected at AQ03 was confirmed to be *Caridina johnsoni* (Cai YX, pers comm). This species was previously recorded in the nearby Lower Seletar Reservoir (Cai et al., 2007).

The non-native riceland prawn (*Macrobrachium lanchesteri*) was captured in a minnow trap at AQ02, as well as via tray-netting at various points along the earth drain. This species was likely introduced through the ornamental pet trade and has been observed in Singapore's reservoirs (Yeo, 2010).

5.5 Impact Assessment

5.5.1 Assessment of Ecological Value

Habitats and species within the EIA Study Area were assessed for their ecological value. Habitats and species accorded with higher ecological value were regarded to be of greater importance for conservation relative to other habitats and species respectively within the EIA Study Area. The assessment was carried out using the biodiversity baseline findings.

5.5.1.1 Habitat

The ecological value assessment for habitats references the metrics in the Singapore Biodiversity Accounting Tool (SGBA) (AECOM & Camphora, 2024). Habitats were assessed and scored based on four criteria – i) flora and fauna species richness, ii) irreplaceability, iii) local rarity of habitats, and iv) unique flora and fauna species. All habitats were then accorded an ecological value, i.e., high, medium, or low, based on the overall scoring.

Based on the SGBA metric, the earth drain in the EIA Study Area is categorised as a naturalised stream, which is defined as a “previously concrete-lined drain that was converted into a soft-bank stream, or concrete-lined drain with a layer of substrate deposited on top of the concrete and vegetation growing on it” (AECOM & Camphora, 2024). This habitat type is considered to have an overall low ecological value. It generally supports moderate flora and fauna species (Score 2), and few unique flora and fauna species (Score 1). This habitat type contains mostly exotic fauna species, which aligns with the baseline findings where the aquatic fauna assemblage in the EIA Study Area was observed to be exotic-dominated. In Singapore, this habitat type is common (Score 1) and is easily re-creatable (Score 1) over a short duration (i.e. 5 years or less). With one criterion assessed to be medium (Score 2) and three criteria assessed to be low (Score 1), the overall score for the stream habitat is five, which indicates a low ecological value for this site.

5.5.1.2 Fauna

All recorded and probable faunal species were accorded an ecological value based on its conservation significance and species origin:

- High ecological value: Species of conservation significance
- Medium ecological value: All other native and migratory bird species, and species of indeterminate status
- Low ecological value: Exotic species

Probable faunal species refer to conservation-significant species that can potentially inhabit the area, even though they were not observed during the surveys. Since it is challenging for any biodiversity survey to capture all species present—especially elusive ones—the impact assessment takes into account the potential presence of these undetected species to ensure a more comprehensive evaluation.

The ecological value of 49 fauna species was assessed. This assessment consisted of both recorded (41 species; 38 aquatic species and 3 terrestrial) and probable (8 species; 2 aquatic species and 6 terrestrial) fauna species.

- For aquatic species, eight (8) probable but unrecorded species were deemed to be of high ecological value, 21 species were deemed to be of medium ecological value and 17 species were deemed to be of low ecological value.
- For terrestrial species, one (1) opportunistically recorded species was deemed to be of high ecological value, while the other two (2) species were deemed to be of medium ecological value. These terrestrial species were incidental records, as terrestrial species were not a targeted taxa for the faunal study at Site 2.

A total of nine (9) fauna species were deemed to be of high ecological value, with one (1) recorded and 8 probable but unrecorded in the EIA Study Area, and were included in the assessment of ecological impact for faunal species. This comprised one (1) odonate, two (2) fish, one (1) mammal and five (5) reptile species.

This list of species—recorded and probable—and the corresponding ecological values are presented in **Appendix 5B**.

5.5.2 Potential Impact Pathways on Biodiversity

The impact of the construction and operational phases were separately assessed for biodiversity sensitive receptors identified in **Section 2**, with a description of potential impact pathways given in this section (**Table 5-5**). For this site, the impact receptors include (i) habitat receptors and (ii) faunal receptors.

Only potential sources of direct impact were assessed. Potential sources of indirect impact are not applicable for this context as there are no other naturalised habitats present directly adjacent to the earth drain, since the earth drain is fringed by predominantly brownfield uses.

During the operational phase, the new box drain will be fully functional to allow movement of fish and decapod crustacean species.

Table 5-5: List of Potential Impact Types during Construction and Operational Phase

Phase	Receptor	Impact Type	Description
Construction	Habitat	Loss of habitat	Changes in waterbody due to backfilling, canalisation, and diversion activities, and/or changes in hydrology
		Loss of/ reduction in habitats and food sources	Changes in waterbody due to canalisation and diversion activities, and/or changes in hydrology
		Accidental injury or mortality	Collisions with machinery, entrapment in construction materials (such as non-biodegradable erosion control blankets) and structures (such as exposed pits or drains), and accidental mortality by construction personnel, including roadkill
	Faunal Species	Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by construction personnel
		Loss/ reduction of ecological connectivity for faunal movement	Habitat fragmentation from the removal of vegetation
		Light disturbances	Increase in light levels from construction activities
		Human disturbances	Increase in human traffic flow, such as workers and site personnel
Operational	Faunal Species	Loss/ reduction of ecological connectivity for faunal movement	Changes that impede connectivity between habitats

Light disturbances	Increase in light levels from development
Human disturbances	Increase in human traffic flow, such as residents and visitors
Human-wildlife conflict	Negative consequences of human-wildlife interactions, such as deliberate killing and depopulation of faunal species perceived as nuisances or threats by members of the public
Accidental injury or mortality	Navigation failures into the wrong areas and entrapment in facility structures, including bird collision into buildings (distorted perceptions of reflective surfaces on buildings as flyways, greenery, and/or water) and roadkills

5.5.3 Minimum Control Measures

This section lists the biodiversity-specific minimum control measures commonly implemented in Singapore for similar construction activities. These are assumed to be implemented for the impact assessment. Minimum controls for each potential impact area during the construction phase are listed on **Table 5-6**. These measures should be proposed in tandem with other environmental receptors (e.g., air and noise).

Table 5-6: Description of Minimum Controls Implemented at Construction Phase for Biodiversity

Work Activities	Minimum Controls
General	<ul style="list-style-type: none"> ▪ Install hoarding to delineate the worksite. ▪ Avoid fogging by implementing preventive measures for mosquito breeding to remove sources of stagnant water or water-bearing receptacles, e.g., clearing discarded items daily, store materials appropriately, level up ground depression/uneven surfaces, ensure effective drainage flow. ▪ Visual checks by an ecologist for animal entrapments on-site during backfilling works, ECBs and among construction materials and equipment ▪ Visual checks for gaps in hoarding. ▪ Execute a wildlife response plan when a trapped/ injured/ dead/ dangerous animal is encountered around or within the worksite according to Appendix 1A, Section 10 of Wildlife Act.
Vegetation Clearance	<ul style="list-style-type: none"> • Conduct inspections of fauna prior to felling or removal of vegetation. This should be done by an ecologist who is able to identify wildlife and/ or active nesting structures, such as bird nests, tree hollows and/ or burrows, and bamboo clusters. • Implement soil erosion control measures as soon as vegetation has been removed and soil is exposed (refer to Section 4.5.1).

Work Activities	Minimum Controls
	<ul style="list-style-type: none"> Engage a Qualified Erosion Control Professional (QECP) to formulate and implement an Earth Control Measures (ECM) plan in accordance with PUB's requirements.

5.5.4 Impact Assessment

In this section, the identified biodiversity sensitive receptors were evaluated based on Group A and Group B criteria in order to derive the impact significance.

5.5.4.1 Assessment of Biodiversity Sensitive Receptors

The definition and scoring of each assessment criterion for biodiversity sensitive receivers follows the framework described in **Section 3.2.1**. However, the definition for two criteria A1 (Value) and A2.2 (Magnitude of Changes) in relation to ecology are refined to represent the ecological value of an impact receiver and the impact significance respectively. These ecological criteria are further explained below.

- a) The A1 value of each biodiversity sensitive value is scored according to its ecological value in **Section 5.5.1**.
- b) Positive impact significance under criterion A2.1 are defined as follows:
 - 2 for enhancement or creation of habitats in a forested site that is likely to significantly improve ecological functions.
 - 1 for planting within a managed landscape context or small localised areas, or ecological features, with potential but limited value in improving ecological functions.
- c) The criterion A2.2 (Magnitude of Changes) factors in the likelihood of occurrence.
 - The preliminary magnitude of change is first derived (Impact Intensity), and subsequently multiplied with its likelihood of occurrence. The final value is assigned a score for the Magnitude of Change.
 - The impact intensity is given a score ranging from 0 to 3 as follows – No Change (0), Minor (1), Moderate (2) and Major (3)
 - The likelihood is given a score ranging from 0 to 4 as follows – Unlikely/Remote (0), Less Likely/Rare (1), Possible/Occasional (2), Likely/Regular (3) and Certain/Continuous (4).
 - The impact intensity and likelihood are then multiplied and assigned with a score under Magnitude of Change – No Change (0), Low (1–3), Medium (4–6) and High (8–12).
 - Given that several projects are occurring in the vicinity, such as ongoing construction works for upcoming public housing developments north of the EIA Study Area and the North-South Corridor west of the EIA Study Area (see **Section 2.2.3**), all ecological impact types are deemed as cumulative/synergistic as each successive negative impact is increasingly damaging to the environment.
 - The various levels of impact intensity and likelihood during the construction and operational phases are defined for the biodiversity sensitive receptors in the following sections.
- d) The impact extent (A2.3) for all biodiversity impact types is assumed to be of a national level (3) since the loss of habitats and populations is regarded as a national impact. The ecological value of habitats has been assessed within a national context (see **Section 5.5.1.1**), making it accurate to consider habitat loss as a national-scale impact. With Singapore's already limited natural habitats, any further loss would not only reduce biodiversity but also place immense pressure on the remaining areas. As fauna are forced to

disperse into increasingly fragmented environments, the consequences of habitat loss extend beyond the immediate site, affecting the entire nation's ecosystem health and conservation efforts.

For both construction and operational phases, the full list of the values assigned for each criterion in the RIAM as well as the resulting impact significance for the habitat and fauna receptors are provided in **Appendix 5C** and **Appendix 5D** respectively.

Identified biodiversity sensitive receptors were evaluated based on impact intensity and likelihood, which eventually informs the impact significance. The impact intensity and likelihood of each impact type during the construction phase are defined for habitats and fauna species respectively below.

5.5.4.2 Construction Phase

The following assumptions were made for works during the construction phase:

- The earth drain would have been diverted before the commencement of backfilling works to allow a permanent and continuous flow of water from the upstream portion in Sembawang Country Club to the downstream portion towards Lower Seletar Reservoir.
- The above applies for both the eastern portion of the earth drain planned for diversion (to the new box drain) and backfilling in the near-term, and the western portion planned for similar diversion and backfilling works in later years, with reference to **Figure 2-4**.

5.5.4.2.1 Habitats

The definitions for impact intensity and likelihood for habitat receptors are presented in **Table 5-7** and **Table 5-8** respectively.

Table 5-7: Definitions of Each Level of Impact Intensity for Impact Types During Construction for Habitat Receptor

Impact Type	Negligible	Low	Medium	High
Loss of habitat	The habitat does not overlap with the worksites	≤ 10% of the habitat overlaps with the worksites	10–40% of the habitat overlaps with the worksites	> 40% of the habitat overlaps with the worksites

Table 5-8: Definitions of Each Level of Likelihood for all Impact Types During Construction for Habitat Receptor

Likelihood	Loss of habitat
Unlikely/Remote	The habitat does not overlap with the worksites
Less Likely/ Rare	N.A.
Possible/ Occasional	N.A.
Likely/ Regular	N.A.
Almost Certain/ Continuous	The habitat overlaps with the worksites

Loss of Habitat

The whole earth drain within the EIA Study Area will be backfilled, resulting in a high (> 40% of the habitat overlaps with the worksite) impact magnitude for habitat loss. The impact likelihood is almost certain/continuous. Overall, the impact significance of habitat loss is **Moderate Negative** for the earth drain. Nevertheless, based on the earlier ecological value assessment in **Section 5.5.1.1**, the earth drain's habitat has been assessed to be of low ecological value.

5.5.4.2.2 Fauna Species

The definitions for impact intensity and likelihood for faunal species receptors are presented in **Table 5-9** and **Table 5-10** respectively.

Table 5-9: Definitions of Level of Impact Intensity for all Impact Types During Construction for Faunal Species Receptors

Impact Type	Negligible	Low	Medium	High
Loss of/reduction in habitats and food sources	No loss of habitat, raptor nests, or roosts	Loss of <10% of habitat, or roosts	Loss of 10–40% of habitat, or roosts	Loss of >40% of habitat or roosts; loss of any raptor nests
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills	Species with low susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Volant species (e.g., odonates) – Aquatic species (most fishes, crabs, shrimps)	Species that are mobile but possibly susceptible to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – All amphibians – Some mammals (e.g., squirrels, shrews)	Species with high susceptibility to accidental injury/mortality from construction activities (large vehicles, excavation, piling, etc.) and roadkills: – Reptiles – Some mammals (e.g., long-tailed macaque)
Human-wildlife conflict	Species that are not perceived as nuisances or threats by construction personnel: – Odonates – Aquatic species	Species that are possibly perceived as both nuisances and threats by construction personnel, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians	Species that are typically perceived as nuisances and possibly as threats by construction personnel, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict:	Species that are typically perceived as both nuisances and threats by construction personnel, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes
Loss of/reduction in of ecological connectivity for faunal movement (within site)	No change to waterbody	Minimal changes in waterbody that may affect connectivity for aquatic species	Some changes in waterbody that may affect connectivity for aquatic species	Considerable changes in waterbody that may affect connectivity for aquatic species

Impact Type	Negligible	Low	Medium	High
Light disturbances	Species that are not sensitive to changes in light levels: most aquatic species	Species that are slightly sensitive to changes in light levels: odonates	Species that are sensitive to changes in light levels: diurnal reptiles and mammals	Species that are extremely sensitive to changes in light levels: nocturnal, crepuscular fauna
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are sensitive to human presence	Species that are extremely sensitive to human presence, and nesting birds

Table 5-10: Definitions of Each Level of Likelihood for all Six Impact Types During Construction for Faunal Species Receptors

Likelihood	Loss of/ reduction in habitats and food sources	Accidental injury or mortality	Human-wildlife conflict	Loss of/ reduction in ecological connectivity for faunal movement	Light disturbances	Human disturbances
Unlikely/ Remote	Impact is not expected to happen during the construction phase of the project					
Less Likely/ Rare	Impact is not likely to happen during the construction phase of the project					
Possible/ Occasional	Impact could possibly happen or is known to occur during the construction phase of the project					
Likely/ Regular	Impact is a common occurrence during the construction phase of the project					
Almost Certain/ Continuous	Impact is a continual or repeated process during the construction phase of the project					

Six impact types during the construction phase were identified and assessed for fauna receptors: (1) Loss of/reduction in habitats and food sources, (2) Accidental injury or mortality, (3) Loss/reduction of ecological connectivity for faunal movement, (4) Human disturbances, (5) Human-wildlife conflict, and (6) Light disturbances. The impact significance ranged from **No Change** to **Major Negative**. The more substantial impact areas arising from each impact type are briefly summarised below. A summary of the impact on fauna receptors is given on **Table 5-11**, with the numbers indicating the number of species that experience that particular magnitude of impact. The impact assessment is summarised below and the detailed evaluation for all species are provided in **Appendix 5D**.

Table 5-11: Summary of Construction Impact to Fauna Receptors with Number Indicating Number of Species

Impact Type	No Change	Minor Negative	Moderate Negative	Major Negative
Loss of/ reduction in habitats and food sources	0	1	0	8
Accidental injury or mortality	0	2	7	0
Loss/reduction of ecological connectivity for faunal movement	1	3	5	0
Human disturbances	2	7	0	0

Impact Type	No Change	Minor Negative	Moderate Negative	Major Negative
Human-wildlife conflict	5	4	0	0
Light disturbances	9	0	0	0

Loss of/ reduction in habitats and food sources

Major Negative impact is expected for all eight probable aquatic species from loss of habitats or food sources, as the existing habitat (i.e., the earth drain) will be lost during the construction phase. **Minor Negative** impact is expected for the terrestrial species, long-tailed macaque (*Macaca fascicularis*), that is less dependent on the earth drain for its survival.

Accidental injury or mortality

Given that minimum controls are in place (i.e. pre-felling fauna inspection and a wildlife response plan), impact significance is expected to range from **Minor to Moderate Negative**. The likelihood of accidental injury or mortality for highly mobile species, such as the damselfly grey sprite (*Pseudagrion pruinatum*) and long-tailed macaque (*Macaca fascicularis*), is considered less likely, and hence the impact significance for these species is **Minor Negative**.

However, vegetation clearance, diversion, excavation and backfilling works carried out at the earth drain is expected to possibly cause siltation impact for seven probable but unrecorded aquatic species (i.e., two fish and five reptile species), resulting in accidental injury or mortality. The two fish, crescent betta (*Betta imbellis*) and threespot gourami (*Trichopodus trichopterus*); and five reptiles, namely the black-headed collared snake (*Sibynophis melanocephalus*), red-tailed pipe snake (*Cylindrophis ruffus*), Asian softshell turtle (*Amyda cartilaginea*), Malayan box terrapin (*Cuora amboinensis*) and puff-faced water snake (*Homalopsis buccata*), were therefore assessed to be subjected to **Moderate Negative** impact.

Human-wildlife conflict

Human-wildlife conflict for freshwater fauna is negligible. Hence, there is **No Change** in impact significance. Only the long-tailed macaque (*Macaca fascicularis*) and black-headed collared snake (*Sibynophis melanocephalus*) have been assessed to have high impact for human-wildlife conflict, while the red-tailed pipe snake and puff-faced water snake have been assessed to have medium impact. However, given the minimum controls that will be put in place (i.e. a wildlife response plan), human-wildlife conflict is less likely to occur and the impact is expected to be **Minor Negative** for these species.

Loss/reduction of ecological connectivity for faunal movement

No change to Moderate Negative impact were expected from the reduction of ecological connectivity for faunal movement.

Impact intensity is considered negligible for the long-tailed macaque (*Macaca fascicularis*) due to its ability to traverse urban areas. Hence, the impact significance for long-tailed macaque is **No Change**.

This impact is considered less likely to occur for two probable but unrecorded fish species as the earth drain will be replaced with the newly constructed box drain that can continue providing connectivity between the upstream water flow from Sembawang Country Club and downstream waterbodies (i.e., Lower Seletar Reservoir). Furthermore, given that the box drain is planned to be covered, this would avoid further disturbances to the watercourse which may impede aquatic connectivity. Hence, the impact significance for such species is **Minor Negative**.

Reduction of ecological connectivity for faunal movement is also less likely for the damselfly grey sprite (*Pseudagrion pruinosum*). As this species prefers fast flowing streams with vegetated banks, Lower Seletar Reservoir is not deemed as a suitable habitat for this species. Therefore, backfilling works here are less likely to affect ecological connectivity for this species to Lower Seletar Reservoir, resulting in **Minor Negative** impact significance.

On the contrary, connectivity for five probable but unrecorded reptile species consisting of two turtles and three snakes, can possibly be reduced despite the presence of the box drain providing continual water flow between the upstream and downstream portions. These species prefer open stream habitats with vegetated banks, much alike to the existing habitat conditions for some portions of the earth drain. Hence, the impact significance for these species is **Moderate Negative**.

Light disturbances

Since no night works are expected to be carried out at Site 2, disturbances from light are likely to result in **No Change** for the impact significance for all species.

Human disturbances

Human disturbances are expected to result in **No Change** to **Minor Negative** impact. Human disturbance for the two probable fish species is considered negligible, hence **No Change** in impact significance is expected. Given that the site will be hoarded up and works will be strictly within the hoarded zone, the impact of human disturbances to the remaining seven probable fauna species is considered less likely.

5.5.4.3 Operational Phase

During the operational phase, the earth drain would have been completely backfilled and replaced with a new covered box drain. There are also plans for residential developments in the area, subject to detailed planning. The newly constructed covered box drain is not considered a habitat receptor, and therefore, will not be assessed.

5.5.4.3.1 Habitat

As the earth drain will be backfilled and replaced with a diverted box drain, there are no habitat receptors present on-site for an operational phase assessment.

5.5.4.3.2 Fauna

During the operational phase, the earth drain will be completely backfilled and replaced with a diverted box drain. The impact intensity and likelihood of each impact type during the operational phase are defined for faunal species receptors in **Table 5-12** and **Table 5-13** respectively.

Table 5-12: Definitions of Each Level of Impact Intensity for all Five Impact Types During Operational Phase for Faunal Species Receptors

Impact type	Negligible	Low	Medium	High
Accidental injury or mortality	Species with negligible susceptibility to accidental injury/mortality from operation activities, roadkills	Species with low susceptibility to accidental injury/mortality from operation activities, roadkills: – Volant species (e.g., odonates, butterflies, raptors and bats)	Species that are mobile but possibly susceptible to accidental injury/mortality from operation activities and roadkills: – All amphibians	Species with high susceptibility to accidental injury/mortality from operation activities and roadkills: – Reptiles – Some mammals (e.g., Sunda pangolin, long-

Impact type	Negligible	Low	Medium	High
		– Aquatic species (most fishes, crabs, shrimps)	– Some mammals (e.g., squirrels, shrews)	tailed macaque, smooth-coated otter)
Human-wildlife conflict	Species that are not perceived as nuisances or threats by members of the public: – Odonates – Butterflies – Most birds – Aquatic species	Species that are possibly perceived as both nuisances and threats by members of the public, less tolerant of human presence and urban environments: – Some reptiles – Most amphibians – Most bats	Species that are typically perceived as nuisances and possibly as threats by members of the public, highly tolerant of human presence and urban environments, and frequently implicated in human-wildlife conflict: – Smooth-coated otter – Red junglefowl – Aculeate hymenopterans	Species that are typically perceived as both nuisances and threats by members of the public, highly tolerant of human presence and urban environments, and are frequently implicated in human-wildlife conflict: – Long-tailed macaque – Some snakes
Loss of/ reduction in ecological connectivity for faunal movement (within site)	No change to waterbody	Minimal changes in waterbody that may affect connectivity for aquatic species	Some changes in waterbody that may affect connectivity for aquatic species	Considerable changes in waterbody that may affect connectivity for aquatic species
Light disturbances	Species that are not sensitive to changes in light levels: aculeate hymenopterans, aquatic and marine species	Species that are slightly sensitive to changes in light levels: odonates, butterflies	Species that are sensitive to changes in light levels: diurnal birds, reptiles, and mammals	Species that are highly sensitive to changes in light levels: nocturnal, crepuscular fauna
Human disturbances	Species that are not sensitive to human presence	Species that are slightly sensitive to human presence	Species that are possibly sensitive to human presence	Species that are sensitive to human presence

Table 5-13: Definitions of Each Level of Likelihood for all Impact Types During Operational Phase for Faunal Species Receptors

Likelihood	Accidental injury or Mortality	Human-Wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbances	Human Disturbances
Unlikely/ Remote	Impact is not expected to happen during the operational phase of the project				
Less Likely/ Rare	Impact is not likely to happen during the operational phase of the project				
Possible/ Occasional	Impact could possibly happen or is known to occur during the operational phase of the project				

Likelihood	Accidental injury or Mortality	Human-Wildlife Conflict	Loss of/ Reduction in Ecological Connectivity for Faunal Movement	Light Disturbances	Human Disturbances
Likely/ Regular	Impact is a common occurrence during the operational phase of the project				
Certain/ Continuous	Impact is a continual or repeated process during the operational phase of the project				

Five impact types during the operational phase were identified and assessed for the fauna receptors: (1) Loss/reduction of ecological connectivity for faunal movement, (2) Light disturbances, (3) Accidental injury or mortality, (4) Human disturbances and (5) Human-wildlife conflict. There is **No Change to Moderate Negative** impact expected. A summary of the impact on fauna receptors is described below and given in **Table 5-14**. A detailed evaluation for all species is provided in **Appendix 5D**.

Table 5-14: Summary of Operational Phase Impact Types to Fauna Receptors with Number indicating Number of Species

Impact Type	No Change	Minor	Moderate	Major
Loss/reduction of ecological connectivity for faunal movement	1	3	5	0
Light disturbances	8	1	0	0
Human disturbances	8	1	0	0
Human-wildlife conflict	8	1	0	0
Accidental injury or mortality	8	1	0	0

Loss/reduction of ecological connectivity for faunal movement

The assessment for this impact type is similar to the one for the construction phase outlined in **Section 5.5.4.2.2**.

Light disturbances, human disturbances, human-wildlife conflict and accidental injury or mortality

Given the absence of the existing earth drain as a potential habitat for aquatic species during the operational phase, there is unlikely to be impact arising from an increase in light and human disturbances, human-wildlife conflict or accidental injury and mortality. Impact significance is deemed to be **No Change**—this is applicable to all species including the eight probable aquatic species, except the long-tailed macaque (*Macaca fascicularis*).

The long-tailed macaque (*Macaca fascicularis*) is expected to experience **Minor Negative** impact from these impact sources as it is a species adapted to urban environments and may still be present in the area.

5.5.5 Mitigation Measures

Avoidance measures were not applicable for Site 2 given the nature of the proposed diversion and backfilling works. Instead, this section focuses on mitigation measures aimed at minimising faunal mortality during the construction phase (e.g. relocating existing fauna, proper wildlife management and response plans) and alternative forms of habitat creation in the operational phase.

5.5.5.1 Construction Phase

- a) Implement additional Erosion Control Measures to reduce siltation to the earth drain as described in **Section 4.5.1**.

As part of diversion works during the construction of the new box drain, the following measures are to be carried out:

- Using silt fences, erosion control blankets (ECBs) and sandbags to clearly demarcate the work area interfacing close to the sections with water before commencing any works. This is to prevent siltation from entering the existing earth drain before it has been completely drained downstream.
- Water should be actively pumped out from the work area to the sedimentation ponds, if present, to prevent silty water from overflowing into the existing earth drain before it has been completely drained out.

- b) Establish a Wildlife Management Plan to minimise accidental injury or mortality to fauna.

Wildlife management measures to be considered during diversion works include:

- Allowing water in the earth drain to be completely diverted out before commencing any backfilling works.
- If there are any residual water left in the earth drain, an ecologist is to carry out inspections to rescue and relocate trapped aquatic species downstream or upstream, where suitable for the aquatic species, before water is pumped out. Before the commencement of backfilling works, an ecologist is to walk the area to be backfilled to ensure no trapped fauna, especially turtles and terrapins, before backfilling works occur.

- c) Establish a Wildlife Response Plan (Figure 5-6) to minimise accidental injury or mortality to fauna.

A Wildlife Response Plan shall be developed in consultation with NParks' Animal Management Centre, to be executed during any encounters with trapped, injured or dead wildlife, as well as incidents of human-wildlife conflict within the development, to minimise animal injury and mortality. All site members need to be familiar with the Wildlife Response Plan.

In scenarios where certain animal groups are encountered around or within the worksite, external specialists may be contacted to handle the animal safely. These scenarios include the following:

- For snakes that require relocation/handling, a trained specialist should be contacted.
- For animal carcasses that require disposal, an animal carcass disposal service should be contacted.
- For injured animals that require medical attention, a veterinarian should be contacted.

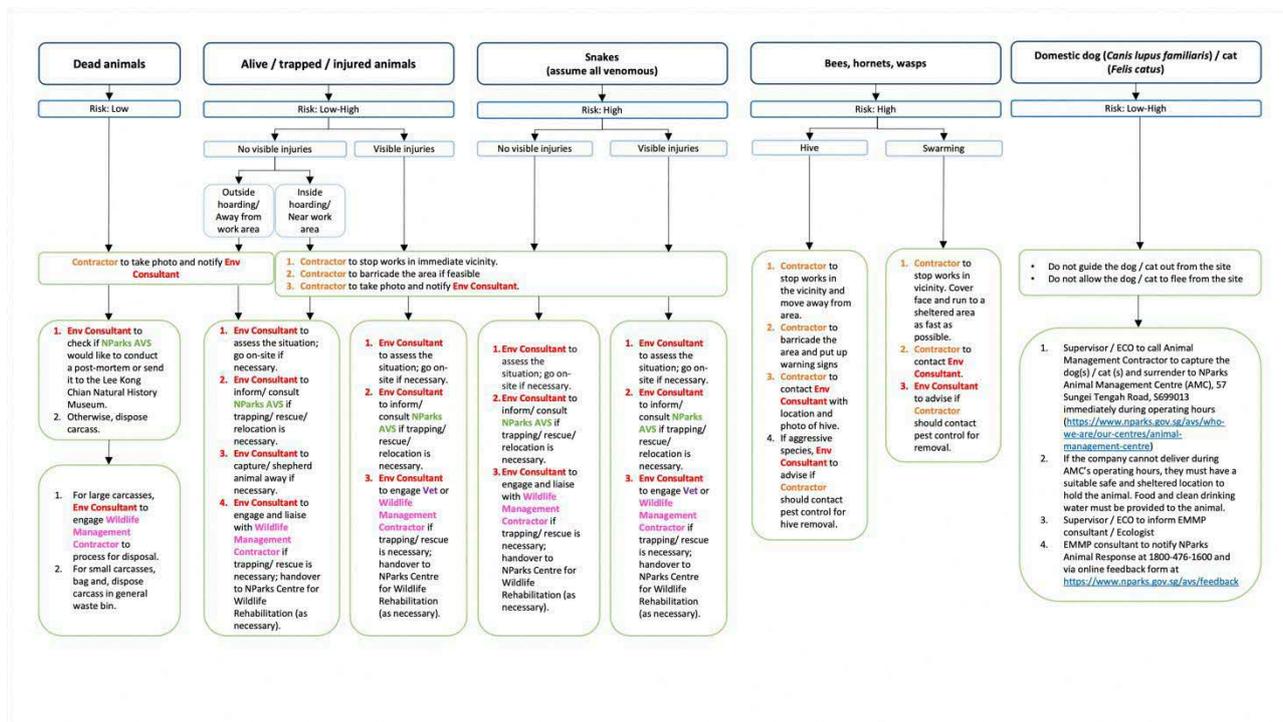


Figure 5-6: A Flowchart of the Wildlife Response Plan

d) Minimise impact of human-wildlife conflict with proper waste and food management, and biodiversity awareness training.

Human-wildlife conflict occur when there are negative interactions between humans and wildlife, e.g., human injury caused by wildlife. One key driver of human-wildlife conflict is access to anthropogenic food sources. Food is a major attractant for wildlife, and anthropogenic sources of food (e.g., rubbish) may provide an easily accessible and a reliable food source for animals. Wildlife attracted to these food sources may encounter humans, thus increasing the likelihood of negative human-wildlife interactions. Reducing human-wildlife conflict would require proper trash and food management within the site. It is important to increase staff's biodiversity awareness and educate site personnel on how to reduce the likelihood of human-wildlife conflict.

The following strategies should be implemented:

- Food should be consumed within indoor areas as much as possible.
- Bins situated outdoors should be wildlife-proof. These bins should not be easily accessible to species such as the long-tailed macaque and rats.
- Rubbish bins with food waste should be regularly cleared.
- Enclose waste management centres to prevent wildlife access. For example, rubbish bins could be kept within an indoor shed to prevent wildlife access.
- Ensure no feeding of wildlife.
- Due to potential presence of wild boars on the site. If there is any wild boar(s) is/are spotted at or around the site at any time during the project, NParks should be notified as soon as possible, via email at nparks_wildlife_management@nparks.gov.sg. An approved wild boar removal contractor should be engaged to trap and remove the said wild boar(s). The trapping and removal process may take about 4-8 weeks.

5.5.5.2 Operational Phase

Compensatory measures could be considered for habitat loss at Site 2. The following measures are recommended:

- Integration of biophilic ABC (Active, Beautiful, Clean Waters) (**Figure 5-7**) features such as rain gardens and vegetated swales within the development that can also be used as bioretention basins to help manage surface water runoff and filter pollutants. These features are typically planted with lush native foliage, which can potentially create habitats for native wildlife across different taxa such as butterflies, birds, odonates and frogs.



Figure 5-7: Biophilic ABC features that can be implemented in future developments to attract local biodiversity (Left: Rain Garden; Right: Vegetated Swales) (HDB)

While ABC features will not provide a permanent waterbody, they provide an opportunity for the creation of new enhanced habitats within the Subject Site, especially considering the degraded conditions of the existing earth drain. A new freshwater habitat could also be integrated as part of the upcoming developments, depending on site considerations and technical complexity.

5.5.6 Evaluation of Residual Impact

5.5.6.1 Construction Phase

5.5.6.1.1 Habitats

During the construction phase, loss of habitat will result in **Moderate Negative** impact as discussed in **Section**, given that the backfilling of the earth drain would be a permanent feature even though the earth drain's existing habitat conditions were assessed to be of low ecological value in **Section 5.4.1**. This is summarised in **Table 5-15** below.

Table 5-15: Summary of Residual Impact to Habitat Receptors during Construction Phase

Impact Type	Env. Score (pre-mitigation)	Impact Significance	Mitigation Measures	Env. Score (post-mitigation)	Residual Impact Significance
Loss of habitat	-234	Moderate Negative Impact	No applicable mitigation measures given nature of proposed works	-234	Moderate Negative Impact

5.5.6.1.2 Fauna

Loss of/ reduction in habitats and food sources

During the construction phase, the loss of/ reduction in habitats and food sources will result in **Major Negative** impact for eight probable but unrecorded species that may inhabit the earth drain. Given the nature of the backfilling works, mitigation measures to prevent habitat loss may not be applicable. Hence, the residual impact for reduction of habitat remains **Major Negative**.

Accidental injury or mortality

Moderate Negative impact due to accidental injury or mortality is expected for the seven probable aquatic species during the construction phase. However, the implementation of additional ECM measures to reduce siltation during drain diversion as well as a wildlife management plan to relocate aquatic species upstream or downstream will help to reduce the likelihood of accidental injury or mortality. Hence, there is a lower likelihood of accidental injury or mortality, and the residual impact for these species is **Minor Negative** during the construction phase.

Human-wildlife conflict

Minor Negative impact is expected for human-wildlife conflict during the construction phase. Biodiversity awareness training can be carried out to reduce the likelihood of human-wildlife conflict to as practicably low as possible. The residual impact remains as **Minor Negative**.

Loss/reduction of ecological connectivity for faunal movement

The new diverted box drain will still allow aquatic connectivity between upstream and downstream portions for species that are less dependent on open vegetated habitats. As there are no additional mitigation measures targeted to improve connectivity during the construction phase, the respective levels of impact will remain for the corresponding species: **Minor Negative** for the two probable fish species and one probable odonate species, **Moderate Negative** for the five probable reptile species, and **No Change** for the long-tailed macaque.

Light disturbances

Since no night works are expected to be carried out at Site 2, no mitigation measures are necessary and there is **No Change** in impact significance.

Human disturbances

Minimum controls such as hoarding installations have already been considered in the assessment to result in **Minor Negative** impact to faunal species.

The residual impact significance for all impact types is summarised on Table 5-16.

Table 5-16: Summary of Residual Impact to Fauna Receptors during Construction Phase, with Number Indicating Number of Species

Impact Type	No Change	Minor Negative	Moderate Negative	Major Negative
Loss of/ reduction in habitats and food sources	0	1	0	8
Accidental injury or mortality	0	9	0	0
Loss/reduction of ecological connectivity for faunal movement	1	3	5	0
Human disturbances	2	7	0	0
Human-wildlife conflict	5	4	0	0
Light disturbances	9	0	0	0

5.5.6.2 Operational Phase

5.5.6.2.1 Habitats

As the earth drain is planned to be backfilled and replaced with a new box drain, there are no habitat receptors present on-site for an operational phase assessment.

5.5.6.2.2 Fauna

The impact significance ranges from **No Change to Moderate Negative**.

Compensatory measures proposed at the design / operational phase such as the integration of biophilic ABC features can introduce new habitats for native wildlife such as butterflies, birds, odonates and frogs. However, these features may not serve as suitable habitat replacements or connectivity pathways for the identified probable species, particularly for snakes and turtles. Hence, the impact to ecological connectivity remains as **Moderate Negative** for the 5 probable reptile species. For the remaining species, the impact to ecological connectivity remains as **No Change or Minor Negative** for the reasons assessed in the construction phase. The residual impact significance is summarised on **Table 5-17**.

Table 5-17: Summary of Operational Phase Residual Impact to Fauna Receptors with Number Indicating Number of Species

Impact Type	No Change	Minor	Moderate	Major
Loss/reduction of ecological connectivity for faunal movement	1	3	5	0
Accidental injury or mortality	8	1	0	0
Human disturbances	8	1	0	0
Human-wildlife conflict	8	1	0	0
Light disturbances	8	1	0	0

6. Conclusion

6.1 Water Quality Assessment

6.1.1 Findings

During dry weather sampling, the results revealed that most parameters were within acceptable limits. During wet weather sampling, most parameters remained within acceptable limits, though slight exceedances for pH, oil and grease, iron and TSS were observed at certain sampling locations. Although arsenic levels exceeded the controlled watercourse discharge limit for both dry weather and wet weather sampling, these results were shared with PUB and tallied against PUB's water quality monitoring results, and the exceedances were assessed to be an isolated occurrence with no adverse impact to the downstream water quality in Lower Seletar Reservoir and its treated water. The presence of these exceedances is likely attributed to discharge from surrounding brownfield uses or upstream activities and implies that the site is not a pristine undisturbed waterway given its primary function as a drain. The data provided in this study serves as a reference point for assessing the anticipated future impact from the proposed diversion and backfilling activities at the Subject Site and implementing necessary mitigation measures to safeguard water quality during the proposed diversion works.

6.1.2 Recommended Mitigation Measures

In summary, mitigation methods such as the implementation of erosion control blankets and sediment containment strategies is expected to lower the impact magnitude of soil erosion, while adopting treatment protocols and regulated discharge is expected to lower the impact magnitude of trade effluent discharge. Lastly mitigation measures such as bunded storage, spill containment, and emergency response planning, are recommended for accidental spillage of pollutive substances during the proposed works.

6.1.3 Impact Assessment Before and After Recommended Mitigation Measures

The water quality impact assessment for Site 2 identifies risks associated with soil erosion, trade effluent discharge, and accidental spillage of pollutive substances during the proposed works. Soil erosion and runoff were predicted to have a **Minor Negative** impact due to increased sedimentation in nearby watercourses, especially Lower Seletar Reservoir. With the implementation of erosion control blankets, sediment containment strategies, and other protective measures, the residual impact from soil erosion and runoff is expected to remain a **Minor Negative** impact but of a lower magnitude, with effective containment of sediment during the construction phase.

Trade effluent discharge from construction activities, including wash water, posed an initial **Minor Negative** impact, with risks of pH imbalance and increased turbidity. By adopting treatment protocols and regulated discharge, the impact from trade effluent discharge is expected to be controlled, maintaining a **Minor Negative** residual significance but at a lower magnitude. These measures will ensure compliance with water quality standards, mitigating adverse effects on the surrounding watercourses.

The handling and storage of diesel, oil, and other pollutive substances posed a **Minor Negative** impact prior to mitigation, primarily due to potential accidental spillage affecting pH levels and dissolved oxygen in the water. To address this, mitigation measures such as bunded storage, spill containment, and emergency response planning, have been recommended. With these controls in place, the residual impact significance of spills is expected to be remain at **Minor Negative** but at a lower magnitude, providing enhanced protection against contamination.

To conclude, the application of these mitigation strategies effectively reduces the potential water quality impact, with the residual impact remaining at **Minor Negative** but at a lower magnitude. The assessment remains consistent when considering either the impact of near-term works for the eastern portion of the earth drain, or the end-state impact including similar diversion works for the western portion in later years.

6.2 Ecology and Biodiversity Assessment

6.2.1 Findings

A total of 41 species were recorded in the baseline study. This included 38 aquatic species and three (3) incidental records of terrestrial species. Except for the long-tailed macaques (globally Endangered but nationally Least Concern) sighted incidentally, there were **no other species of conservation significance recorded**. The aquatic fauna assemblage within the earth drain was exotic-dominated and many of the exotic species are likely to have been introduced via the ornamental pet trade.

The earth drain was assessed to be of low ecological value with a moderate fauna and flora assemblage, mostly exotic fauna species, and no unique species.

The ecological value of 49 species were assessed, including 41 recorded species and additional eight (8) species of conservation significance that were considered probable to occur on-site though not recorded. Since it is unlikely to record all faunal species on-site in any biodiversity studies, these eight (8) species were included in the impact assessment to provide a more holistic assessment. A total of nine (9) fauna receptors of conservation significance, were selected to guide the impact assessment. This comprised one odonate, two fish, one mammal and five reptile species – of which only the mammal species (long-tailed macaque) was observed on-site during the study.

6.2.2 Recommended Mitigation Measures

In summary, during the construction phase, mitigation measures include a Wildlife Management Plan involving the relocation of aquatic fauna upstream or downstream, a Wildlife Response Plan to guide proper protocol during wildlife encounters, and carrying out biodiversity awareness training for on-site staff. During the operational phase, compensatory measures such as a biophilic ABC features can be introduced as alternative forms of habitat creation.

6.2.3 Impact Assessment Before and After Recommended Mitigation Measures

During the construction phase, **Moderate Negative** impact was expected for the habitat receptor (i.e., earth drain) from habitat loss, considering the permanent nature of the backfilling works and the low ecological value of the earth drain. For faunal receptors, **Major Negative** impact was expected from the loss of habitats and food sources for eight (8) probable but unrecorded species. **Moderate Negative** impact was expected for accidental injury or mortality and loss/reduction of ecological connectivity for faunal movement for several probable species. However, mitigation measures such as implementing additional erosion control measures, a Wildlife Management Plan involving the relocation of aquatic fauna upstream or downstream, a Wildlife Response Plan to guide proper protocol during wildlife encounters, and carrying out biodiversity awareness training for on-site staff, can minimise the impact to **Minor Negative** for accidental injury or mortality of fauna. Ecological connectivity remains at **Minor Negative** for species that can either use the new box drain for aquatic movement or do not rely on the existing earth drain for connectivity, and **Moderate Negative** for species that require open vegetated habitats for connectivity.

During the operational phase, there is broadly **No Change to Moderate Negative** impact for the faunal receptors. Compensatory measures such as biophilic ABC features can be introduced as alternative forms of habitat creation within the future developments. These strategies may not reduce the loss of ecological connectivity for the nine (9) specific faunal receptors for the reasons established above but can provide new habitats with lush native planting palettes to attract other native wildlife such as butterflies and birds.

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8. Appendices

Appendix 1A. Relevant EIA Regulations in Singapore

The Environmental Protection and Management Act (EPMA) provides the legislative framework for the control of environmental pollution, and covers air pollution, water pollution, land pollution, noise pollution and hazardous substances control. The EPMA is administered and enforced by NEA. While Singapore does not have specific laws or regulations on EIA studies, some sections of the EPMA are relevant to the preparation of EIA report for this Project, namely Section 35 on the prevention of pollution from construction sites and Section 36 on pollution control studies.

In addition to the EPMA, the following Acts and their subsidiary regulations (**Table 1A.1**) are also relevant to environmental protection in Singapore with implications to EIA studies:

Table 1A.1: Applicable Acts and Subsidiary Regulations

Environmental Aspects	Relevant Local Acts/ Regulations/ Action Plans	Jurisdiction/ Administrative/ Enforcement Agencies
Parks, Tree and Flora Protection	<ul style="list-style-type: none"> • Parks and Trees Act • Parks and Trees Regulations • Parks and Trees (Preservation of trees) order • Parks and Trees (Heritage Road Green Buffer) 	NParks
Animal/ Wildlife/ Fauna Protection ¹	<ul style="list-style-type: none"> • Wildlife Act 	NParks
Development and Redevelopment	<ul style="list-style-type: none"> • Planning Act 	MND/URA
Reservoirs and Catchment Area Protection	<ul style="list-style-type: none"> • Public Utilities Act • Public Utilities (Water Supply) regulations • Public Utilities Act (Reservoirs and Catchment Areas) Regulations, 2006 	PUB
Sewerage and Drainage Planning and Development	<ul style="list-style-type: none"> • Sewerage and Drainage Act • Sewerage and Drainage (Surface Water Drainage) Regulations • Sewerage and Drainage (Trade Effluent) Regulations 	PUB
Noise at Construction Sites	<ul style="list-style-type: none"> • Environmental Protection and Management (Control of Noise at Construction Sites) Regulations 2008 	NEA

¹ Formerly administered and enforced by Agri-Food & Veterinary Authority of Singapore (AVA)

Environmental Aspects	Relevant Local Acts/ Regulations/ Action Plans	Jurisdiction/ Administrative/ Enforcement Agencies
Air Pollution	<ul style="list-style-type: none"> • Environmental Protection and Management (Vehicular Emissions) Regulations 2008 • Environmental Protection and Management (Air Impurities) Regulations 2008 • Environmental Protection and Management (Off-Road Diesel Engine Emissions) Regulations 2008 • Singapore Air Quality Targets 	NEA
Water Pollution	<ul style="list-style-type: none"> • Environmental Protection and Management (Trade Effluent) Regulations 2008 	NEA
Public Health and Environment	<ul style="list-style-type: none"> • Environmental Public Health Act • Environmental Public Health (Registration of Environmental Control Officer) regulations • Environmental Public Health (Employment of Environmental Control Officer) Order • Environmental Public Health (Qualifications of Environmental Control Officer) 	NEA
Waste	<ul style="list-style-type: none"> • Environmental Protection and Management (Hazardous Substances) Regulations • Environmental Public Health (General Waste Collection) Regulations, 2000 • Environmental Public Health (Toxic Industrial Waste) Regulations, 2000 	NEA
Vector Management	<ul style="list-style-type: none"> • Control of Vectors and Pesticides Act, 2002 • Environmental Public Health (Food hygiene) regulations 	NEA

These frameworks also give relevant agencies the power to issue directions on environmental management and pollution control as required. This has led to the development of Code of Practices (COPs) and guidelines issued by the relevant agencies. These COPs and guidelines detail more specific requirements on regulatory compliance, various control techniques as well as best practices with regards to environmental management and related issues. The relevant COPs and guidelines are described on **Table 1A.2**.

Table 1A.2: Relevant Code of Practice and Guidelines

Environmental Aspects	Relevant Local Acts/ Regulations/ Action Plans	Jurisdiction/ Administrative/ Enforcement Agencies
Biodiversity	<ul style="list-style-type: none"> • Singapore Red Data Book • NParks Biodiversity Impact Assessment (BIA) Guidelines 	NParks

Specialist Consultancy Services for Environmental Impact Assessment (EIA) at
Chencharu (Site 2)

Environmental Aspects	Relevant Local Acts/ Regulations/ Action Plans	Jurisdiction/ Administrative/ Enforcement Agencies
General Environment	<ul style="list-style-type: none"> • SS 593 : 2013 Code of Practice on Pollution Control • Code of Practice for Environmental Control Officers 	NEA
Surface Water	<ul style="list-style-type: none"> • Code of Practice on Surface Water Drainage • Guidebook on Erosion and Sediment Control at Construction Sites • PUB Circular on Preventing Muddy Water from the Construction Site 	PUB
Noise	<ul style="list-style-type: none"> • Code of Practice for Noise Control on Construction and Demolition Sites • BS 5228-1 2009: Code of Practice for Noise and Vibration Control on Construction – Part 1: Noise 	NEA International
Waste	<ul style="list-style-type: none"> • Code of Practice for Licensed General Waste Collectors • SS 603 : 2014 Code of Practice for Hazardous Waste Management 	NEA
Sustainability	<ul style="list-style-type: none"> • United Nations Sustainable Development Goals: 17 Goals to Transform our World 	International

Appendix 4A. Water Quality Site and Sampling Photos

Dry Weather Sampling (16th September 2024)

16-Sep-24
[DWS]



WQ1

WQ2

GPS coord	N1.416050 E103.823870	N1.415794 E103.824610
Time of Sampling	14:25	14:16

Dry Weather Sampling (16th September 2024)



WQ3

WQ4

WQ5

N1.415288 E103.825582	N1.414805 E103.826496	N1.414522 E103.827263
14:08	13:55	13:48

Dry Weather Sampling (16th September 2024)



WQ6

WQ7

WQ8

N1.414387 E103.828366	N1.414381 E103.828392	N1.413768 E103.829819
13:38	13:30	13:15

Dry Weather Sampling (16th September 2024)



WQ9

WQ10

N1.413465 E103.830250	N1.413195 E103.830954
13:08	13:03

Dry Weather Sampling (23rd September 2024)

23-Sep-24 [DWS]			
			
	WQ1	WQ2	WQ3
GPS coord	N1.416030 E103.823914	N1.415734 E103.824722	N1.415322 E103.825683
Time of Sampling	11:43	11:36	11:28



WQ4

WQ5

WQ6

WQ7

N1.414736 E103.826482	N1.414566 E103.827305	N1.414341 E103.827824	N1.414381 E103.828417
11:17	11:08	11:00	10:53



WQ8

WQ9

WQ10

N1.413761 E103.829814	N1.413523 E103.830316	N1.413159 E103.830952
10:42	10:35	10:30

Wet Weather Sampling (23rd September 2024)

23-Sep-24 [WWS]			
			
	WQ1	WQ2	WQ3
GPS coord	N1.416058 E103.823878	N1.415758 E103.824835	N1.415311 E103.825632
Time of Sampling	17:00	16:53	16:47
Remarks			

Wet Weather Sampling (23rd September 2024)



WQ4



WQ5



WQ6



N1.414704 E103.826618	N1.414582 E103.827252	N1.414416 E103.827847
16:40	16:34	16:26
<p>Sampling location shifted approx. 10m downstream as the original location was too slippery to access. Top photo shows original sampling location.</p>		

Wet Weather Sampling (23rd September 2024)



WQ7

WQ8

WQ9

WQ10

N1.414412 E103.828335	N1.413816 E103.829829	N1.413561 E103.830328	N1.413165 E103.830955
16:20	16:15	16:10	16:05

Wet Weather Sampling (23rd September 2024)



Appendix 4B. Water Sampling Results

RESULTS

Test Parameter	Unit	NEA Allowable limits for trade effluent	Dry weather event									
			WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	WQ9	WQ10
			16/09/2024, 1425hrs	16/09/2024, 1416hrs	16/09/2024, 1408hrs	16/09/2024, 1355hrs	16/09/2024, 1348hrs	16/09/2024, 1338hrs	16/09/2024, 1330hrs	16/09/2024, 1315hrs	16/09/2024, 1308hrs	16/09/2024, 1303hrs
Temperature (In-situ)	°C	45	31.1	31.0	30.5	30.2	30.8	30.9	30.8	30.6	31.1	30.5
pH value (In-situ)	-	6 to 9	7.15	7.10	7.02	6.91	6.80	6.94	6.94	7.28	7.22	7.13
Conductivity	µS/cm		89.60	91.10	127.00	138.00	152.00	149.00	149.00	184.00	183.00	195.00
Dissolved Oxygen as DO	mg/L		6.73	6.39	7.10	6.79	6.29	6.81	6.88	7.07	6.48	6.77
Turbidity	NTU		22.70	21.50	21.40	19.20	17.10	18.0	16.0	41.0	39.0	40.0
Salinity	ppt		0.04	0.04	0.06	0.06	0.07	0.07	0.07	0.09	0.09	0.09
Biochemical Oxygen Demand, BOD5	mg/L	20	ND	4.61	ND							
Chemical Oxygen Demand, COD	mg O2/L	60	ND	29	ND							
Total Alkalinity	mg/L		25.00	26.00	27.00	29.00	36.00	33.00	33.00	34.00	34.00	34.00
Total Phosphorus as TP	mg/L		0.098	0.104	0.079	0.080	0.092	0.091	0.080	0.067	0.044	0.069
Total Nitrogen as TN	mg/L		1.1703	1.1148	1.1190	1.1251	1.2128	1.1278	1.1482	1.0259	0.9737	1.0723
Total Organic Carbon, TOC	mg/L	10	3.7290	3.6680	3.2020	3.2600	3.1530	3.0860	2.6510	2.5940	2.5180	2.5650
Nitrate as NO3-N	mg/L	20	0.5208	0.5156	0.6317	0.6344	0.6948	0.6565	0.6678	0.5845	0.5780	0.5894
Ammonia as NH3-N	mg/L		0.0652	0.0726	0.0699	0.0909	0.1440	0.1037	0.1068	0.0990	0.0973	0.0970
Orthophosphate as PO4-P	mg/L	2	0.0271	0.0290	0.0289	0.0305	0.0345	0.0324	0.0323	0.0317	0.0308	0.0311
Total Dissolved Solids, TDS	mg/L	1000	55	57	81	91	100	96	93	116	117	124
Total Suspended Solids, TSS	mg/L	30	11.00	15.00	12.67	11.67	11.67	ND	ND	24.67	17.33	18.67
Enterococci	cfu/100mL		71	180	210	320	180	330	370	250	360	310
Arsenic as As	µg/L	10	14.94	15.82	10.99	11.13	11.42	12.03	10.34	8.89	8.79	8.79
Barium as Ba	µg/L	1000	16.16	15.82	17.60	18.39	18.71	18.41	20.78	16.57	15.65	15.70
Tin as Sn	µg/L	5000	ND									
Boron as B	µg/L	500	13.87	14.34	16.85	17.09	19.77	17.11	17.13	19.98	19.13	19.79
Manganese as Mn	µg/L	500	10.39	10.27	12.09	14.57	22.91	16.24	16.28	13.50	12.91	14.50
Beryllium as Be	µg/L	500	ND									
Iron as Fe	µg/L	1000	638.57	596.54	502.53	534.27	639.01	576.82	507.45	554.95	535.47	563.20
*Lead as Pb	µg/L	100	5.14	5.18	ND	ND	ND	ND	ND	14.62	ND	9.16
*Zinc as Zn	µg/L	500	ND	ND	6.63	7.32	5.73	5.24	ND	ND	5.89	ND
*Mercury as Hg	µg/L	1	ND									
*Cadmium as Cd	µg/L	3	ND									
*Chromium as Cr (trivalent and hexavalent)	µg/L	50	ND									
*Copper as Cu	µg/L	100	ND									
*Nickel as Ni	µg/L	100	ND									
*Selenium as Se	µg/L	10	ND									
*Silver as Ag	µg/L	100	ND									
*Metals in Total	µg/L	500	5.1	5.18	6.63	7.32	5.73	5.24	0.00	14.6	5.89	9.2
Oil & Grease (Total)	mg/L	1	0.15	0.19	0.17	0.15	0.13	0.11	ND	0.13	0.15	0.17
Oil & Grease (Hydrocarbon)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.12

RESULTS

Test Parameter	Unit	Wet weather event													
		WQ1 WWS	WQ2 WWS	WQ3 WWS	WQ4 WWS	WQ5 WWS	WQ6 WWS	WQ7 WWS	WQ8 WWS	WQ9 WWS	WQ10 WWS	WQ1 DWS	WQ2 DWS	WQ3 DWS	WQ4 DWS
		23/09/2024, 1700hrs	23/09/2024, 1653hrs	23/09/2024, 1647hrs	23/09/2024, 1640hrs	23/09/2024, 1634hrs	23/09/2024, 1626hrs	23/09/2024, 1620hrs	23/09/2024, 1615hrs	23/09/2024, 1610hrs	23/09/2024, 1605hrs	23/09/2024, 1143hrs	23/09/2024, 1136hrs	23/09/2024, 1128hrs	23/09/2024, 1117hrs
Temperature (In-situ)	°C	29.6	29.5	29.1	29.8	29.2	29.2	28.9	29.5	29.6	30.1	30.7	30.3	30.5	30.7
pH value (In-situ)	-	7.92	10.7	8.84	7.07	6.78	6.86	6.84	6.90	9.92	7.43	7.40	6.94	6.80	6.64
Conductivity	µS/cm	108	232	142	213	223	195	221	176	184	175	99.9	297	225	188
Dissolved Oxygen as DO	mg/L	7.15	6.66	7.13	5.65	5.26	6.36	5.91	6.22	6.29	6.50	7.44	5.89	6.48	3.80
Turbidity	NTU	39.3	308	67.4	31.2	14.2	23.5	22.4	22.0	20.8	22.3	13.2	12.3	15.9	14.7
Salinity	ppt	0.05	0.11	0.070	0.10	0.11	0.090	0.11	0.080	0.090	0.080	0.05	0.14	0.11	0.09
Biochemical Oxygen Demand, BOD5	mg/L	ND	5.85	ND	7.89	ND	ND	ND	ND						
Chemical Oxygen Demand, COD	mg O2/L	ND	44.0	20.0	ND	ND	ND	ND	ND	ND	33.0	ND	ND	ND	ND
Total Alkalinity	mg/L	34.0	146	41.0	44.0	45.0	49.0	49.0	48.0	47.0	44.0	32.0	40.0	46.0	48.0
Total Phosphorus as TP	mg/L	0.27	0.31	0.17	0.12	0.14	0.12	0.12	0.13	0.17	0.11	0.11	0.11	0.12	0.12
Total Nitrogen as TN	mg/L	0.87	1.34	1.13	1.16	1.20	1.24	1.46	1.08	1.12	1.26	0.66	0.87	1.06	1.54
Total Organic Carbon, TOC	mg/L	4.59	8.99	4.56	4.33	3.25	3.19	3.38	3.58	3.55	7.10	3.45	2.47	2.98	3.29
Nitrate as NO3-N	mg/L	0.36	0.54	0.70	0.68	0.74	0.75	0.94	0.47	0.40	0.17	0.26	0.53	0.64	0.89
Ammonia as NH3-N	mg/L	0.069	0.034	ND	0.10	0.11	0.16	0.21	0.22	0.25	ND	0.070	0.092	0.13	0.25
Orthophosphate as PO4-P	mg/L	0.036	0.10	0.046	0.051	0.046	0.049	0.056	0.050	0.067	0.043	0.036	0.045	0.047	0.055
Total Dissolved Solids, TDS	mg/L	66.0	121	93.0	136	146	128	145	114	119	116	63.0	185	142	121
Total Suspended Solids, TSS	mg/L	19.8	315	36.2	23.6	ND	17.0	10.0	12.4	13.8	18.2	ND	ND	13.2	ND
Enterococci	cfu/100mL	1,600	2,800	2,400	2,300	1,200	1,000	1,900	1,400	2,000	900	20	250	1,400	320
Arsenic as As	µg/L	19.8	17.1	12.2	15.4	15.9	17.4	17.8	17.8	18.1	15.0	19.1	12.1	16.3	19.2
Barium as Ba	µg/L	18.1	28.3	20.2	22.7	25.0	24.1	24.7	21.1	20.7	17.6	16.3	19.9	25.2	27.0
Tin as Sn	µg/L	ND													
Boron as B	µg/L	23.6	29.9	26.3	30.5	23.0	21.7	20.1	22.1	21.5	24.4	15.0	15.0	15.9	17.2
Manganese as Mn	µg/L	10.9	18.3	9.02	14.1	23.4	25.6	32.4	28.8	24.2	12.7	ND	23.3	28.3	24.8
Beryllium as Be	µg/L	ND													
Iron as Fe	µg/L	851	1,871	875	876	796	883	1,028	894	835	537	571	601	701	810
*Lead as Pb	µg/L	ND													
*Zinc as Zn	µg/L	12.7	25.4	19.7	12.0	10.5	26.2	16.1	11.1	10.6	5.31	8.27	7.38	9.74	16.8
*Mercury as Hg	µg/L	ND													
*Cadmium as Cd	µg/L	ND													
*Chromium as Cr (trivalent and hexavalent)	µg/L	ND	6.90	ND											
*Copper as Cu	µg/L	ND	13.7	ND											
*Nickel as Ni	µg/L	ND													
*Selenium as Se	µg/L	ND													
*Silver as Ag	µg/L	ND													
*Metals in Total	µg/L	12.7	45.9	19.7	12.0	10.5	26.2	16.1	11.1	10.6	5.31	8.27	7.38	9.74	16.8
Oil & Grease (Total)	mg/L	0.34	1.29	0.34	0.14	ND	0.35	ND	0.34	0.64	0.72	ND	0.11	0.18	ND
Oil & Grease (Hydrocarbon)	mg/L	0.18	0.98	0.25	0.13	ND	0.18	ND	0.14	0.11	0.13	ND	ND	0.11	ND

RESULTS

Test Parameter	Unit	Dry weather event						LOR
		WQ5 DWS	WQ6 DWS	WQ7 DWS	WQ8 DWS	WQ9 DWS	WQ10 DWS	
		23/09/2024, 1108hrs	23/09/2024, 1100hrs	23/09/2024, 1053hrs	23/09/2024, 1042hrs	23/09/2024, 1035hrs	23/09/2024, 1030hrs	
Temperature (In-situ)	°C	30.8	30.7	30.1	29.8	29.5	30.8	-
pH value (In-situ)	-	6.78	6.77	6.63	6.78	6.74	7.47	-
Conductivity	µS/cm	140	162	152	157	143	158	-
Dissolved Oxygen as DO	mg/L	5.76	6.30	5.48	5.16	4.71	6.58	-
Turbidity	NTU	12.6	12.8	11.9	16.3	14.7	20.0	-
Salinity	ppt	0.07	0.08	0.07	0.07	0.07	0.07	-
Biochemical Oxygen Demand, BOD5	mg/L	ND	ND	ND	ND	ND	5.75	2
Chemical Oxygen Demand, COD	mg O2/L	ND	ND	ND	ND	ND	46	20
Total Alkalinity	mg/L	44.0	52.0	50.0	48.0	44.0	48.0	20
Total Phosphorus as TP	mg/L	0.11	0.13	0.30	0.19	0.15	0.20	0.01
Total Nitrogen as TN	mg/L	0.78	0.74	0.73	0.90	0.79	1.56	0.01
Total Organic Carbon, TOC	mg/L	3.48	3.34	3.48	3.16	3.23	8.98	1
Nitrate as NO3-N	mg/L	0.36	0.29	0.33	0.37	0.36	0.037	0.015
Ammonia as NH3-N	mg/L	0.14	0.16	0.19	0.24	0.19	ND	0.01
Orthophosphate as PO4-P	mg/L	0.042	0.048	0.048	0.046	0.046	0.040	0.025
Total Dissolved Solids, TDS	mg/L	89.0	102	97.0	101	91.0	98.0	10
Total Suspended Solids, TSS	mg/L	ND	ND	ND	15.0	ND	20.2	10
Enterococci	cfu/100mL	310	350	320	2,200	850	420	1
Arsenic as As	µg/L	17.0	24.6	23.2	16.3	17.2	15.3	5
Barium as Ba	µg/L	24.0	23.3	22.5	19.5	21.3	14.7	5
Tin as Sn	µg/L	ND	ND	ND	ND	ND	ND	5
Boron as B	µg/L	16.6	17.0	15.7	16.6	16.1	21.4	5
Manganese as Mn	µg/L	12.5	34.4	36.8	12.9	15.4	11.3	5
Beryllium as Be	µg/L	ND	ND	ND	ND	ND	ND	5
Iron as Fe	µg/L	679	975	991	697	758	434	5
*Lead as Pb	µg/L	ND	ND	ND	ND	ND	ND	5
*Zinc as Zn	µg/L	9.01	21.3	20.3	6.60	14.4	5.57	5
*Mercury as Hg	µg/L	ND	ND	ND	ND	ND	ND	0.2
*Cadmium as Cd	µg/L	ND	ND	ND	ND	ND	ND	5
*Chromium as Cr (trivalent and hexavalent)	µg/L	ND	ND	ND	ND	ND	ND	5
*Copper as Cu	µg/L	ND	ND	ND	ND	ND	ND	5
*Nickel as Ni	µg/L	ND	ND	ND	ND	ND	ND	5
*Selenium as Se	µg/L	ND	ND	ND	ND	ND	ND	5
*Silver as Ag	µg/L	ND	ND	ND	ND	ND	ND	5
*Metals in Total	µg/L	9.01	21.3	20.3	6.60	14.4	5.57	-
Oil & Grease (Total)	mg/L	ND	ND	ND	ND	ND	ND	0.1
Oil & Grease (Hydrocarbon)	mg/L	ND	ND	ND	ND	ND	ND	0.1

Appendix 4C. Water Analysis Test Reports

TEST REPORT

Our Reference No. : **R240 7909**
Project Code / Ref. : Yishun

Date Received : 16/09/2024
Date Commenced : 16/09/2024
Date Reported : 24/09/2024

Customer Ref. No. : -
Customer Name : CH2M (Jacobs)
Customer Address : 150 Beach Road
Gateway West 34th Floor
Singapore 189720

Attention To : Mr Lester Teh

Sample Description : Water Sampling carried out by MLS personnel in accordance to MLS-SOP-ES-001 Rev 4 for 10 Sampling Points

RESULTS : Refer to Page 2 to Page 4



Tan Thuan Piang
Senior Technical Manager

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- 3) MLS agrees to use reasonable diligence in the performance of the service.

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R240 7909

RESULTS

Test Parameter	Unit	Test Method	WQ1	WQ2	WQ3	WQ4
			16/09/2024, 1425hrs	16/09/2024, 1416hrs	16/09/2024, 1408hrs	16/09/2024, 1355hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	31.1	31.0	30.5	30.2
pH value (In-situ)	-		7.15	7.10	7.02	6.91
Conductivity	µS/cm		89.6	91.1	127	138
Dissolved Oxygen as DO	mg/L		6.73	6.39	7.10	6.79
Turbidity	NTU		22.7	21.5	21.4	19.2
Salinity	ppt		0.04	0.04	0.06	0.06
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	4.61	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	29	ND	ND
Total Alkalinity	mg/L	APHA 2320B	25.0	26.0	27.0	29.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.098	0.10	0.079	0.080
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.17	1.11	1.12	1.13
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.73	3.67	3.20	3.26
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.52	0.52	0.63	0.63
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.065	0.073	0.070	0.091
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.027	0.029	0.029	0.031
Total Dissolved Solids, TDS	mg/L	APHA 2540C	55.0	57.0	81.0	91.0
Total Suspended Solids, TSS	mg/L	APHA 2540D	11.0	15.0	12.7	11.7
Enterococci	cfu/100mL	APHA 9230C	71	180	210	320
Arsenic as As	µg/L	APHA 3125B	14.9	15.8	11.0	11.1
Barium as Ba	µg/L	APHA 3125B	16.2	15.8	17.6	18.4
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	ND
Boron as B	µg/L	APHA 3125B	13.9	14.3	16.9	17.1
Manganese as Mn	µg/L	APHA 3125B	10.4	10.3	12.1	14.6
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	639	597	503	534
*Lead as Pb	µg/L	APHA 3125B	5.14	5.18	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	ND	ND	6.63	7.32
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	ND
*Metals in Total	µg/L	By Calculation	5.1	5.18	6.63	7.32
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	0.15	0.19	0.17	0.15
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	ND	ND

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition, 2023)

1. LOR = Limit of Reporting.

2. ND = Not Detected. The result is less than the LOR.



R240 7909

RESULTS

Test Parameter	Unit	Test Method	WQ5	WQ6	WQ7
			16/09/2024, 1348hrs	16/09/2024, 1338hrs	16/09/2024, 1330hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	30.8	30.9	30.8
pH value (In-situ)	-		6.80	6.94	6.94
Conductivity	µS/cm		152	149	149
Dissolved Oxygen as DO	mg/L		6.29	6.81	6.88
Turbidity	NTU		17.1	18.0	16.0
Salinity	ppt		0.07	0.07	0.07
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	ND
Total Alkalinity	mg/L	APHA 2320B	36.0	33.0	33.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.092	0.091	0.080
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.21	1.13	1.15
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.15	3.09	2.65
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.69	0.66	0.67
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.14	0.10	0.11
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.035	0.032	0.032
Total Dissolved Solids, TDS	mg/L	APHA 2540C	100	96.0	93.0
Total Suspended Solids, TSS	mg/L	APHA 2540D	11.7	ND	ND
Enterococci	cfu/100mL	APHA 9230C	180	330	370
Arsenic as As	µg/L	APHA 3125B	11.4	12.0	10.3
Barium as Ba	µg/L	APHA 3125B	18.7	18.4	20.8
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND
Boron as B	µg/L	APHA 3125B	19.8	17.1	17.1
Manganese as Mn	µg/L	APHA 3125B	22.9	16.2	16.3
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	639	577	507
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	5.73	5.24	ND
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND
*Metals in Total	µg/L	By Calculation	5.73	5.24	0.00
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	0.13	0.11	ND
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	ND

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition)

1. LOR = Limit of Reporting.

2. ND = Not Detected. The result is less than the LOR.



R240 7909

RESULTS

Test Parameter	Unit	Test Method	WQ8	WQ9	WQ10	LOR
			16/09/2024, 1315hrs	16/09/2024, 1308hrs	16/09/2024, 1303hrs	
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	30.6	31.1	30.5	-
pH value (In-situ)	-		7.28	7.22	7.13	-
Conductivity	µS/cm		184	183	195	-
Dissolved Oxygen as DO	mg/L		7.07	6.48	6.77	-
Turbidity	NTU		41.0	39.0	40.0	-
Salinity	ppt		0.09	0.09	0.09	-
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	ND	2
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	ND	20
Total Alkalinity	mg/L	APHA 2320B	34.0	34.0	34.0	20
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.067	0.044	0.069	0.01
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.03	0.97	1.07	0.01
Total Organic Carbon, TOC	mg/L	APHA 5310B	2.59	2.52	2.57	1
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.58	0.58	0.59	0.015
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.099	0.097	0.097	0.01
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.032	0.031	0.031	0.025
Total Dissolved Solids, TDS	mg/L	APHA 2540C	116	117	124	10
Total Suspended Solids, TSS	mg/L	APHA 2540D	24.7	17.3	18.7	10
Enterococci	cfu/100mL	APHA 9230C	250	360	310	1
Arsenic as As	µg/L	APHA 3125B	8.89	8.79	8.79	5
Barium as Ba	µg/L	APHA 3125B	16.6	15.6	15.7	5
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	5
Boron as B	µg/L	APHA 3125B	20.0	19.1	19.8	5
Manganese as Mn	µg/L	APHA 3125B	13.5	12.9	14.5	5
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	5
Iron as Fe	µg/L	APHA 3125B	555	535	563	5
*Lead as Pb	µg/L	APHA 3125B	14.6	ND	9.16	5
*Zinc as Zn	µg/L	APHA 3125B	ND	5.89	ND	5
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	0.2
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	5
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	5
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	5
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	5
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	5
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	5
*Metals in Total	µg/L	By Calculation	14.6	5.89	9.2	-
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	0.13	0.15	0.17	0.1
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	0.12	0.1

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition)

1. LOR = Limit of Reporting.

2. ND = Not Detected. The result is less than the LOR.



TEST REPORT

Our Reference No. : **R240 8119**
Project Code / Ref. : Yishun

Date Received : 23/09/2024
Date Commenced : 23/09/2024
Date Reported : 03/10/2024

Customer Ref. No. : -
Customer Name : CH2M (Jacobs)
Customer Address : 150 Beach Road
Gateway West 34th Floor
Singapore 189720

Attention To : Mr Lester Teh
Sample Description : Water Sampling carried out by MLS personnel in accordance to MLS-SOP-ES-001 Rev 4 for 10 Sampling Points

RESULTS : Refer to Page 2 to Page 4



Tan Thuan Piang
Senior Technical Manager

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- 3) MLS agrees to use reasonable diligence in the performance of the service.

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R240 8119

RESULTS

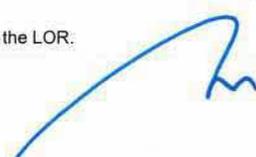
Test Parameter	Unit	Test Method	WQ1	WQ2	WQ3	WQ4
			23/09/2024, 1143hrs	23/09/2024, 1136hrs	23/09/2024, 1128hrs	23/09/2024, 1117hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	30.7	30.3	30.5	30.7
pH value (In-situ)	-		7.40	6.94	6.80	6.64
Conductivity	µS/cm		99.9	297	225	188
Dissolved Oxygen as DO	mg/L		7.44	5.89	6.48	3.80
Turbidity	NTU		13.2	12.3	15.9	14.7
Salinity	ppt		0.05	0.14	0.11	0.09
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	ND	ND
Total Alkalinity	mg/L	APHA 2320B	32.0	40.0	46.0	48.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.11	0.11	0.12	0.12
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	0.66	0.87	1.06	1.54
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.45	2.47	2.98	3.29
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.26	0.53	0.64	0.89
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.070	0.092	0.13	0.25
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.036	0.045	0.047	0.055
Total Dissolved Solids, TDS	mg/L	APHA 2540C	63.0	185	142	121
Total Suspended Solids, TSS	mg/L	APHA 2540D	ND	ND	13.2	ND
Enterococci	cfu/100mL	APHA 9230C	20	250	1,400	320
Arsenic as As	µg/L	APHA 3125B	19.1	12.1	16.3	19.2
Barium as Ba	µg/L	APHA 3125B	16.3	19.9	25.2	27.0
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	ND
Boron as B	µg/L	APHA 3125B	15.0	15.0	15.9	17.2
Manganese as Mn	µg/L	APHA 3125B	ND	23.3	28.3	24.8
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	571	601	701	810
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	8.27	7.38	9.74	16.8
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	ND
*Metals in Total	µg/L	By Calculation	8.27	7.38	9.74	16.8
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	ND	0.11	0.18	ND
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	0.11	ND

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition, 2023)

1. LOR = Limit of Reporting.

2. ND = Not Detected. The result is less than the LOR.



R240 8119

RESULTS

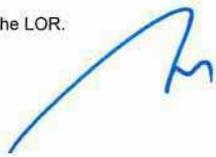
Test Parameter	Unit	Test Method	WQ5	WQ6	WQ7
			23/09/2024, 1108hrs	23/09/2024, 1100hrs	23/09/2024, 1053hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	30.8	30.7	30.1
pH value (In-situ)	-		6.78	6.77	6.63
Conductivity	µS/cm		140	162	152
Dissolved Oxygen as DO	mg/L		5.76	6.30	5.48
Turbidity	NTU		12.6	12.8	11.9
Salinity	ppt		0.07	0.08	0.07
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	ND
Total Alkalinity	mg/L	APHA 2320B	44.0	52.0	50.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.11	0.13	0.30
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	0.78	0.74	0.73
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.48	3.34	3.48
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.36	0.29	0.33
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.14	0.16	0.19
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.042	0.048	0.048
Total Dissolved Solids, TDS	mg/L	APHA 2540C	89.0	102	97.0
Total Suspended Solids, TSS	mg/L	APHA 2540D	ND	ND	ND
Enterococci	cfu/100mL	APHA 9230C	310	350	320
Arsenic as As	µg/L	APHA 3125B	17.0	24.6	23.2
Barium as Ba	µg/L	APHA 3125B	24.0	23.3	22.5
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND
Boron as B	µg/L	APHA 3125B	16.6	17.0	15.7
Manganese as Mn	µg/L	APHA 3125B	12.5	34.4	36.8
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	679	975	991
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	9.01	21.3	20.3
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND
*Metals in Total	µg/L	By Calculation	9.01	21.3	20.3
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	ND	ND	ND
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	ND

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition)

1. LOR = Limit of Reporting.

2. ND = Not Detected, The result is less than the LOR.



R240 8119

RESULTS

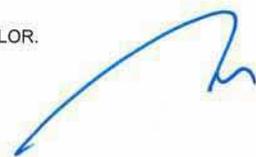
Test Parameter	Unit	Test Method	WQ8	WQ9	WQ10	LOR
			23/09/2024, 1042hrs	23/09/2024, 1035hrs	23/09/2024, 1030hrs	
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	29.8	29.5	30.8	-
pH value (In-situ)	-		6.78	6.74	7.47	-
Conductivity	µS/cm		157	143	158	-
Dissolved Oxygen as DO	mg/L		5.16	4.71	6.58	-
Turbidity	NTU		16.3	14.7	20.0	-
Salinity	ppt		0.07	0.07	0.07	-
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	5.75	2
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	46	20
Total Alkalinity	mg/L	APHA 2320B	48.0	44.0	48.0	20
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.19	0.15	0.20	0.01
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	0.90	0.79	1.56	0.01
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.16	3.23	8.98	1
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.37	0.36	0.037	0.015
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.24	0.19	ND	0.01
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.046	0.046	0.040	0.025
Total Dissolved Solids, TDS	mg/L	APHA 2540C	101	91.0	98.0	10
Total Suspended Solids, TSS	mg/L	APHA 2540D	15.0	ND	20.2	10
Enterococci	cfu/100mL	APHA 9230C	2,200	850	420	1
Arsenic as As	µg/L	APHA 3125B	16.3	17.2	15.3	5
Barium as Ba	µg/L	APHA 3125B	19.5	21.3	14.7	5
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	5
Boron as B	µg/L	APHA 3125B	16.6	16.1	21.4	5
Manganese as Mn	µg/L	APHA 3125B	12.9	15.4	11.3	5
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	5
Iron as Fe	µg/L	APHA 3125B	697	758	434	5
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND	5
*Zinc as Zn	µg/L	APHA 3125B	6.60	14.4	5.57	5
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	0.2
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	5
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	5
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	5
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	5
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	5
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	5
*Metals in Total	µg/L	By Calculation	6.60	14.4	5.57	-
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	ND	ND	ND	0.1
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	ND	ND	0.1

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition

1. LOR = Limit of Reporting.

2. ND = Not Detected. The result is less than the LOR.



TEST REPORT

Our Reference No. : **R240 8118**
Project Code / Ref. : Yishun

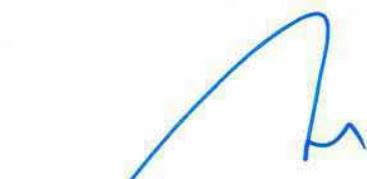
Date Received : 23/09/2024
Date Commenced : 23/09/2024
Date Reported : 02/10/2024

Customer Ref. No. : -
Customer Name : CH2M (Jacobs)
Customer Address : 150 Beach Road
Gateway West 34th Floor
Singapore 189720

Attention To : Mr Lester Teh

Sample Description : Water Sampling carried out by MLS personnel in accordance to MLS-SOP-ES-001 Rev 4
for 10 Sampling Points

RESULTS : Refer to Page 2 to Page 4



Tan Thuan Piang
Senior Technical Manager

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R240 8118

RESULTS

Test Parameter	Unit	Test Method	WQ1 WWS	WQ2 WWS	WQ3 WWS	WQ4 WWS
			23/09/2024, 1700hrs	23/09/2024, 1653hrs	23/09/2024, 1647hrs	23/09/2024, 1640hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	29.6	29.5	29.1	29.8
pH value (In-situ)	-		7.92	10.7	8.84	7.07
Conductivity	µS/cm		108	232	142	213
Dissolved Oxygen as DO	mg/L		7.15	6.66	7.13	5.65
Turbidity	NTU		39.3	308	67.4	31.2
Salinity	ppt		0.05	0.11	0.07	0.10
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	5.85	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	44	20	ND
Total Alkalinity	mg/L	APHA 2320B	34.0	146	41.0	44.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.27	0.31	0.17	0.12
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	0.87	1.34	1.13	1.16
Total Organic Carbon, TOC	mg/L	APHA 5310B	4.59	8.99	4.56	4.33
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.36	0.54	0.70	0.68
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.069	0.034	ND	0.10
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.036	0.10	0.046	0.051
Total Dissolved Solids, TDS	mg/L	APHA 2540C	66.0	121	93.0	136
Total Suspended Solids, TSS	mg/L	APHA 2540D	19.8	315	36.2	23.6
Enterococci	cfu/100mL	APHA 9230C	1,600	2,800	2,400	2,300
Arsenic as As	µg/L	APHA 3125B	19.8	17.1	12.2	15.4
Barium as Ba	µg/L	APHA 3125B	18.1	28.3	20.2	22.7
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	ND
Boron as B	µg/L	APHA 3125B	23.6	29.9	26.3	30.5
Manganese as Mn	µg/L	APHA 3125B	10.9	18.3	9.02	14.1
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	851	1,871	875	876
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	12.7	25.4	19.7	12.0
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	6.90	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	13.7	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	ND
*Metals in Total	µg/L	By Calculation	12.7	45.9	19.7	12.0
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	0.34	1.29	0.34	0.14
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	0.18	0.98	0.25	0.13

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition, 2023)
1. LOR = Limit of Reporting.
2. ND = Not Detected. The result is less than the LOR.



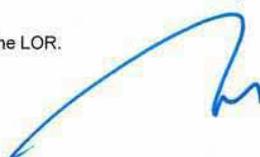
R240 8118

RESULTS

Test Parameter	Unit	Test Method	WQ5 WWS	WQ6 WWS	WQ7 WWS
			23/09/2024, 1634hrs	23/09/2024, 1626hrs	23/09/2024, 1620hrs
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	29.2	29.2	28.9
pH value (In-situ)	-		6.78	6.86	6.84
Conductivity	µS/cm		223	195	221
Dissolved Oxygen as DO	mg/L		5.26	6.36	5.91
Turbidity	NTU		14.2	23.5	22.4
Salinity	ppt		0.11	0.09	0.11
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	ND
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	ND
Total Alkalinity	mg/L	APHA 2320B	45.0	49.0	49.0
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.14	0.12	0.12
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.20	1.24	1.46
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.25	3.19	3.38
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.74	0.75	0.94
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.11	0.16	0.21
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.046	0.049	0.056
Total Dissolved Solids, TDS	mg/L	APHA 2540C	146	128	145
Total Suspended Solids, TSS	mg/L	APHA 2540D	ND	17.0	10.0
Enterococci	cfu/100mL	APHA 9230C	1,200	1,000	1,900
Arsenic as As	µg/L	APHA 3125B	15.9	17.4	17.8
Barium as Ba	µg/L	APHA 3125B	25.0	24.1	24.7
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND
Boron as B	µg/L	APHA 3125B	23.0	21.7	20.1
Manganese as Mn	µg/L	APHA 3125B	23.4	25.6	32.4
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND
Iron as Fe	µg/L	APHA 3125B	796	883	1,028
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND
*Zinc as Zn	µg/L	APHA 3125B	10.5	26.2	16.1
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND
*Metals in Total	µg/L	By Calculation	10.5	26.2	16.1
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	ND	0.35	ND
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	ND	0.18	ND

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition, 2023)
1. LOR = Limit of Reporting.
2. ND = Not Detected. The result is less than the LOR.



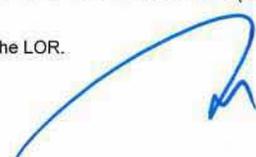
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RESULTS

Test Parameter	Unit	Test Method	WQ8 WWS	WQ9 WWS	WQ10 WWS	LOR
			23/09/2024, 1615hrs	23/09/2024, 1610hrs	23/09/2024, 1605hrs	
Temperature (In-situ)	°C	MLS-SOP-ES-004 using Multi-parameter	29.5	29.6	30.1	-
pH value (In-situ)	-		6.90	9.92	7.43	-
Conductivity	µS/cm		176	184	175	-
Dissolved Oxygen as DO	mg/L		6.22	6.29	6.50	-
Turbidity	NTU		22.0	20.8	22.3	-
Salinity	ppt		0.08	0.09	0.08	-
Biochemical Oxygen Demand, BOD5	mg/L	APHA 5210B	ND	ND	7.89	2
Chemical Oxygen Demand, COD	mg O2/L	HACH Method 8000 (Jul 2021)	ND	ND	33	20
Total Alkalinity	mg/L	APHA 2320B	48.0	47.0	44.0	20
Total Phosphorus as TP	mg/L	APHA 4500-P (J)	0.13	0.17	0.11	0.01
Total Nitrogen as TN	mg/L	APHA 4500-P (J)	1.08	1.12	1.26	0.01
Total Organic Carbon, TOC	mg/L	APHA 5310B	3.58	3.55	7.10	1
Nitrate as NO3-N	mg/L	APHA 4500-NO3 (I)	0.47	0.40	0.17	0.015
Ammonia as NH3-N	mg/L	APHA 4500-NH3 (H)	0.22	0.25	ND	0.01
Orthophosphate as PO4-P	mg/L	APHA 4500-P (G)	0.050	0.067	0.043	0.025
Total Dissolved Solids, TDS	mg/L	APHA 2540C	114	119	116	10
Total Suspended Solids, TSS	mg/L	APHA 2540D	12.4	13.8	18.2	10
Enterococci	cfu/100mL	APHA 9230C	1,400	2,000	900	1
Arsenic as As	µg/L	APHA 3125B	17.8	18.1	15.0	5
Barium as Ba	µg/L	APHA 3125B	21.1	20.7	17.6	5
Tin as Sn	µg/L	APHA 3125B	ND	ND	ND	5
Boron as B	µg/L	APHA 3125B	22.1	21.5	24.4	5
Manganese as Mn	µg/L	APHA 3125B	28.8	24.2	12.7	5
Beryllium as Be	µg/L	APHA 3125B	ND	ND	ND	5
Iron as Fe	µg/L	APHA 3125B	894	835	537	5
*Lead as Pb	µg/L	APHA 3125B	ND	ND	ND	5
*Zinc as Zn	µg/L	APHA 3125B	11.1	10.6	5.31	5
*Mercury as Hg	µg/L	USEPA 245.1 (FIMS) (1994)	ND	ND	ND	0.2
*Cadmium as Cd	µg/L	APHA 3125B	ND	ND	ND	5
*Chromium as Cr (trivalent and hexavalent)	µg/L	APHA 3125B	ND	ND	ND	5
*Copper as Cu	µg/L	APHA 3125B	ND	ND	ND	5
*Nickel as Ni	µg/L	APHA 3125B	ND	ND	ND	5
*Selenium as Se	µg/L	APHA 3125B	ND	ND	ND	5
*Silver as Ag	µg/L	APHA 3125B	ND	ND	ND	5
*Metals in Total	µg/L	By Calculation	11.1	10.6	5.31	-
Oil & Grease (Total)	mg/L	Accredited In-house Method MLS-SOP-WQ-033 Rev 0 (adapted from APHA 5520C)	0.34	0.64	0.72	0.1
Oil & Grease (Hydrocarbon)	mg/L	APHA 5520F	0.14	0.11	0.13	0.1

Note:

1. APHA is a Standard Method for Determination of Water and Wastewater (APHA 24th Edition, ;2023)
1. LOR = Limit of Reporting.
2. ND = Not Detected. The result is less than the LOR.



Appendix 5A. Faunal Survey Data

Date	Cycle	Sampling point	Latitude	Longitude	Time	Taxon	Scientific name	Common name	Global status	National status	Quantity	Observation type	Survey method
9/24/2024	1	AQ1	1.41338	103.83072	7:42:00 PM	Fish	<i>Demogenys collettei</i>	Greater glass-halfback	Least Concern	Near Threatened	24	Seen	Targeted
9/24/2024	1	AQ1	1.41338	103.83072	7:42:00 PM	Fish	<i>Gobiopetrus brachypterus</i>	Sunda pygmy halfback	Data Deficient	Near Threatened	3	Seen	Targeted
9/24/2024	1	AQ1	1.41338	103.83072	7:42:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	Least Concern	Not Evaluated	13	Seen	Targeted
9/24/2024	1	AQ1	1.41338	103.83072	7:42:00 PM	Decapod	<i>Cardina</i> sp.	NA	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ1	1.41338	103.83072	7:42:00 PM	Amphibian	<i>Fijervarya limnocharis</i>	Field frog	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ2	1.41362	103.83019	8:02:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ2	1.41362	103.83019	8:02:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	7	Seen	Targeted
9/24/2024	1	AQ2	1.41362	103.83019	8:02:00 PM	Fish	<i>Channa striata</i>	Common snakehead	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ2	1.41362	103.83019	8:02:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	3	Seen	Targeted
9/24/2024	1	NA	1.413803	103.829568	8:13:00 PM	Amphibian	<i>Fijervarya limnocharis</i>	Field frog	NA	NA	1	Seen	Incidental
9/24/2024	1	NA	1.414341	103.828318	8:17:00 PM	Amphibian	<i>Limnonectes bythi</i>	Malayan giant frog	NA	NA	1	Seen	Incidental
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	11	Seen	Targeted
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	15	Seen	Targeted
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	5	Seen	Targeted
9/24/2024	1	AQ6	1.41438	103.82833	8:18:00 PM	Reptile	<i>Dendrelaphis pictus</i>	Painted bronzeback	NA	NA	2	Seen	Targeted
9/24/2024	1	AQ5	1.41422	103.8288	8:31:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	5	Seen	Targeted
9/24/2024	1	AQ5	1.41422	103.8288	8:31:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	2	Seen	Targeted
9/24/2024	1	AQ5	1.41422	103.8288	8:31:00 PM	Amphibian	<i>Sylviana guentheri</i>	Guenther's frog	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ5	1.41422	103.8288	8:31:00 PM	Fish	<i>Ostochilus vittatus</i>	Hasselt's bony-tipped barb	NA	NA	1	Seen	Targeted
9/24/2024	1	NA	1.414461	103.828991	8:51:00 PM	Fish	<i>Channa striata</i>	Common snakehead	NA	NA	1	Seen	Incidental
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	8	Seen	Targeted
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	8	Seen	Targeted
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	3	Seen	Targeted
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Aplocheilichthys</i>	Whitespot	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ7	1.41444	103.82778	8:51:00 PM	Fish	<i>Puntius parvipetazona</i>	Malayan tiger barb	NA	NA	1	Seen	Targeted
9/24/2024	1	NA	1.414224	103.827921	9:05:00 PM	Amphibian	<i>Kalcula pulchra</i>	Banded bull frog	NA	NA	1	Seen	Incidental
9/24/2024	1	AQ9	1.41469	103.82678	9:18:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	5	Seen	Targeted
9/24/2024	1	AQ9	1.41469	103.82678	9:18:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	2	Seen	Targeted
9/24/2024	1	AQ9	1.41469	103.82678	9:18:00 PM	Fish	<i>Channa striata</i>	Common snakehead	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ10	1.41497	103.82626	9:27:00 PM	Amphibian	<i>Limnonectes bythi</i>	Malayan giant frog	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ10	1.41497	103.82626	9:27:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	7	Seen	Targeted
9/24/2024	1	AQ10	1.41497	103.82626	9:27:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	3	Seen	Targeted
9/24/2024	1	AQ11	1.41531	103.82569	9:47:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	2	Seen	Targeted
9/24/2024	1	AQ11	1.41531	103.82569	9:47:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ11	1.41531	103.82569	9:47:00 PM	Amphibian	<i>Limnonectes bythi</i>	Malayan giant frog	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ11	1.41531	103.82569	9:47:00 PM	Reptile	<i>Dendrelaphis pictus</i>	Painted bronzeback	NA	NA	1	Seen	Targeted
9/24/2024	1	AQ12	1.4156	103.82519	10:08:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	5	Seen	Targeted
9/24/2024	1	AQ14	1.41606	103.82412	10:26:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	3	Seen	Targeted
9/24/2024	1	AQ14	1.41606	103.82412	10:26:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	40	Seen	Targeted
9/24/2024	1	AQ14	1.41606	103.82412	10:26:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	12	Seen	Targeted
9/24/2024	1	AQ14	1.41606	103.82412	10:26:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	12	Seen	Targeted
10/3/2024	2	AQ1	1.41338	103.83072	8:50:00 AM	Reptile	<i>Trachemys scripta</i>	Red-eared slider	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ1	1.41338	103.83072	9:16:00 AM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ1	1.41338	103.83072	9:16:00 AM	Decapod	<i>Cardina</i> sp.	NA	NA	1	Seen	Targeted	
10/3/2024	2	AQ6	1.41438	103.82833	9:30:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ6	1.41438	103.82833	9:30:00 AM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	5	Seen	Targeted
10/3/2024	2	AQ6	1.41438	103.82833	9:30:00 AM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ7	1.41444	103.82778	9:42:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	4	Seen	Targeted
10/3/2024	2	AQ7	1.41444	103.82778	9:42:00 AM	Odonata	<i>Neurothemis fluctans</i>	Common scarlet	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ7	1.41444	103.82778	9:42:00 AM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	2	Seen	Targeted
10/3/2024	2	AQ7	1.41444	103.82778	9:42:00 AM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	40	Seen	Targeted
10/3/2024	2	AQ7	1.41444	103.82778	9:42:00 AM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	5	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Odonata	<i>Crocothemis servilla</i>	Common scarlet	NA	NA	10	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	10	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	32	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Odonata	<i>Rhyothemis phyllis</i>	Yellow-barred flutterer	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Fish	<i>Aplocheilichthys</i>	Whitespot	NA	NA	4	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Odonata	<i>Neurothemis fluctans</i>	Common scarlet	NA	NA	4	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	2	Seen	Targeted
10/3/2024	2	AQ8	1.41456	103.82721	10:08:00 AM	Odonata	<i>Brachypteryx chalybea</i>	Blue dasher	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ9	1.41469	103.82678	10:10:00 AM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	8	Seen	Targeted
10/3/2024	2	AQ9	1.41469	103.82678	10:10:00 AM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	5	Seen	Targeted
10/3/2024	2	AQ9	1.41469	103.82678	10:10:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ9	1.41469	103.82678	10:10:00 AM	Odonata	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ11	1.41531	103.82569	10:38:00 AM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	12	Seen	Targeted
10/3/2024	2	AQ11	1.41531	103.82569	10:38:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	2	Seen	Targeted
10/3/2024	2	AQ12	1.4156	103.82519	10:38:00 AM	Butterfly	<i>Odia hieroglyphica orina</i>	Hieroglyphic flat	NA	NA	1	Seen	Incidental
10/3/2024	2	AQ12	1.4156	103.82519	10:50:00 AM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	30	Seen	Targeted
10/3/2024	2	AQ12	1.4156	103.82519	10:50:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	2	Seen	Targeted
10/3/2024	2	AQ13	1.41575	103.82483	11:02:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	2	Seen	Targeted
10/3/2024	2	AQ14	1.41606	103.82412	11:11:00 AM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	15	Seen	Targeted
10/3/2024	2	AQ14	1.41606	103.82412	11:11:00 AM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	25	Seen	Targeted
10/3/2024	2	AQ14	1.41606	103.82412	11:11:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	1	Seen	Targeted
10/3/2024	2	AQ14	1.41606	103.82412	11:11:00 AM	Fish	<i>Rhinogobius smlis</i>	Barcheek river-goby	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	21	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	8	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Fish	<i>Gobiopetrus brachypterus</i>	Greater glass-goby	NA	NA	7	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ1	1.41338	103.83072	7:39:00 PM	Amphibian	<i>Limnonectes bythi</i>	Malayan giant frog	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ2	1.41362	103.83019	8:00:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	22	Seen	Targeted
10/1/2024	2	AQ2	1.41362	103.83019	8:00:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	40	Seen	Targeted
10/1/2024	2	AQ2	1.41362	103.83019	8:00:00 PM	Fish	<i>Monopterus albus</i>	Oriental swamp eel	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ2	1.41362	103.83019	8:00:00 PM	Fish	<i>Gambusia affinis</i>	Mosquitofish	NA	NA	15	Seen	Targeted
10/1/2024	2	AQ3	1.41384	103.82971	8:59:00 PM	Fish	<i>Barbodes rhombeus</i>	Indonesian spotted barb	NA	NA	1	Seen	Targeted
10/1/2024	2	AQ3	1.41384	103.82971	8:59:00 PM	Decapod	<i>Cardina johnsoni</i>	Johnson's shrimp	NA	NA	2	Seen	Targeted
10/1/2024	2	AQ3	1.41384	103.82971	8:59:00 PM	Fish	<i>Rasbora borapensis</i>	Red-tailed rasbora	NA	NA	8	Seen	Targeted
10/1/2024	2	AQ3	1.41384	103.82971	8:59:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfback	NA	NA	14	Seen	Targeted
10/1/2024	2	AQ3	1.41384	103.82971	8:59:00 PM								

Date	Cycle	Sampling point	Latitude	Longitude	Time	Taxon	Scientific name	Common name	Global status	National status	Quantity	Observation type	Survey method
10/2/2024	1	AQ6	1.41438	103.82833	12:55:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfbeak	NA	NA	5	Seen	Targeted
10/2/2024	1	AQ7	1.41444	103.82778	9:59:00 AM	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	NA	NA	3	Seen	Targeted
10/2/2024	1	AQ7	1.41444	103.82778	9:59:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	5	Seen	Targeted
10/2/2024	1	AQ7	1.41444	103.82778	9:59:00 AM	Odonata	<i>Agrocnemis femina</i>	Variable whisp	NA	NA	2	Seen	Targeted
10/2/2024	1	AQ7	1.41444	103.82778	12:16:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfbeak	NA	NA	2	Seen	Targeted
10/2/2024	1	AQ7	1.41444	103.82778	12:16:00 PM	Fish	<i>Rhinogobius similis</i>	Barcheek river-goby	NA	NA	3	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Brachyptilax chalybea</i>	Blue diasher	NA	NA	12	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	NA	NA	10	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	4	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Rhyothemis phyllis</i>	Yellow-barred fluterer	NA	NA	7	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Crocotermis servilla</i>	Common scarlet	NA	NA	10	Seen	Targeted
10/2/2024	1	AQ8	1.41456	103.82721	10:25:00 AM	Odonata	<i>Trithemis aurora</i>	Crimson drowping	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ9	1.41469	103.82678	10:42:00 AM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	2	Seen	Targeted
10/2/2024	1	AQ9	1.41469	103.82678	10:42:00 AM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ9	1.41469	103.82678	10:42:00 AM	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ11	1.41531	103.82569	11:05:00 AM	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	NA	NA	3	Seen	Targeted
10/2/2024	1	AQ11	1.41531	103.82569	11:05:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	4	Seen	Targeted
10/2/2024	1	AQ11	1.41531	103.82569	11:05:00 AM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	3	Seen	Targeted
10/2/2024	1	AQ11	1.41531	103.82569	11:05:00 AM	Odonata	<i>Agrocnemis femina</i>	Variable whisp	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ11	1.41531	103.82569	11:05:00 AM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	4	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	4	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Odonata	<i>Orthemis testaceum</i>	Scarlet skimmer	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Odonata	<i>Neurothemis fluctuans</i>	Common parasol	NA	NA	3	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Odonata	<i>Rhodotermis rufa</i>	Common redbot	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	40	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Decapod	<i>Cardina sp.</i>	N.A	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Decapod	<i>Macrobrachium lanchesteri</i>	Roseland shrimp	NA	NA	6	Seen	Targeted
10/2/2024	1	AQ12	1.4156	103.82519	11:21:00 AM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	7	Seen	Targeted
10/2/2024	1	AQ13	1.41575	103.82483	11:40:00 AM	Odonata	<i>Crocotermis servilla</i>	Common scarlet	NA	NA	2	Seen	Targeted
10/2/2024	1	AQ13	1.41575	103.82483	11:40:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	2	Seen	Targeted
10/2/2024	1	AQ14	1.41606	103.82412	11:51:00 AM	Odonata	<i>Pseudagrion microcephalum</i>	Blue sprite	NA	NA	1	Seen	Targeted
10/2/2024	1	AQ14	1.41606	103.82412	11:51:00 AM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	30	Seen	Targeted
10/2/2024	1	AQ14	1.41606	103.82412	11:51:00 AM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	27	Seen	Targeted
10/2/2024	2	AQ8	1.41456	103.82721	8:15:00 PM	Amphibian	<i>Sylvirana guentheri</i>	Guenther's frog	NA	NA	5	Heard	Targeted
10/2/2024	2	AQ8	1.41456	103.82721	8:15:00 PM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	4	Seen	Targeted
10/2/2024	2	AQ8	1.41456	103.82721	8:15:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ8	1.41456	103.82721	8:15:00 PM	Fish	<i>Demogenys collettei</i>	Sunda pygmy halfbeak	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Amphibian	<i>Limnodynastes bythii</i>	Malayan giant frog	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	10	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Fish	<i>Rasbora borapetensis</i>	Red-tailed rasbora	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Fish	<i>Gobiopertus brachypterus</i>	Greater glass-goby	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Amphibian	<i>Hylarana erythraea</i>	Green paddy frog	NA	NA	1	Heard	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Amphibian	<i>Microhyla heymonsi</i>	Dark-sided chorus frog	NA	NA	1	Heard	Targeted
10/2/2024	2	AQ9	1.41469	103.82678	8:27:00 PM	Reptile	<i>Dendrelaphis pictus</i>	Painted bronzeback	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ11	1.41531	103.82569	8:50:00 PM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	8	Seen	Targeted
10/2/2024	2	AQ11	1.41531	103.82569	8:50:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	13	Seen	Targeted
10/2/2024	2	AQ11	1.41531	103.82569	8:50:00 PM	Amphibian	<i>Sylvirana guentheri</i>	Guenther's frog	NA	NA	1	Heard	Targeted
10/2/2024	2	AQ12	1.4156	103.82519	9:18:00 PM	Fish	<i>Oreochromis sp.</i>	N.A	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ12	1.4156	103.82519	9:18:00 PM	Amphibian	<i>Sylvirana guentheri</i>	Guenther's frog	NA	NA	1	Heard	Targeted
10/2/2024	2	AQ12	1.4156	103.82519	9:18:00 PM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	NA	NA	13	Seen	Targeted
10/2/2024	2	AQ12	1.4156	103.82519	9:18:00 PM	Fish	<i>Barborymms schwanefeldi</i>	Stripe-tailed infol barb	NA	NA	2	Seen	Targeted
10/2/2024	2	AQ12	1.4156	103.82519	9:18:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	7	Seen	Targeted
10/2/2024	2	AQ13	1.41575	103.82483	9:30:00 PM	Amphibian	<i>Sylvirana guentheri</i>	Guenther's frog	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ13	1.41575	103.82483	9:30:00 PM	Reptile	<i>Trachemys scripta</i>	Red-eared slider	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ13	1.41575	103.82483	9:30:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Gobiopertus brachypterus</i>	Greater glass-goby	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Oxyeleotris marmorata</i>	Marbled goby	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Channa Sp.</i>	N.A	NA	NA	1	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Poecilia reticulata</i>	Guppy	Least Concern	Not Evaluated	TMTC	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Barbodes rhombeus</i>	Indochinese spotted barb	Least Concern	Not Evaluated	2	Seen	Targeted
10/2/2024	2	AQ14	1.41606	103.82412	9:45:00 PM	Fish	<i>Barborymms schwanefeldi</i>	Stripe-tailed infol barb	Least Concern	Not Evaluated	3	Seen	Targeted

TTC - Too many to count

Date	Cycle	Survey type	Transect/ Survey point	Taxa	Time in	Time out	Surveyors	Weather (Clear/cloudy/rain)
24/9/2024	1	Aquatic (PM)	AQ1-AQ14	Aquatic	7:42:00 PM	10:40PM	AH JT VL IK	Cloudy
1/10/2024	2	Aquatic (PM)	AQ1-AQ7	Aquatic	7:30:00 PM	10:00:00 PM	AH VL DY IK	Clear
2/10/2024	1	Aquatic (AM)	AQ1-AQ14	Aquatic	9:00:00 AM	2:15:00 PM	AH SS RN	Clear
2/10/2024	2	Aquatic (PM)	AQ8-AQ14	Aquatic	8:10:00 PM	10:00:00 PM	AH SS DY	Clear
3/10/2024	2	Aquatic (AM)	AQ1-AQ14	Aquatic	9:10:00 AM	11:20:00 AM	JT IK Tang	Clear

Appendix 5B. List of Recorded Faunal Species and Probable Species of Conservation Significance

Faunal group	Total no. of recorded species		No. of probable CS species
	All species	CS species	
Odonata	9	0	1
Dragonfly	7	0	0
Damselfly	2	0	1
Herpetofauna	10	0	5
Amphibian	8	0	0
Reptile	2	0	5
Freshwater Decapod Crustacean	2	0	0
Fish	17	0	2
Butterfly	1	0	NA
Mammal	2	1	w
Total	41	1	9

*butterflies and mammals are not targeted taxa, hence probable CS species were not assessed

No.	Type	Family	Scientific Name	Common Name	Global Status (IUCN/CITES)	National Status (NParks, 2024)	Species of Conservation Significance	Distribution/Rarity (Figueroa et al., 2023)	Native Status (Figueroa et al., 2023)	Recorded Species	Ecological value
1	Dragonfly	Coenagrionidae	<i>Agriocnemis femina</i>	Variable wisp	Least Concern	Least Concern	No	Widespread but Uncommon	Native	Yes	Medium
2	Dragonfly	Coenagrionidae	<i>Pseudagrion microcephalum</i>	Blue sprite	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
3	Dragonfly	Coenagrionidae	<i>Pseudagrion pruininum</i>	Grey sprite	Least Concern	Vulnerable	Yes	Restricted but Common	Native	No	High
4	Damselfly	Libellulidae	<i>Neurothemis fluctuans</i>	Common parasol	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
5	Damselfly	Libellulidae	<i>Crocothemis virvilia</i>	Common scarlet	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
6	Damselfly	Libellulidae	<i>Rhyothemis phyllis</i>	Yellow-barred flutterer	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
7	Dragonfly	Libellulidae	<i>Brachydiplax chalybea</i>	Blue dasher	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
8	Dragonfly	Libellulidae	<i>Trithemis aurora</i>	Crimson drowping	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
9	Dragonfly	Libellulidae	<i>Orthemis testaceum</i>	Scarlet skimmer	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
10	Dragonfly	Libellulidae	<i>Rhodothemis rufa</i>	Common redbolt	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
11	Butterfly	Hesperiidae	<i>Odina hieroglyphica ortina</i>	Hieroglyphic flat	Not Listed	Near Threatened	No	Moderately rare	Native	Yes	Medium
12	Fish	Apocheilidae	<i>Apocheilichthys armatus</i>	Whitespot	Not Listed	Least Concern	No	Not Evaluated	Native	Yes	Medium
13	Fish	Channidae	<i>Channa striata</i>	Common snakehead/aruan	Least Concern	Least Concern	No	Not Evaluated	Native	Yes	Medium
14	Fish	Cichlidae	<i>Cichlasoma hybrid</i>	Flowerhorn cichlid	Not Listed	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
15	Fish	Cichlidae	<i>Oreochromis niloticus</i>	Nile tilapia	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
16	Fish	Cichlidae	<i>Oreochromis mossambicus</i>	Mozambique tilapia	Vulnerable	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
17	Fish	Cyprinidae	<i>Barbodes rhombeus</i>	Indochinese spotted barb	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
18	Fish	Cyprinidae	<i>Barbonymus microstomus</i>	Stripe-tailed tinfin barb	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
19	Fish	Cyprinidae	<i>Osteochilus vittatus</i>	Hasselt's bony-lipped barb	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
20	Fish	Cyprinidae	<i>Puntigrus partipentazona</i>	Malayan tiger barb	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
21	Fish	Cyprinidae	<i>Rasbora borapetensis</i>	Red-tailed rasbora	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
22	Fish	Eleotridae	<i>Oxyeleotris marmorata</i>	Marbled goby	Least Concern	Near Threatened	No	Not Evaluated	Non-native	Yes	Low
23	Fish	Gobiidae	<i>Gobiopetrus brachypterus</i>	Greater glass-goby	Data Deficient	Near Threatened	No	Not Evaluated	Native	Yes	Medium
24	Fish	Gobiidae	<i>Rhinogobius similis</i>	Barcheek river-goby	Least Concern	Least Concern	No	Not Evaluated	Non-native	Yes	Low
25	Fish	Osphronemidae	<i>Betta imbellis</i>	Crescent betta	Least Concern	Endangered	Yes	Not Evaluated	Native	No	High
26	Fish	Osphronemidae	<i>Trichopodus trichopterus</i>	Threespot gourami	Least Concern	Vulnerable	Yes	Not Evaluated	Native	No	High
27	Fish	Poeciliidae	<i>Gambusia affinis</i>	Mosquitofish	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
28	Fish	Poeciliidae	<i>Poecilia reticulata</i>	Guppy	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
29	Fish	Synbranchidae	<i>Monopterus javanensis</i>	Sunda swamp eel	Least Concern	Least Concern	No	Not Evaluated	Native	Yes	Medium
30	Fish	Zenarchopteridae	<i>Dermogenys collettei</i>	Sunda pygmy halfbeak	Least Concern	Least Concern	No	Not Evaluated	Native	Yes	Medium
31	Crustacean	Atyidae	<i>Caridina johnsoni</i>	Johnson's shrimp	Least Concern	Not Evaluated	No	Not Evaluated	Native	Yes	Medium
32	Crustacean	Palaemonidae	<i>Macrobrachium lancesteri</i>	Riceland shrimp	Least Concern	Not Evaluated	No	Not Evaluated	Non-native	Yes	Low
33	Frog	Dicroglossidae	<i>Limnonectes blythii</i>	Malayan giant frog	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
34	Frog	Microhylidae	<i>Kaloula pulchra</i>	Banded bull frog	Least Concern	NA	No	Ubiquitous and Common	Non-native	Yes	Low
35	Frog	Microhylidae	<i>Microhyla heymonsi</i>	Dark-sided chorus frog	Least Concern	Least Concern	No	Ubiquitous and Common	Native	Yes	Medium
36	Frog	Ranidae	<i>Hylarana erythraea</i>	Green paddy frog	Least Concern	Least Concern	No	Wide-ranging but Uncommon	Native	Yes	Medium
37	Frog	Ranidae	<i>Sylvirana quentheri</i>	Guenther's frog	Least Concern	NA	No	Widespread but Uncommon	Non-native	Yes	Low
38	Frog	Dicroglossidae	<i>Fejervarya cancrivora</i>	Crab-eating frog	Least Concern	Least Concern	No	Ubiquitous and Common	Native	Yes	Medium
39	Frog	Microhylidae	<i>Microhyla mukhesuri</i>	Mukhesur's chorus frog	Least Concern	NA	No	Ubiquitous and Common	Non-native	Yes	Low
40	Toad	Dicroglossidae	<i>Fejervarya limnocharis</i>	Field frog	Least Concern	Least Concern	No	Ubiquitous and Common	Native	Yes	Medium
41	Reptiles	Colubridae	<i>Dendrelaphis pictus</i>	Painted bronzeback	Least Concern	Least Concern	No	Widespread and Common	Native	Yes	Medium
42	Reptiles	Colubridae	<i>Sibynophis melanoccephalus</i>	Black-headed collared snake	Least Concern	Vulnerable	Yes	Wide-ranging but Uncommon	Native	No	High
43	Reptiles	Cylindrophidae	<i>Cylindrophis ruffus</i>	Red-tailed pipe snake	Least Concern	Vulnerable	Yes	Widespread but Rare	Native	No	High
44	Reptiles	Emydidae	<i>Trachemys scripta</i>	Red-eared slider	Least Concern	NA	No	Ubiquitous and Common	Non-native	Yes	Low
45	Reptiles	Geomydidae	<i>Cuora cuora</i>	Malayan box terrapin	Endangered	Near Threatened	Yes	Wide-ranging and Common	Native	No	High
46	Reptiles	Homalopsidae	<i>Homalopsis buccata</i>	Puff-faced water snake	Least Concern	Vulnerable	Yes	Wide-ranging but Uncommon	Native	No	High
47	Reptiles	Trionychidae	<i>Amyda cartilaginea</i>	Asian softshell turtle	Endangered	Near Threatened	Yes	Restricted and Uncommon	Native	No	High
48	Mammals	Cercopithecidae	<i>Macaca fascicularis</i>	Long-tailed macaque	Endangered	Least Concern	Yes	Widespread and Common	Native	Yes	High
49	Mammals	Viverridae	<i>Paradoxurus musangus</i>	Sumatran palm civet	Least Concern	Least Concern	No	Widespread but Uncommon	Native	Yes	Medium

Appendix 5C. Impact Assessment on Habitat Receptor

Appendix 5D. Impact Assessment for Fauna Receptor

Phase	Impact type	Taxon	Receptor	Common name	Environmental Score (pre mitigation)										Key Minimum Criteria	Impact Significance (pre-mitigation)	Mitigation Measures	Environmental Score (post mitigation)										Residual Impact Significance				
					A1	A2.1	A2.2a	A2.2b	A2.2c	A2.3	AT	B1	B2	B3				B4	BT	A1	A2.1	A2.2a	A2.2b	A2.2c	A2.3	AT	B1		B2	B3	B4	BT
Construction	Loss of production in habitats and food sources	Odonata	Pseudischnura punctulata	Grey spittle	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Amphibia	Bufo orientalis	Common toad	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Amphibia	Thymopoda sibirica	Thymopod garter	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Mammalia	Marmota sibirica	Long-tailed marmot	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Reptilia	Phrynosoma macleayi	Spiny-tailed lizard	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Reptilia	Lacerta orientalis	Common lizard	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Reptilia	Colubridae sp.	Unidentified snake	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Reptilia	Hydrophis melanocapillus	Black-headed ribbon snake	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact
Construction	Loss of production in habitats and food sources	Reptilia	Chelonia mydas	Galapagos tortoise	3	1	3	3	3	3	27	4	3	3	13	351	N/A	Major Negative Impact	N/A	3	1	3	3	3	3	27	4	3	3	13	351	Minor Negative Impact