Contract 9175

Advance Engineering Study for the Proposed Downtown Line 2 Extension and a New Station on Existing North-South Line

Environmental Study Report
Biodiversity and Hydrology Study Report

Design Stage: Preliminary

Submitted by:
AECOM Singapore Pte Ltd

Submitted to:
Land Transport Authority

14 January 2025

Volume 3 of 5

10 Airborne Noise

10.1 Introduction

This section details the assessment of airborne noise impacts arising from noise emissions pertaining to the Project development. The study of airborne noise impacts will encompass both construction and operational related noise emissions to the identified ecological and human noise sensitive receptors (NSRs).

The Project site has been proposed for the siting of the DTL2e and potential future infrastructure. Project sites under consideration for airborne noise impact assessment will comprise of above-ground worksites that will contribute to airborne noise emissions during the construction and operational phases.

10.1.1 Construction Phase

Construction noise impacts will be assessed and studied in detail in this report following these key steps:

- Review baseline noise monitoring data, conduct and assess current baseline noise levels in the Airborne Noise Study Area (see Section 10.2.2);
- Identify and classify sensitivity of receptors surrounding the Project site within the Airborne Noise Study Area;
- Conduct noise impact assessment to quantitatively assess potential noise impacts arising from construction phase activities;
- Recommend minimum control and mitigation measures to be implemented; and
- Determine overall significance of residual noise impacts after implementation of mitigation measures.

10.1.2 Operational Phase

The assessment for operational noise impacts relating to air-conditioning and mechanical ventilation (ACMV) systems and land traffic will be addressed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. The relevant associated findings were extracted from the separate standalone reports and reflected in this report.

10.2 Methodology and Assumptions

This section outlines the methodology and assumptions applied to noise impact assessment conducted for the construction and operational phases of the Project.

10.2.1 Assessment Approach

As defined in the Inception Stage [O-1], impact assessment for noise emissions arising from construction and operational phases will adopt both the quantitative and qualitative approach. The study mapped out impacts from noise generated during the construction and operational stages on the NSRs. Baseline airborne noise monitoring was carried out to establish the baseline airborne noise levels to develop the specific construction and operational noise criteria for the Project to analyse the impacts on the NSRs.

10.2.1.1 Construction Phase

The quantitative means of assessment was applied to determine the impact predicted at the NSRs due to construction noise emissions, in accordance with noise legislations outlined in *Environmental Protection and Management (Control of Noise at Construction Sites) Regulations, 2008* [R-22] (EPM, 2008). While the qualitative means of assessment was applied to assess for cumulative noise impacts accounting for potential noise emissions from other concurrent developments in proximity to the Project site.

10.2.1.1.1 Rock Breaking and Excavation

As part of construction works, rock breaking and excavation has been proposed as an effective and efficient method to break down and remove rocks when common excavation techniques are not able to. At the point of time in writing this report, detailed information was not available. The rock breaking and excavation works could only be carried out by an appointed Contractor at a later stage.

Hence, the assessment approach detailed in *BSI Standards Publication, Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* [R-84] (BS5228-2:2009+A1:2014) has been adopted as the assessment criterion. Furthermore, due to the lack of information for rock breaking and excavation works specific to Singapore, the site constant was assumed based on *Australian Standard AS 2187.2-2006 Explosives – Storage and Use – Use of Explosives* [R-91] (AS 2187.2-2006).

10.2.1.2 Operational Phase

The quantitative means of assessment was applied to determine the impact predicted at the human NSRs due to operational noise emissions from ACMV systems and land traffic development associated with the Project, in accordance with noise legislations outlined in the *NEA Technical Guideline on Boundary Noise Limits for Air Conditioning and Mechanical Ventilation Systems in Non-Industrial Buildings, 2018* [R-26] (ACMV Noise Guidelines, 2018), and *NEA Technical Guideline for Land Traffic Noise Impact Assessment, 2016* [R-25] (TNIA Guidelines, 2016) respectively.

While for the assessment of operational noise impacts on ecological NSRs, the ES report has taken reference of the results presented in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report as detailed in the Inception Report [O-1].

Details on the assessment approach for operational noise impacts relating to ACMV systems and land traffic were addressed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. The relevant associated findings were extracted from the separate standalone reports and reflected in this report.

10.2.2 Study Area

Noise from construction and operational activities may be perceivable, especially to receptors in proximity and those having a direct line-of-sight to the noise sources.

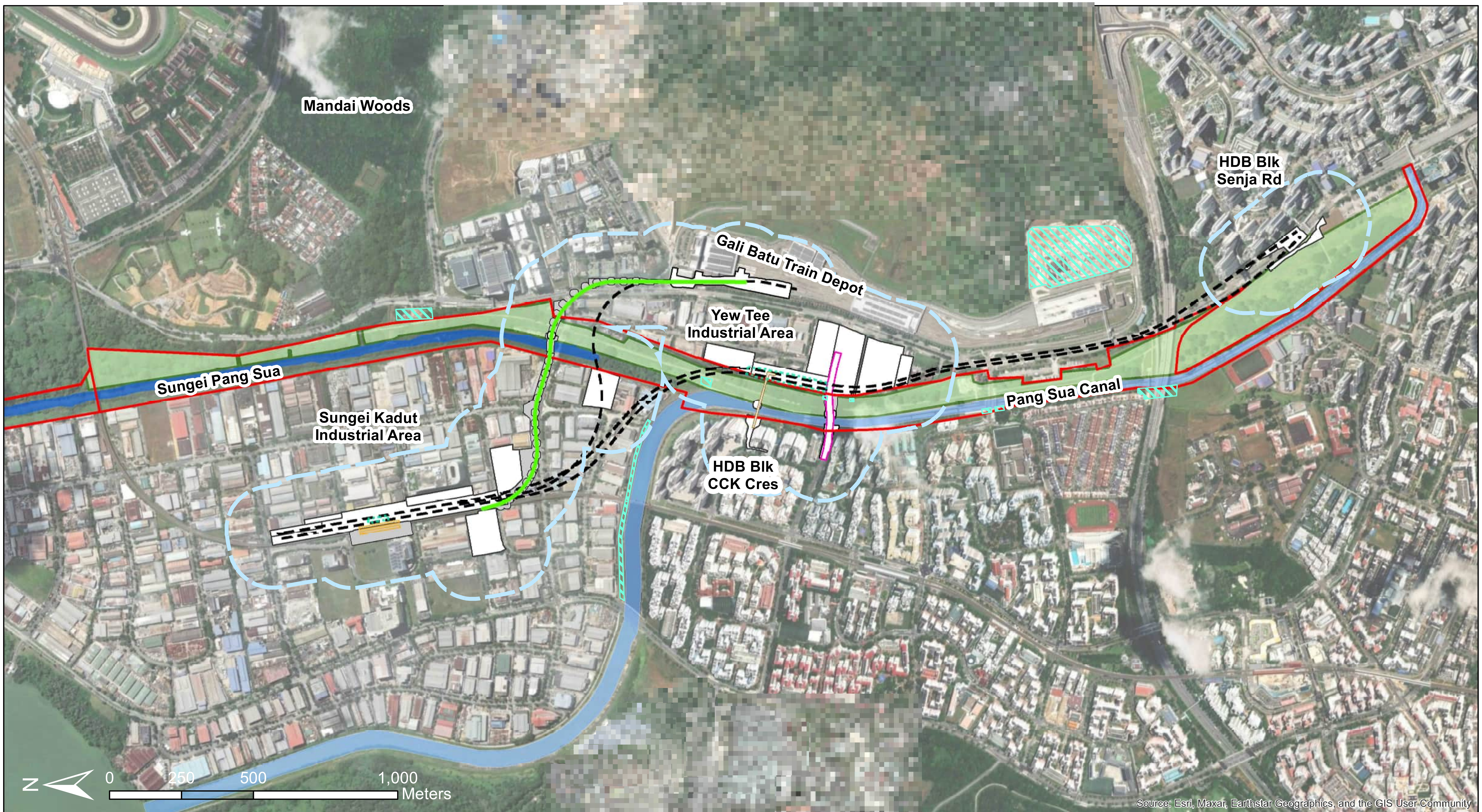
10.2.2.1 Construction Phase

The Airborne Noise Study Area, recommended as 150 m from the proposed construction worksites, was established in accordance with EPM, 2008 [R-22] to identify the human NSRs potentially impacted by the construction noise emissions.

The Airborne Noise Study Area was extended to include the Biodiversity Study Area, demarcating the Rail Corridor, Sungei Pang Sua, and the Pang Sua Canal where faunistic field surveys documented the fauna species found inhabiting or traversing the periphery of the proposed construction worksites. The inclusion of the Biodiversity Study Area is to assess for potential airborne noise impacts on mobile ecological NSRs in proximity of the construction worksites.

It should be noted the proposed construction worksites are subject to changes in accordance with the associated construction stage and required footprint (e.g., demolition, site clearance). As such, the Airborne Noise Study Area will also change in congruence with the relevant worksite footprint being assessed.

Figure 10-1 presents an example of the Airborne Noise Study Area. Refer to Section 10.3.1 for details on the construction stages selected for assessment in this study.



Legend

- Airborne Noise Study Area 150m
- Indicative Ongoing Construction
- Proposed DTL2e Tunnel Alignment
- Potential Future Infrastructure
- Proposed Cut and Cover Areas
- Proposed Elevated Vehicular Bridge
- Proposed Pedestrian Overhead Bridge
- Proposed DTL2e Stations (Underground)
- Proposed NSL Elevated Station
- Pang Sua Canal Sungei
- Pang Sua
- Biodiversity Study Area
- Existing Vegetated Area

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
AIRBORNE NOISE STUDY AREA - CONSTRUCTION PHASE

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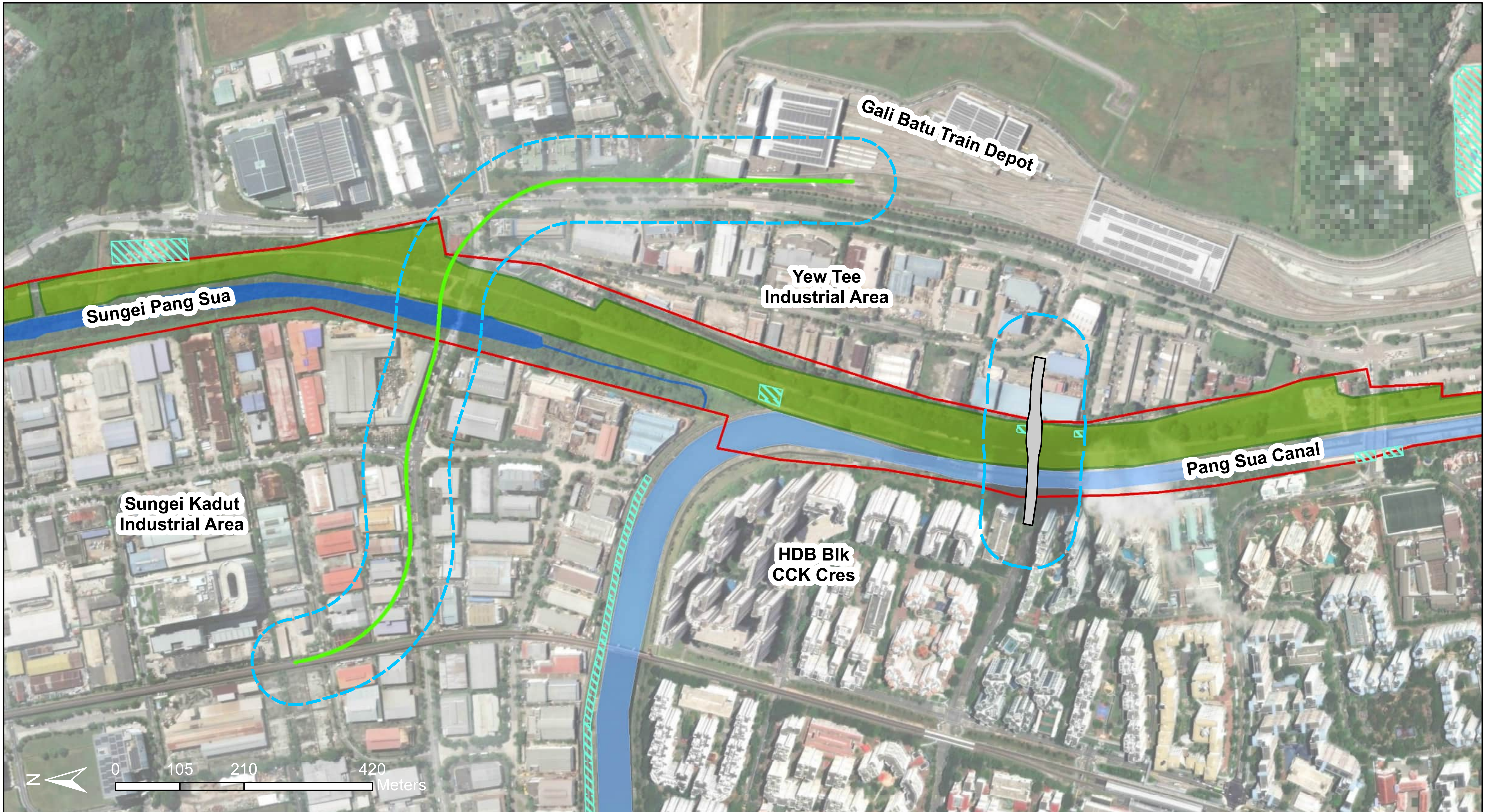
10.2.2.2 Operational Phase

For operational noise, the study areas defined in the separate standalone reports in accordance with the NEA ACMV Guideline 2018 [R-26] and TNIA Guidelines, 2016 [R-25] are extracted and reflected in Figure 10-2. The study areas for the assessment of impacts arising from activities associated with the operational phase are contributed by two (2) elements – noise from ACMV systems for non-industrial buildings within the Project Site (i.e., DTL2e underground intermediate station, above-ground station Sungei Kadut, and station interchange), and vehicular noise from new traffic networks within the Project Site (i.e., Above-ground potential future infrastructure and elevated vehicular bridge).



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- Airborne Noise Study Area 70m
- Proposed Elevated Vehicular Bridge
- Potential Future Infrastructure
- Indicative Ongoing Construction
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

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10.2.3 Baseline Airborne Noise Study

Baseline airborne noise study was conducted within the bounds of the Airborne Noise Study Area to develop an understanding of the existing ambient noise conditions experienced by the NSRs.

10.2.3.1 Desktop Assessment (Secondary Data Collection)

Desktop research consists of a review of secondary data (including existing land use and development activities, satellite images, etc.) to aid in determining the ideal baseline airborne noise monitoring locations based on the considerations detailed in Section 10.2.3.2.1. The information retrieved during the desktop research comprised of publicly available data from the government and technical agencies, existing available data, relevant articles, and other online sources.

Additionally, in an agreement between LTA and HDB on information exchange – baseline noise monitoring results and construction noise impact assessment findings from the HDB CCK N1 EIS Project [R-92] in the green area within the Biodiversity Study Area (South of KJE) have been referenced and adopted in this study.

10.2.3.2 Field Assessment (Primary Data Collection)

This section reflects the field assessment methodology used to capture the baseline airborne noise conditions in accordance with the requirements for noise impact assessment of noise emissions from the construction and operational phase (extracted from separate standalone reports) respectively.

10.2.3.2.1 Construction Phase

As part of field assessment to capture the baseline airborne noise conditions within the 150 m Airborne Noise Study Area for construction noise, a total of eleven (11) noise monitoring locations were selected with ten (10) proposed at locations in the vicinity of the proposed DTL2e and one (1) near to where the proposed potential future infrastructure would be erected (see Figure 10-3).

These locations were selected based on the following considerations to capture primary baseline data along with site reconnaissance conducted on 16 February 2021 and 21 September 2021:

- Identification of Noise Sensitive Receptors (NSRs) such as hospitals, schools, childcare facilities, old age homes, residences, fauna, and habitats of high ecological value, within the defined Airborne Noise Study Area;
- Other NSRs away from the proposed construction worksites were eliminated and not considered in this study as these receptors are assumed to be barricaded by the first row of buildings;
- NSRs with areas having ongoing construction works were avoided;
- NSRs where the owner denied permission during site walkover were excluded;
- The Biodiversity Study Area (refer to Section 7) suitable in supporting the presence of fauna – inclusive of the Rail Corridor, Sungei Pang Sua, and the Pang Sua Canal, were selected to represent the ecological NSRs;
- The closest NSR to the Project site were selected; and
- For high rise residential sensitive receptors, monitoring was conducted at different floor heights (e.g., mid-level, top level) to capture the terrain variation and its impact on noise levels.

Unattended baseline airborne noise monitoring was conducted for a period of one (1) week (inclusive of weekdays and weekends) to capture baseline noise levels over time periods of 12 hours (long-term), 1 hour, and 5 minutes (short-term) at each of the monitoring locations detailed in Table 10-1, Table 10-2, and Figure 10-3, performed to determine $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$ and $L_{Aeq(5\ mins)}$ for the time periods of 7am – 7pm, 7pm – 10pm and 10pm – 7am, in accordance with the requirements of EPM 2008 [R-22].

The NEA-approved Norsonic 131 Type 1 Sound Level Meter (SLM) were used to record the noise levels during these time periods. This information will be further discussed and used later in Section 10.2.5 to deduce the respective noise criteria applicable as part of noise impact assessment for the noise sensitive ecological and human receptors in this study. The method and findings from the baseline airborne noise monitoring are detailed in the baseline noise monitoring report in Appendix R.

Table 10-1 Baseline Airborne Noise Monitoring Locations (DTL2e) – Construction Phase

S/N	Monitoring Location	Justification	Photo of Monitoring Location
N1	Vicinity of Nexxis Asia Pte. Ltd., Sungei Kadut Street 3	Representative baseline noise monitoring location for commercial buildings along Sungei Kadut Street 2 on the West of the Study Area. The baseline noise level was dominated by the MRT trains of the nearby NSL and traffic noise along Sungei Kadut Street 2.	
N2	JTC Lot No. MK11-00541K near The Stone Gallery by Hafary, Sungei Kadut Central	Representative baseline noise monitoring location for commercial buildings along Sungei Kadut Central on the West of the Study Area. The baseline noise level was dominated by the MRT trains passing directly overhead and traffic noise along Sungei Kadut Central Road.	

S/N	Monitoring Location	Justification	Photo of Monitoring Location
N3	Vicinity of JSM Construction Group Pte Ltd facing Woodlands Road	Representative baseline noise monitoring location for commercial buildings along Woodlands Road. The baseline noise level was dominated by traffic noise along Woodlands Road.	
N4	Vicinity of HDB Block 691B facing Pang Sua Canal	Representative baseline noise monitoring location for HDB residences near Block 691B facing Pang Sua Canal.	
N5	Vicinity of commercial buildings such as Chong Timber Pte Ltd, along Rail Corridor	Representative baseline noise monitoring location for commercial buildings located along Sungei Kadut Avenue and ecological sensitive receptors along Rail Corridor.	

S/N	Monitoring Location	Justification	Photo of Monitoring Location
N6	Along Rail Corridor on side opposite and facing Windermere Residences	Representative of baseline noise monitoring location for ecological sensitive receptors along the Rail Corridor on side facing Windermere residences adjacent of Yew Tee Primary School.	
N7a	HDB Block 632A Senja Road: N7a – ground level N7b – mid-level N7c – top-level	Representative baseline noise monitoring location for residential buildings on the East of the Study Area. The baseline noise level was dominated by traffic noise along Woodlands Road.	
N7b			

S/N	Monitoring Location	Justification	Photo of Monitoring Location
N7c			
N8	Near Teck Whye Secondary School, facing the Pang Sua Canal	Representative baseline noise monitoring location for educational institutions along the Pang Sua Canal on the East of the Study Area and ecological receptors in the Pang Sua Canal and Rail Corridor.	

Table 10-2 Baseline Airborne Noise Monitoring Locations (Potential Future Infrastructure) – Construction Phase

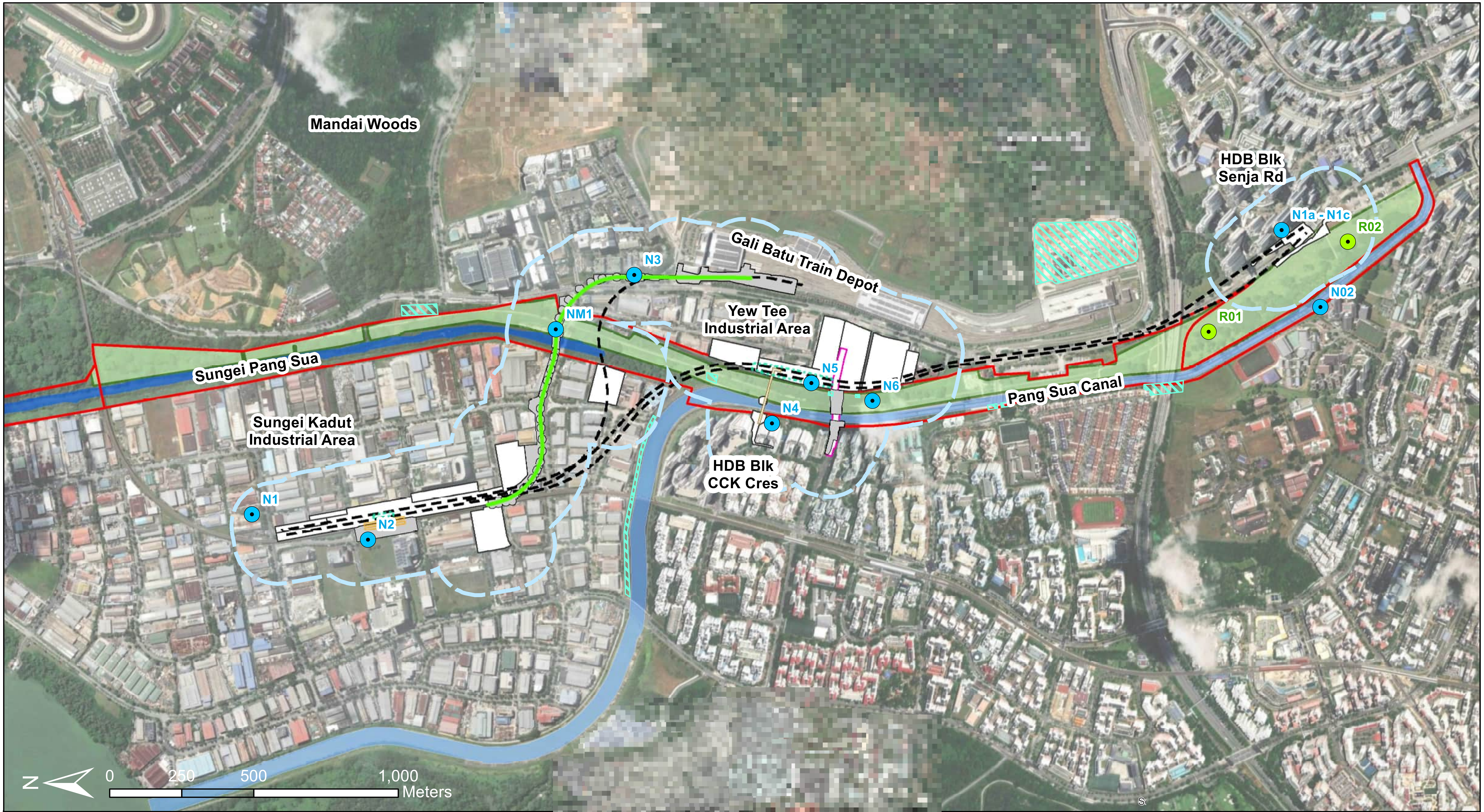
S/N	Monitoring Location	Justification	Photo of Monitoring Location
NM1	Along Rail Corridor near Sungei Kadut Avenue	Representative baseline noise monitoring location for ecological receptors along Rail Corridor and Pang Sua Canal.	

In addition, baseline airborne noise information collected for the HDB CCK N1 EIS Project [R-92] have been referenced and adopted in this study. The two (2) monitoring locations reflected in Table 10-3 presents the baseline airborne noise levels representative of the green area south of KJE and within the Biodiversity Study Area experienced by ecological NSRs.

This information will serve to supplement the baseline airborne noise levels captured for the green areas near the HDB CCK N1 EIS Worksite Areas (refer to Figure 10-3).

Table 10-3 Baseline Airborne Noise Monitoring Locations (Secondary Data, HDB CCK N1 EIS) – Construction Phase

S/N	Monitoring Location	Justification	Photo of Monitoring Location
R01	Green Area within CCK N1 EIS Study Area (Northern)	Representative baseline noise monitoring location for Green Area within the Study Area (Northern). The selected location represents the internal environment within the Study Area (Northern). The baseline noise level is dominated by traffic noise from Yew Tee Flyover and Kranji Expressway (KJE).	
R02	Green Area within CCK N1 EIS Study Area (Southern)	Representative baseline noise monitoring location for Green Area within the Study Area (Southern). The selected location represents the internal environment within the Study Area (Southern).	



Legend

- Airborne Noise Study Area 150m
- Indicative Ongoing Construction
- Proposed DTL2e Tunnel Alignment
- Potential Future Infrastructure
- Proposed Cut and Cover Areas
- Proposed Elevated Vehicular Bridge
- Proposed Pedestrian Overhead Bridge
- Proposed DTL2e Stations (Underground)
- Proposed NSL Elevated Station
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Primary Data (LTA)

- Baseline Airborne Noise Monitoring Locations

Secondary Data (HDB CCK N1 EIS)

- Baseline Airborne Noise Monitoring Locations

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Figure Title :

BASELINE AIRBORNE NOISE MONITORING LOCATIONS (CONSTRUCTION PHASE)

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Note: Source of basemap - GoogleEarth Maps

10.2.3.2.2 Operational Phase

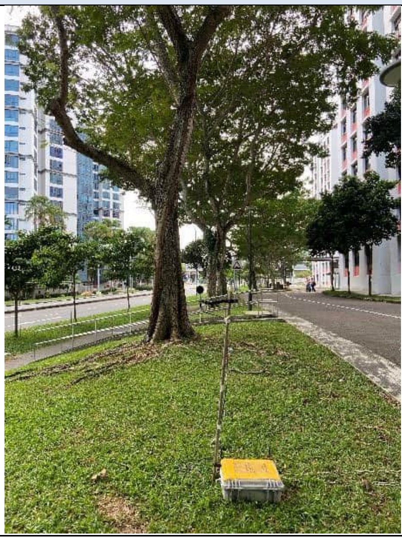
As part of field assessment to capture the baseline airborne noise conditions within the study areas defined for operational noise impact assessment (extracted and reflected in Figure 10-4, refer to the standalone reports for more details), a total of three (3) noise monitoring locations were selected with one (1) proposed near the location of potential future infrastructure selected based on the Concept design alignment detailed in the Preliminary NVS Report, and two (2) proposed near receptors in proximity of the proposed elevated vehicular bridge assessed in the Traffic NIA Study Report.

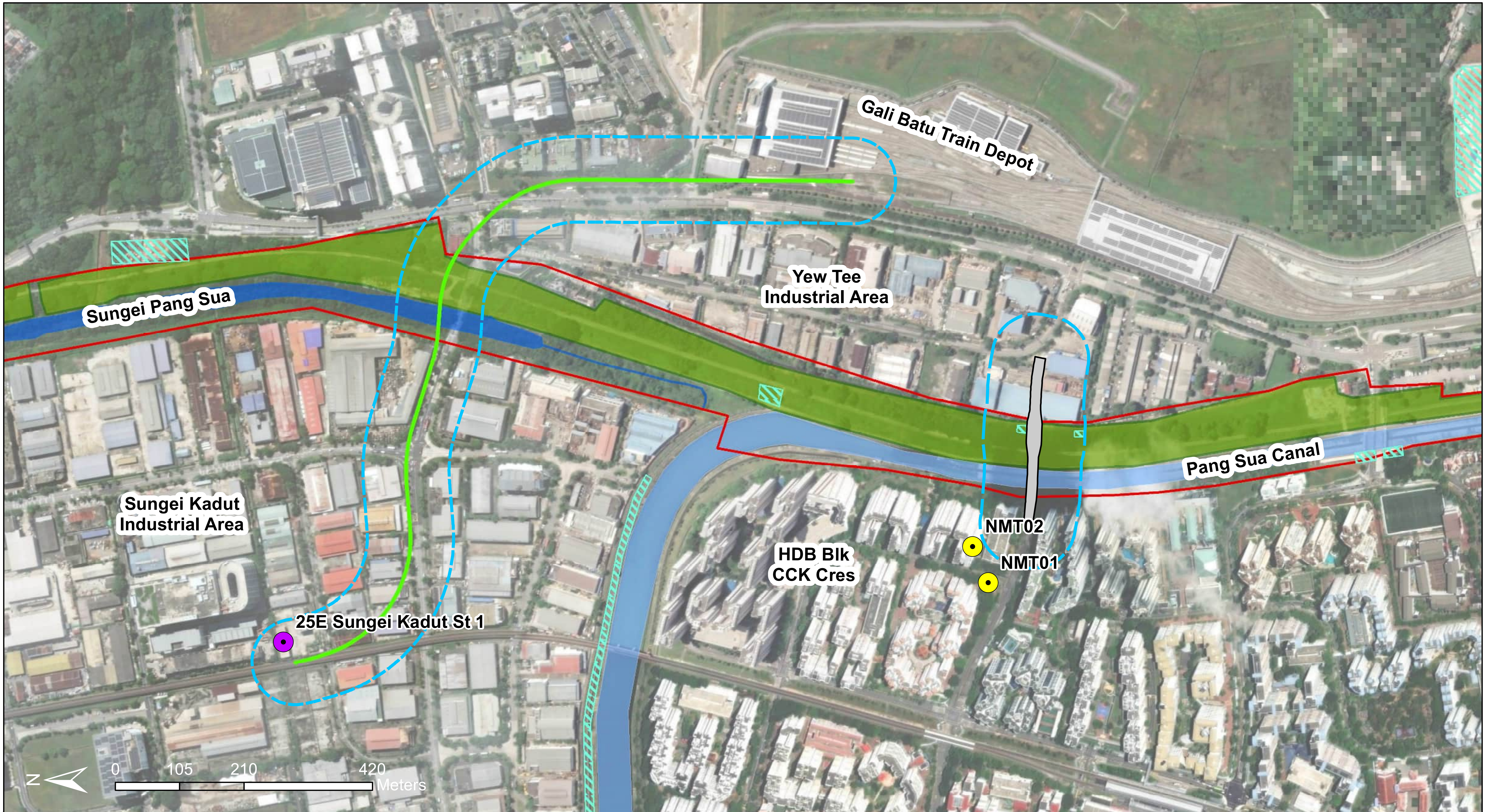
For the operational phase, the noise monitoring locations extracted from the separate standalone NVS Preliminary Report and Traffic NIA Study Report are reflected below in Table 10-4, Table 10-5 and Figure 10-4 respectively. Details of the considerations for the selection of the monitoring locations and methodology have been addressed in the separate standalone reports. The findings have been extracted and presented in this report alongside the findings and assessment for the construction phase.

Table 10-4 Baseline Airborne Noise Monitoring Locations (Potential Future Infrastructure) – Operational Phase, extracted from NVS Preliminary Report

S/N	Monitoring Location	Justification	Photo of Monitoring Location
1	25E Sungei Kadut Street 1	Representative baseline noise monitoring location for industrial buildings on the South of the Study Area if the potential future infrastructure is adopted for the design. The baseline noise level was expected to be dominated by traffic noise along Sungei Kadut Street 1 and the existing north-south line.	

Table 10-5 Baseline Airborne Noise Monitoring Locations (Elevated Vehicular Bridge) – Operational Phase, extracted from Traffic NIA report

S/N	Monitoring Location	Justification	Photo of Monitoring Location
NMT01	HDB Block 656 Choa Chu Kang Crescent	Representative baseline noise monitoring location for residential buildings along Choa Chu Kang North 7 road. The baseline noise level was expected to be dominated by traffic noise along Choa Chu Kang North 7.	
NMT02	HDB Block 692A Choa Chu Kang Crescent	Representative baseline noise monitoring location for residential buildings along Choa Chu Kang Crescent road. The baseline noise level was expected to be dominated by traffic noise along Choa Chu Kang Crescent.	



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- Baseline Airborne Noise Monitoring Locations for Traffic NIA (extracted from Traffic NIA report)
- Baseline Airborne Noise Monitoring Location for Potential Future Infrastructure Operation (extracted from NVS report)
- Airborne Noise Study Area 70m
- Proposed Elevated Vehicular Bridge
- Potential Future Infrastructure
- Indicative Ongoing Construction
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

N

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Figure Title :
BASELINE AIRBORNE NOISE MONITORING LOCATIONS (OPERATIONAL PHASE)

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10.2.4 Classification of Noise Sensitive Receptors

This section describes the classification of both ecological and human NSRs. Further discussion on the identification of the NSRs are detailed in Section 10.4.

10.2.4.1 Ecological Receptors

Birds utilize and rely heavily on sound to communicate, hunt, and avoid predators [W-104]. Noise pollution has been documented to negatively impact the avian specie, causing chronic stress with birds exposed to persistent noise showing symptoms remarkably similar to those in humans suffering from post-traumatic stress disorders (PTSD), with skewed stress hormone levels induced from increased anxiety, distraction, and hypervigilance [P-83]. In accordance to Inception Report [O-1], noise impacts on birds were studied to identify the indicator receptor species with which the noise sensitivity thresholds would be devised from.

Based on literature findings, hearing in avian species were found to encompass a narrower range of frequencies than human hearing [P-83], with avian hearing being most sensitive to sounds from 1 – 4 kHz [P-83]. Akin to human species, birds were found to suffer from damage to auditory receptors (hair cells) from loud noise. However, unlike the human species, certain species of birds such as barn owls were found to be able to repair damaged hair cells [P-83].

Considering the constant construction noise that the birds will be subjected to, continued exposure to loud noises would likely prevent the recovery of avian hearing for birds residing within the Biodiversity Study Area, in proximity to the noise sources [P-83]. Furthermore, as reported by researchers, a 10-decibel increase in noise above ambient noise levels can reduce animals' listening area by 90% [P-83].

As such, a more conservative approach towards the assessment of noise sensitivity threshold levels for the assessment of noise impacts on ecological NSRs have been adopted as opposed to factors such as seasonal and behavioural variation and habituation detailed in the Inception Report [O-1] considering the constant noise source. The fauna specialists have devised a sensitivity classification for the ecological NSRs, accounting for fauna species of Conservation Significance (CS) and non-CS found residing within the Biodiversity Study Area.

In line with the assessment methodology presented in Table 6-2 the classification of ecological NSRs were defined based on the area delimited by the presence of fauna species of Conservation Significance (CS)/ non-CS, their susceptibility to airborne noise impacts, and ability to move away from the area as reflected below:

- Priority 1 – Areas inhabited by CS/ non-CS fauna species that use sound for communication, foraging, and breeding, and are known to have their behaviours disrupted by the increase in airborne noise levels (e.g., due to immobility from impacted area such as raptor nests);
- Priority 2 – Areas inhabited by CS fauna species that are less affected by airborne noise/ CS species which have the ability to move away temporarily to neighbouring areas which are not impacted by construction noise; and
- Priority 3 – Areas inhabited by fauna species that are less affected by airborne noise and are non-CS species.

The classification of ecological NSRs is applicable for both the construction and operational phases and has been further discussed in Section 10.4.

10.2.4.2 Human Receptors

10.2.4.2.1 Construction Phase

Based on the assessment methodology detailed in Table 6-2, there are three (3) classifications of human NSRs (i.e., Priority 1, Priority 2, and Priority 3) which relates to the nature of the establishment as reflected in the following:

- Priority 1 – Schools and Education Buildings, Hospitals and Medical Centres, Nursing Homes, Religious Buildings;
- Priority 2 – Residential Buildings; and
- Priority 3 – Other Buildings (Industrial, Commercial, Infrastructure, Sport & Recreation Areas, etc.)

The classification of auditory sensitivities of human NSRs has been further discussed in Section 10.4.1.

10.2.4.2.2 Operational Phase

Human NSRs subjected to potential impacts from noise associated with the operational phase are classified respective to the type of noise emissions.

Human NSRs subjected to operational noise from ACMV systems of non-industrial buildings are defined as establishments at the immediate boundary of the non-industrial building with the classifications relating to the type of establishment, similar to that of the construction phase (refer to Section 10.2.4.2.1).

The human NSRs subjected to vehicular noise from new/ existing traffic networks are defined as residential and NSRs within 70 m from the traffic source (refer to Section 10.2.2.2).

The classification of auditory sensitivities of the human NSRs has been discussed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustic Preliminary Report. A summary of the classification of receptor sensitivity is reflected in Table 10-6.

Table 10-6 Human Receptor Sensitivity Classification (Operational Phase)

Receptor Sensitivity		
Most Sensitive	**Sensitive**	**Least Sensitive**
Noise sensitive premises	Residential buildings	Commercial premises, Factory premises and sports and recreation centres (e.g., golf courses, stadiums, clubhouses).

10.2.5 Assessment Criteria

This section details the quantitative noise assessment criteria extracted from the respective noise legislations/ guidelines relevant to the assessment of noise impacts associated with the construction and operational phases.

10.2.5.1 Construction Phase

10.2.5.1.1 Ecological Receptors

The airborne noise impacts on the ecological NSRs are species-dependent. Species which are noise sensitive are those that use noise, for example for their communication or navigation, at certain times of the day. Construction and noisy activities during periods where fauna is active can result in interference to their day-to-day activities. As such, the assessment would be based on the species identified during faunal surveys conducted within the Airborne Noise Study Area, aligned with the biodiversity survey in Section 7.2.2.3.

Due to an absence of adequate research data on criterions applicable for the assessment of construction noise impacts on ecological NSRs, with no current existing established guidelines or standards, a more-stringent criterion of no-worse-off than the average of baseline was adopted for the purpose of assessment in this ES.

It should be noted that while there exist assessment criterions for construction noise impacts on human NSRs, the more-stringent baseline noise monitoring results were chosen as a basis of comparison for ecological NSRs as fauna species face a direct form of impact, given that the previously undisturbed habitat they reside in are directly impacted by the human disturbances in the form of construction activities and noise emissions.

Therefore, it is not advisable to adopt a similar assessment criterion to human NSRs as they operate in a different nature. Furthermore, akin to the correction factor used to deduce the corrected noise criteria for human NSRs discussed in the section below adjustments will be made to the predicted noise levels for ecological NSRs to account for existing average baseline noise levels.

Furthermore, akin to the correction factor used to deduce the corrected noise criteria for human NSRs discussed in the section below adjustments will be made to the predicted noise levels for ecological NSRs to account for existing average baseline noise levels.

10.2.5.1.2 Human Receptors

Specific construction noise criteria for the construction phase were developed with the baseline noise levels detailed in Section 10.5.1 included in the calculation to derive a background noise correction factor to establish the adjusted maximum permissible construction noise levels in accordance with the EPM, 2008 [R-22].

It should be noted that airborne noise impacts will only occur from above-ground construction worksites. The legislative requirements for environmental noise arising from construction activities in Singapore contains three (3) parts which specifies the applicable noise criteria for construction sites over different time periods. The corresponding permissible noise criteria have been extracted from EPM, 2008 [R-22] and presented in Table 10-7 to Table 10-9 for different time periods.

They are reflected in the order as follows:

- $L_{Aeq(12\ hours)}$ refers to the equivalent continuous noise level over a period of 12 hours within a 24-hour period;
- $L_{Aeq(1\ hour)}$ refers to the equivalent continuous noise level over a period of 1 hour within a 24-hour period; and
- $L_{Aeq(5\ mins)}$ refers to the equivalent continuous noise level over a period of 5 minutes within a 24-hour period.

Table 10-7 Maximum permissible noise levels for construction works over a period of 12 hours

Types of Affected Buildings	Days of the Week	Maximum Permissible $L_{Aeq(12\ hours)}$, dB	
		7am – 7pm	7pm – 7am
(a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc.	All days	60	50
(b) Residential buildings located less than 150 m from the construction site	All days	75	–
(c) Buildings other than those in (a) and (b) above	All days	75	65

Table 10-8 Maximum permissible noise levels for construction works over a period of 1 hour

Types of Affected Buildings	Days of the Week	Maximum Permissible $L_{Aeq(1\ hour)}$, dB	
		7pm – 10pm	10pm – 7am
(b) Residential buildings located less than 150 m from the construction site	Monday – Saturday	65	56

Table 10-9 Maximum permissible noise levels for construction works over a period of 5 minutes

Types of Affected Buildings	Days of the Week	Maximum Permissible $L_{Aeq(5\ mins)}$, dB		
		7am – 7pm	7pm – 10pm	10pm – 7am
(a) Hospitals, Schools, Institutions of Higher Learning, Homes for the Aged or Sick, etc.	All days	75	55	55
(b) Residential buildings located less than 150 m from the construction site	Monday – Saturday	90	70	55
	Sundays and Public Holidays	75	55	55
(c) Buildings other than those in (a) and (b) above	All days	90	70	70

As per the legislation, if there exist other sources of noise affecting the measurement of noise emitted from the construction site, the maximum permissible noise levels from the construction sites will be subjected to adjustment by the addition of a correction factor to account for the existing background noise levels in the area. The correction factor corresponds to the difference between the relevant permissible noise levels and the background noise levels as presented in Table 10-10. The difference in noise levels is then added to the higher of the two (2) noise levels (i.e., maximum permissible noise criteria/ background noise level) to deduce the applicable noise criteria for the specified construction area.

Table 10-10 Construction noise correction factor

Difference between Permissible and Background Noise Levels, dB(A)	Correction Factor to be added to the Higher of the two (2) Noise Levels, dB(A)
Below 2	3
2 to 4	2
4 to 10	1
10 and above	NIL

The corrected construction noise criteria were presented and further elaborated in Section 10.5.3.

10.2.5.2 Operational Phase

10.2.5.2.1 Ecological Receptors

As addressed in Section 10.2.5.1.1, due to an absence of adequate research data on criterions applicable for the assessment of operational noise impacts on ecological NSRs, with no current existing established guidelines or standards, a more-stringent criterion of no-worse-off than the average of baseline was adopted for the purpose of assessment in this ES.

10.2.5.2.2 Human Receptors

For airborne noise arising from the operational phase, there exists two (2) aspects of impact for consideration (refer to Section 10.2.1.2):

- Operation of ACMV systems for non-industrial buildings within the Project Site; and
- Vehicular noise on new/ existing traffic networks within/ near the Project Site.

<u>Air Conditioning and Mechanical Ventilation Boundary Noise Limits</u>

According to the ACMV Guideline, 2018 [R-26], non-industrial buildings refers to any permanent or temporary building or structure used for the purposes of trade, business or commerce and includes any shopping complex, financial institution, office tower, hotel, educational institution, hospital, transport infrastructures, community infrastructure, sport and recreational infrastructure but does not include any factory and residential premises.

The boundary noise limits for ACMV systems have been extracted from the ACMV Guideline, 2018 [R-26] and outlined in Table 10-11 below.

Table 10-11 NEA boundary noise limits

Types of Affected Buildings	**Boundary Noise Limits $L_{Aeq(15 mins)}$ (reckoned as the equivalent continuous level over 15 minutes), dB**		
	Day	**Evening**	**Night**
	7am – 7pm	**7pm – 11pm**	**11pm – 7am**
Noise Sensitive Premises (e.g., hospital, home for the aged sick, library)	60	55	50
Residential Premises	65	60	55
Others	70	65	60

As part of the requirements of operational noise impact assessment mandated by NEA, baseline noise results captured during noise monitoring have been used to derive the operational noise criteria for noise impacts over a continuous period of 15 minutes.

According to the guideline:

> "Where a noise source contains certain characteristics such as tonality, impulsiveness, intermittency, irregularity or dominant low frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same level and a penalty of 5 dB (A) shall be added for each of the following characteristics, up to a maximum to 10 dB (A)."

Hence, noise correction factors have been applied to the baseline noise results to determine the operational noise criteria for the Project. The maximum permissible noise levels for the Project have been deduced and adjusted by the correction factor reflected in Table 10-12 below to account for the existing noise levels measured at defined boundaries of the non-industrial buildings.

The correction factor corresponds to the difference between maximum permitted noise levels (see Table 10-12) and the baseline noise levels (see Section 10.2.3.2.2), to the higher of the two (2) noise levels. The adjusted value for the maximum permissible noise limit (i.e., the operational noise criteria), has been determined through the addition of the correction factor to the baseline noise results.

Table 10-12 ACMV noise correction factor

Difference between Permissible and Background Noise Levels, dB(A)	Correction Factor to be added to the Higher of the two (2) Noise Levels, dB(A)
Below 2	3
2 to 4	2
4 to 10	1
10 and above	NIL

<u>Land Traffic Noise</u>

The TNIA Guideline, 2016 [R-25] provides guidance to conduct the following:

- Part 1 – Land traffic Noise Impact Assessment on new residential and noise sensitive developments located in close proximity to existing land traffic noise sources/hotspots (e.g., expressways/ major arterial roads/ MRT tracks); and
- Part 2 – Land traffic Noise Impact Assessment on existing residential and noise sensitive developments located in close proximity to new transport-related developments (e.g., expressway/ major arterial roads/ MRT track/ bus interchanges/ bus depots), inclusive of the expansion of existing transport-related infrastructures.

The noise emissions due to movement of traffic have been assessed against the TNIA Guideline, 2016 [R-25] for operational noise arising from vehicular noise on new/ existing traffic networks within/ near the Project Site. The noise levels of the new residential and noise sensitive development shall comply with the following NEA noise requirements from the TNIA Guideline, 2016 [R-25] presented as follows:

- The noise levels at 1m from the façade of the new residential/ noise sensitive building shall not exceed $L_{Aeq(1\ hour)}$ 67 dB; and
- The indoor noise level of the new residential/ noise sensitive building under natural ventilation shall not exceed $L_{Aeq(1\ hour)}$ 57 dB.

10.3 Potential Sources of Airborne Noise Impacts and Likelihood of Occurrence

10.3.1 Construction Phase

This section discusses on the equipment and activities which can potentially contribute to noise impacts during the construction phase of the Project. The main sources of noise is expected to originate from the powered mechanical equipment (PME) used for the construction stages. The PME and their respective sound power levels (SWLs) used in this study are listed in the equipment inventory list provided in Appendix T.

10.3.1.1 Potential Sources of Construction Noise Impacts

As identified in the Inception Report [O-1], the potential sources of construction noise considered for assessment are namely:

- the proposed above-ground structure of the underground intermediate station and station interchange, facility building and mechanical facilities serving the underground DTL2e route and reception track;
- the proposed pedestrian linkbridge beside the DTL2e underground intermediate station;
- the elevated vehicular bridge proposed to connect Choa Chu Kang North 7 on the West of Pang Sua Canal and Woodlands Road on the East of Pang Sua Canal;
- the proposed elevated above-ground station to be added to the NSL at Sungei Kadut;
- the proposed above ground potential future infrastructure;
- the proposed docking shaft where the TBM will be dismantled and removed;
- the TBM retrieval shaft for the reception track located close to Gali Batu Train Depot; and
- the proposed rock breaking and excavation at Sungei Kadut Cut and Cover Station and Docking Shaft.

This amounts to a total of seven (7) main construction features (i.e., A. Sungei Kadut Cut and Cover Station; B. Intermediate Station; C. Reception Track Cut and Cover; D. Docking Shaft; E. Potential Future Infrastructure; F. Pedestrian linkbridge; and G. Elevated Vehicular Bridge) as listed and presented in Table 10-13 and Figure 10-5 respectively. The AES Design Team has designed a preliminary construction programme for the seven (7) construction features with the proposed construction activities and associated effective SWLs of the PMEs reflected in Table 10-13 below. Noise sources associated with rock breaking and excavation works will be addressed separately from main construction works in Section 10.3.1.1.1.

It should be noted that to minimize noise disturbances to the ecological and human NSRs, construction activities that are not safety critical shall be restricted to 8am – 6pm. Construction works involving safety critical activities that cannot be halted due to safety reasons include the installation of D Wall (Diaphragm Wall) and works involving the Tunnel Boring Machine (TBM). The detailed list of equipment inventory with corresponding SWLs are provided in Appendix T.

Table 10-13 Effective sound power level

No.	Construction Features	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
A. Sungei Kadut Cut and Cover Station								
1.1	Demolition (per gang) – Building Level	109	N/A	N/A	N/A	114	N/A	N/A
1.2	Demolition (per gang) – Ground Level	107	N/A	N/A	N/A	115	N/A	N/A
2	Clearance for Construction Area	116	N/A	N/A	N/A	117	N/A	N/A

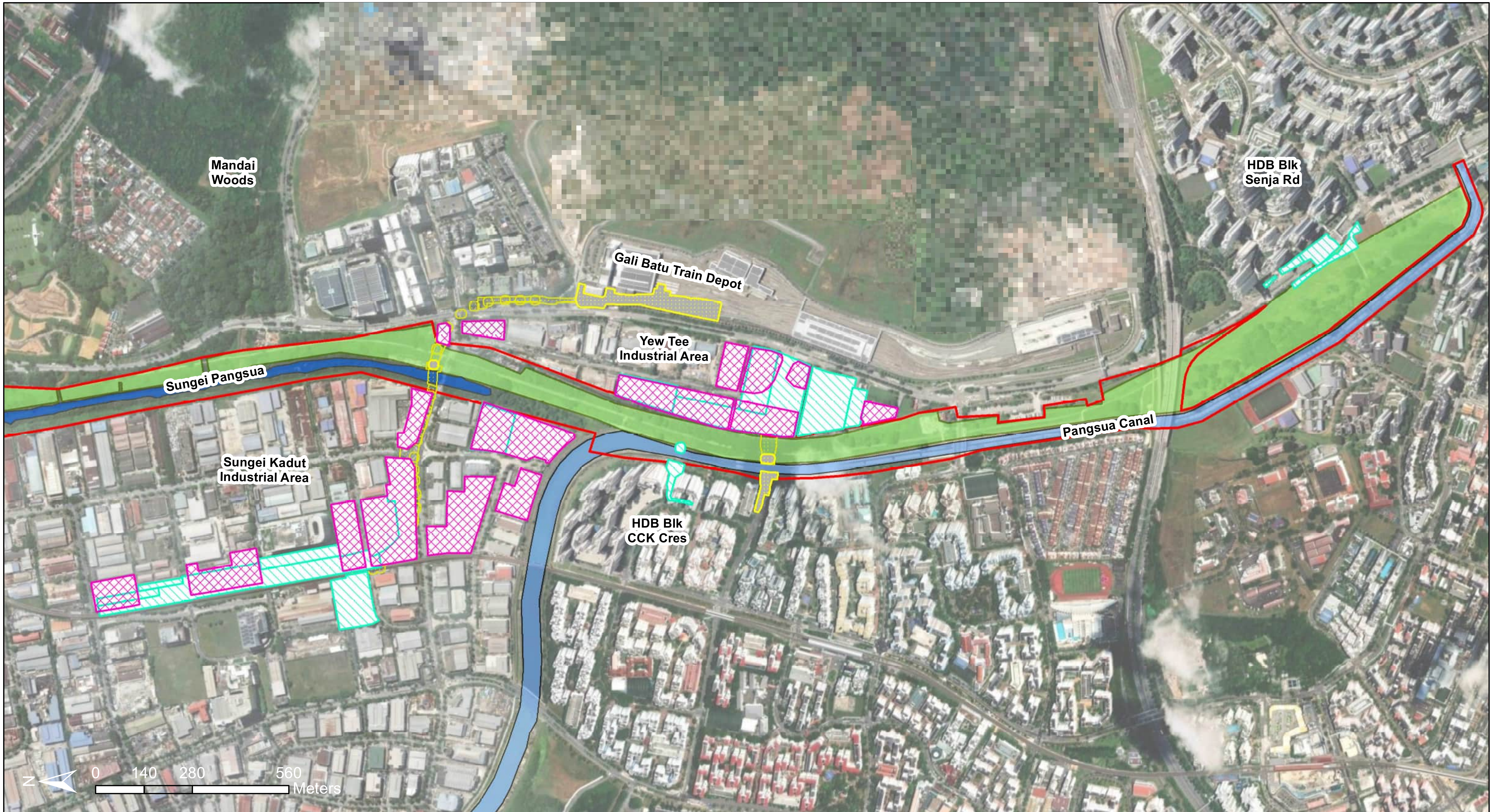
No.	Construction Features	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
3	Traffic Diversion	109	N/A	N/A	N/A	112	N/A	N/A
4	Excavation of Work Platform Level	115	N/A	N/A	N/A	118	N/A	N/A
5	Temporary Work – Installation of D-Wall, Sheet Pile*	124	124	125	125	125	125	125
6	Installation of Wallers and Struts/ Stage Excavation	116	N/A	N/A	N/A	117	N/A	N/A
7.1	Tunnel Boring Machine (TBM) – Launch from Sungei Kadut Launch Shaft to Intermediate Station*	115	115	116	116	118	118	118
7.2	TBM – Lowering and Main Drive*	118	118	118	118	118	118	118
8	Construction of Permanent Structure	115	N/A	N/A	N/A	117	N/A	N/A
9	Reinstatement of Work and Exiting Road	116	N/A	N/A	N/A	117	N/A	N/A
10	Entrances – Construction of D-Wall and Sheet Piles*	114	114	115	115	115	115	115
11	Foundation Work – Substructures including piles and pile caps for above-ground station box	119	N/A	N/A	N/A	120	N/A	N/A
12	Superstructure above-ground station box	115	N/A	N/A	N/A	116	N/A	N/A
13	Landscape Works	113	N/A	N/A	N/A	115	N/A	N/A
14	Remove all Temporary Works and Re-instatement	119	N/A	N/A	N/A	122	N/A	N/A
15	Site Office	114	N/A	N/A	N/A	118	N/A	N/A
16	Site Dormitory	113	N/A	N/A	N/A	118	N/A	N/A
17	Site Storage	115	N/A	N/A	N/A	119	N/A	N/A
B. Intermediate Station								
1	Clearance for Construction Area	116	N/A	N/A	N/A	117	N/A	N/A
2	Excavation of Work Platform Level	115	N/A	N/A	N/A	118	N/A	N/A

No.	Construction Features	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
3	Temporary Work – Installation of D-Wall, Sheet Pile*	119	119	120	120	121	121	121
4	Installation of Wallers and Struts/ Stage Excavation	113	N/A	N/A	N/A	114	N/A	N/A
5.1	Tunnel Boring Machine (TBM) – Launch from Sungei Kadut Launch Shaft to Intermediate Station*	115	115	116	116	118	118	118
5.2	TBM – Lowering and Main Drive*	118	118	118	118	118	118	118
6	Construction of Permanent Structure	113	N/A	N/A	N/A	116	N/A	N/A
7	Reinstatement of Work and Exiting Road	116	N/A	N/A	N/A	117	N/A	N/A
8	Entrances – Construction of D-Wall and Sheet Piles*	118	118	118	118	118	118	118
9	Landscape Works	113	N/A	N/A	N/A	115	N/A	N/A
10	Remove all Temporary Works and Re-instatement	110	N/A	N/A	N/A	113	N/A	N/A
C.	**Reception Track Cut and Cover**							
1	Clearance for Construction Area	116	N/A	N/A	N/A	117	N/A	N/A
2	Excavation to Work Platform Level	115	N/A	N/A	N/A	118	N/A	N/A
3	Temporary Work – Installation of D-Wall, Sheet Pile*	114	114	115	115	116	116	116
4	Installation of Wallers and Struts/ Stage Excavation	113	N/A	N/A	N/A	114	N/A	N/A
5	Construction of Permanent Structure	113	N/A	N/A	N/A	115	N/A	N/A
6	Reinstatement of Work and Exiting Road	116	N/A	N/A	N/A	117	N/A	N/A
7	Landscape Works	113	N/A	N/A	N/A	115	N/A	N/A

No.	Construction Features	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12 hours)}$		$L_{Aeq(1 hour)}$		$L_{Aeq(5 mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
8	Removal of Temporary Works and Re-instatement	119	N/A	N/A	N/A	122	N/A	N/A
D.	**Docking Shaft**							
1	Clearance for Construction Area	116	N/A	N/A	N/A	117	N/A	N/A
2	Traffic Diversion	111	N/A	N/A	N/A	112	N/A	N/A
3	Excavation of Work Platform Level	115	N/A	N/A	N/A	118	N/A	N/A
4	Temporary Work – Installation of D-Wall, Sheet Pile*	119	119	120	120	121	121	121
5	Installation of Wallers and Struts/ Stage Excavation	117	N/A	N/A	N/A	121	N/A	N/A
6	Construction of Permanent Structure	113	N/A	N/A	N/A	116	N/A	N/A
7	Reinstatement of Work and Exiting Road	116	N/A	N/A	N/A	117	N/A	N/A
8	Landscape Works	113	N/A	N/A	N/A	115	N/A	N/A
9	Removal of Temporary Works and Re-instatement	122	N/A	N/A	N/A	124	N/A	N/A
E.	**Potential Future Infrastructure**							
1	Clearance for Construction Area	116	N/A	N/A	N/A	116	N/A	N/A
2	Foundation Work – Substructures including piles and pile caps for above-ground bridge structure (per pile cap)	108	N/A	N/A	N/A	114	N/A	N/A
3	Superstructure	117	N/A	N/A	N/A	117	N/A	N/A
F.	**Pedestrian Linkbridge**							
1	Clearance for Construction Area	113	N/A	N/A	N/A	115	N/A	N/A
2	Foundation Work – Substructures including piles and pile caps for above-ground bridge structure (per pile cap)	117	N/A	N/A	N/A	119	N/A	N/A
3	Superstructure	115	N/A	N/A	N/A	117	N/A	N/A

No.	Construction Features	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
G. Elevated Vehicular Bridge								
1	Demolition	114	N/A	N/A	N/A	115	N/A	N/A
2	Clearance for Construction Area	119	N/A	N/A	N/A	119	N/A	N/A
3	Foundation Work – Substructures including piles and pile caps for above-ground bridge structure	120	N/A	N/A	N/A	123	N/A	N/A
4	Superstructure	122	N/A	N/A	N/A	124	N/A	N/A
5	Road Works	115	N/A	N/A	N/A	115	N/A	N/A
6	Removal of Temporary Works and Re-instatement	120	N/A	N/A	N/A	120	N/A	N/A

Note: *N/A – Not Applicable*
** Works involving the installation of D Wall (Diaphragm Wall) and the Tunnel Boring Machine (TBM) are safety critical activities that cannot be halted due to safety reasons.*
Construction activities that are not safety critical shall be restricted to 8am – 6pm.



Legend

- Proposed Worksite Areas (Scenario 1)
- Proposed Worksite Areas (Scenario 2)
- Proposed Worksite Areas (Scenario 3)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :

CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

POTENTIAL AIRBORNE NOISE SOURCES

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-5	B	1 of 1

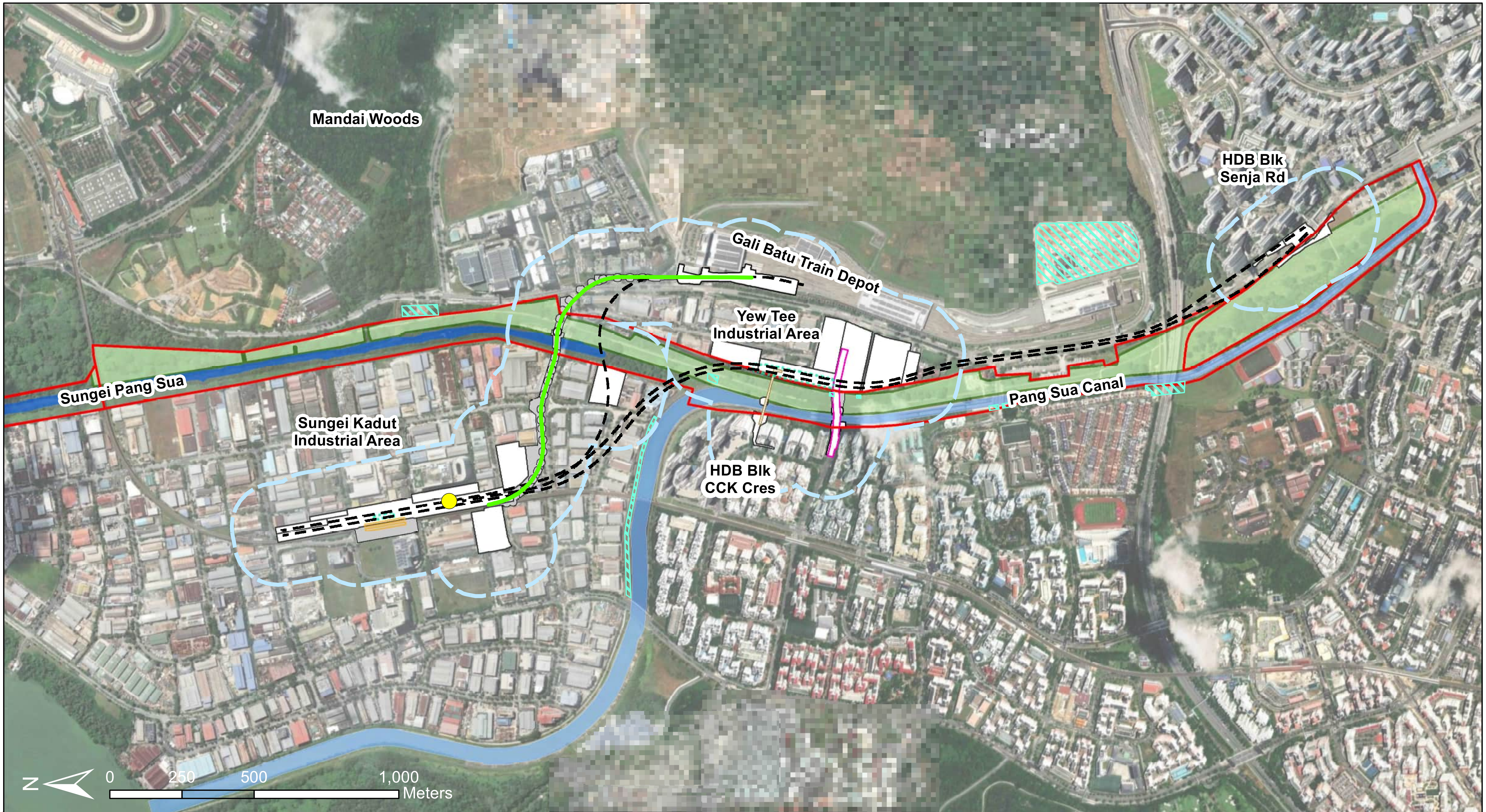
	Drawn	Date	CAD File Name	
	SYT	MAY 2023	N/A	A3

Note: Source of basemap - GoogleEarth Maps

10.3.1.1.1 Rock Breaking and Air Overpressure

Rock breaking and excavation has been proposed at the Sungei Kadut Cut and Cover Station (see Figure 10-6) with rock levels expected to be above the required formation level based on available borehole data from site investigation results.

As a product of rock breaking and excavation, the major side effects on the environment includes air overpressure. When a maximum instantaneous charge (MIC) of any magnitude is discharged, air which acts as a fluid radiates from the rock breaking location outwards towards the surrounding environment. This radiation of energy compresses the air with diminishing pressure over distance.



Legend

- Proposed Rock Breaking and Excavation at Sungei Kadut Cut and Cover Station
- Airborne Noise Study Area 150m
- Indicative Ongoing Construction
- Proposed DTL2e Tunnel Alignment
- Potential Future Infrastructure
- Proposed Cut and Cover Areas
- Proposed Vehicle Bridge
- Proposed Pedestrian Overhead Bridge
- Proposed DTL2e Stations (Underground)
- Proposed NSL Elevated Station
- Pang Sua Canal
- Sungei Pang Sua
- Biodiversity Study Area
- Existing Vegetated Area

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Figure Title :

LOCATION OF PROPOSED ROCK BREAKING AND EXCAVATION

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Figure No.	Rev.	Sheet
10-6	B	1 of 1

CAD File Name :N/A

A3

Note: Source of basemap - GoogleEarth Maps

10.3.1.2 Determination of Assessment Scenarios

Following the construction schedule devised by the AES Design Team (refer to Appendix T), three main (3) assessment scenarios were determined based on the sequence of construction works:

- Scenario 1: Advanced Works;
- Scenario 2: Main Civil Works:
    - Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day);
    - Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night); and
- Scenario 3:
    - Scenario 3a: Potential Future Infrastructure, Reception Track Cut and Cover Areas, and Vehicular Bridge Construction (Day);
    - Scenario 3b: Potential Future Infrastructure, Reception Track Cut and Cover Areas, and Vehicular Bridge Construction (Night).

The main construction works are planned to kick off with “Scenario 1: Advanced Works”, involving the demolition of selected buildings within the Sungei Kadut Industrial Area and Yew Tee Industrial Area to make way for upcoming works.

Thereafter, “Scenario 2: Main Civil Works” involving the construction of the proposed Sungei Kadut Interchange Station; above-ground structure of the underground intermediate station and station interchange, facility building and mechanical facilities serving the underground DTL2e route; pedestrian linkbridge beside the DTL2e underground intermediate station; and docking shaft; will commence alongside the demolition works of remaining buildings within the two industrial areas.

Upon completion of main civil works, “Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction” involving the construction of the proposed above-ground potential future infrastructure, at-grade reception track, and vehicular bridge will initiate, completing the works proposed in this Project. Figure 10-7, Figure 10-8, and Figure 10-9 reflects the three (3) assessment scenarios, their respective Airborne Noise Study Area, and airborne noise sources. In predicting for the construction noise impacts associated with the three (3) assessment scenarios, the highest overall SWLs of the construction stages associated with each assessment scenario were selected to assess for the worst-case noisiest scenarios. The rationale behind deducing the worst-case scenarios is under the assumption that if the construction stage with the highest SWL can be mitigated for instance with permanent fixtures such as noise barriers or other means proposed in Section 10.8, noise impacts from other construction stages/ activities with lower SWLs will also be addressed.

The summary of the proposed construction stages and their associated effective SWLs are reflected in Table 10-14 below with the detailed list of equipment inventory with corresponding SWLs found in Appendix T. It should be noted that to minimize noise disturbances to the ecological and human NSRs, construction activities that are not safety critical shall be restricted to 8am – 6pm. Construction works involving safety critical activities that cannot be halted due to safety reasons include the installation of ERSS, D-Wall and works involving the TBM.

As such, in accordance with the noise legislation detailed in EPM, 2008 [R-22], construction noise impact assessment for Scenario 1: Advanced Works that does not involve works associated with the installation of D Wall and TBM will only be assessed for $L_{Aeq(12\ hours)}$, and $L_{Aeq(5\ mins)}$ for the construction period of 7am – 7pm for Weekdays, while Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction and Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction, will be assessed for $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$, $L_{Aeq(5\ mins)}$ for the construction periods of 7am – 7pm, 7pm – 7am, 7pm – 10pm, 10pm – 7am for Weekdays and the Weekend due to safety critical works that cannot be halted.

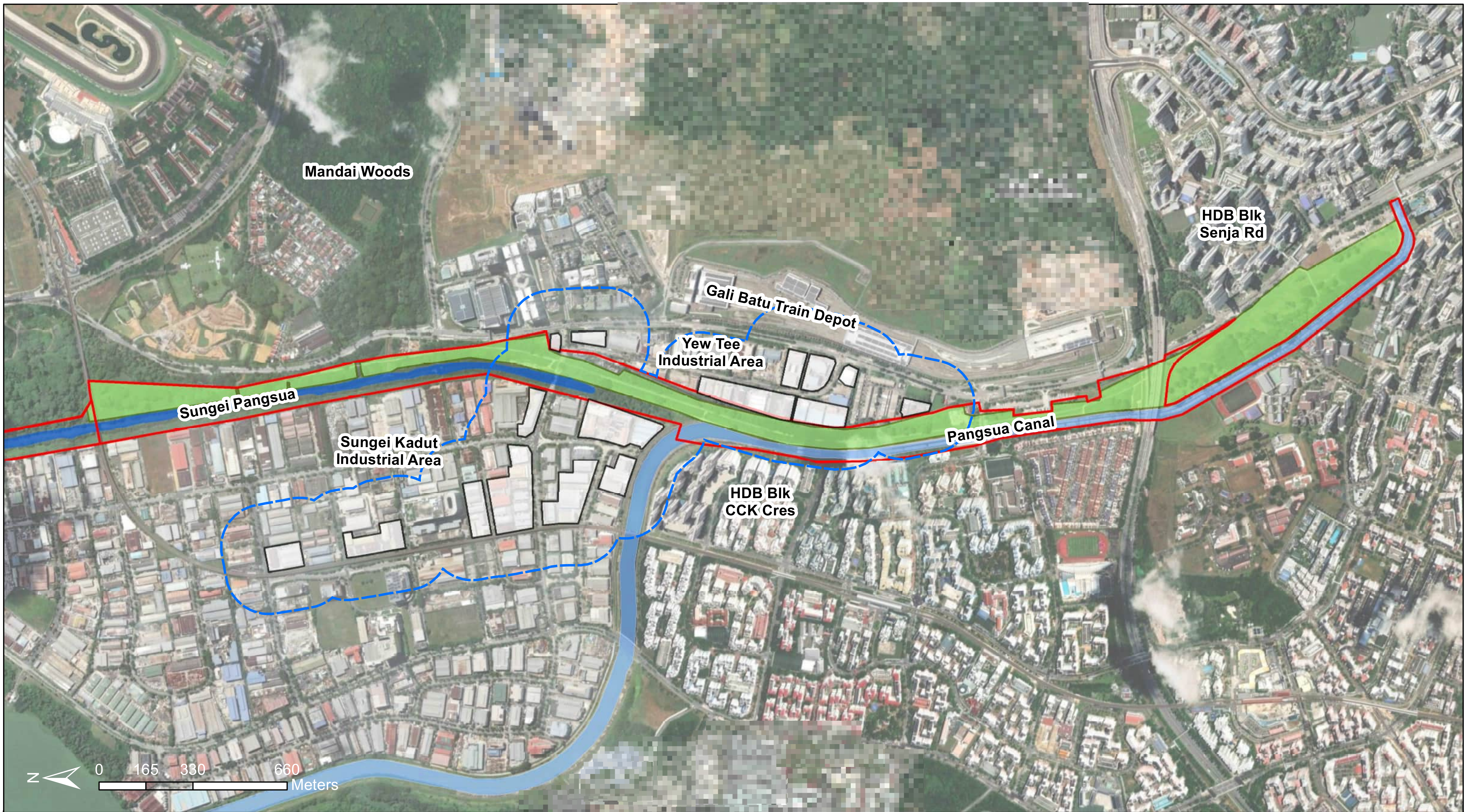
In this report, the three (3) assessment scenarios shall be assessed against the worst-case, noisiest $L_{Aeq(5\ mins)}$, dB descriptor which has the highest effective SWL (reflected in Table 10-14) as a conservative means of assessment following the rationale that if the construction stage with the highest SWL can be mitigated, noise impacts from other construction stages/ activities with lower SWLs will also be addressed.

Table 10-14 Effective Sound Power Level – Noise Model Input

No.	Construction Stages/ Assessment Scenarios	Effective Sound Power Level (SWL), dB from overall equipment inventory						
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
Scenario 1: Advanced Works								
A	Demolition (per gang) – Building Level	109	N/A	N/A	N/A	114	N/A	N/A
B	Demolition (per gang) – Ground Level	107	N/A	N/A	N/A	115	N/A	N/A
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction								
A	Demolition (per gang) – Building Level	109	N/A	N/A	N/A	114	N/A	N/A
B	Demolition (per gang) – Ground Level	107	N/A	N/A	N/A	115	N/A	N/A
C	Temporary Work – Installation of D-Wall, Sheet Pile* (Sungei Kadut Cut and Cover Station)	124	124	125	125	125	125	125
D	Temporary Work – Installation of D-Wall, Sheet Pile* (Intermediate Station)	119	119	120	120	121	121	121
E	Temporary Work – Installation of D-Wall, Sheet Pile*	119	119	120	120	121	121	121
F	Site Office	114	N/A	N/A	N/A	118	N/A	N/A
G	Site Dormitory	113	N/A	N/A	N/A	118	N/A	N/A
H	Site Storage	115	N/A	N/A	N/A	119	N/A	N/A
Scenario 3: Potential Future infrastructure, reception track cut and cover areas, and vehicular bridge construction								
A	Temporary Work – Installation of D-Wall, Sheet Pile (Reception Track Cut and Cover Areas)*	114	114	115	115	116	116	116
B	Removal of Temporary Works and Re-instatement (Reception Track Cut and Cover Areas)	119	N/A	N/A	N/A	122	N/A	N/A
C	Superstructure (Potential Future infrastructure)	117	N/A	N/A	N/A	117	N/A	N/A
D	Foundation Work – Substructures including piles and pile caps for above-ground bridge structure (per pile	117	N/A	N/A	N/A	119	N/A	N/A

No.	**Construction Stages/ Assessment Scenarios**	**Effective Sound Power Level (SWL), dB from overall equipment inventory**						
		$L_{Aeq(12\ hours)}$		**$L_{Aeq(1\ hour)}$**		**$L_{Aeq(5\ mins)}$**		
		7am – 7pm	**7pm – 7am**	**7pm – 10pm**	**10pm – 7am**	**7am – 7pm**	**7pm – 10pm**	**10pm – 7am**
	cap) (Pedestrian Linkbridge)							
E	Superstructure (Elevated Vehicular Bridge)	122	N/A	N/A	N/A	124	N/A	N/A

Note: *N/A – Not Applicable*
** Works involving the installation of D Wall (Diaphragm Wall) and the Tunnel Boring Machine (TBM) are safety critical activities that cannot be halted due to safety reasons.*
Construction activities that are not safety critical shall be restricted to 8am – 6pm.



Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

N

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Figure Title :
CONSTRUCTION PHASE, ASSESSMENT SCENARIOS (SCENARIO 1: ADVANCED WORKS)

Designed	Checked	Approved
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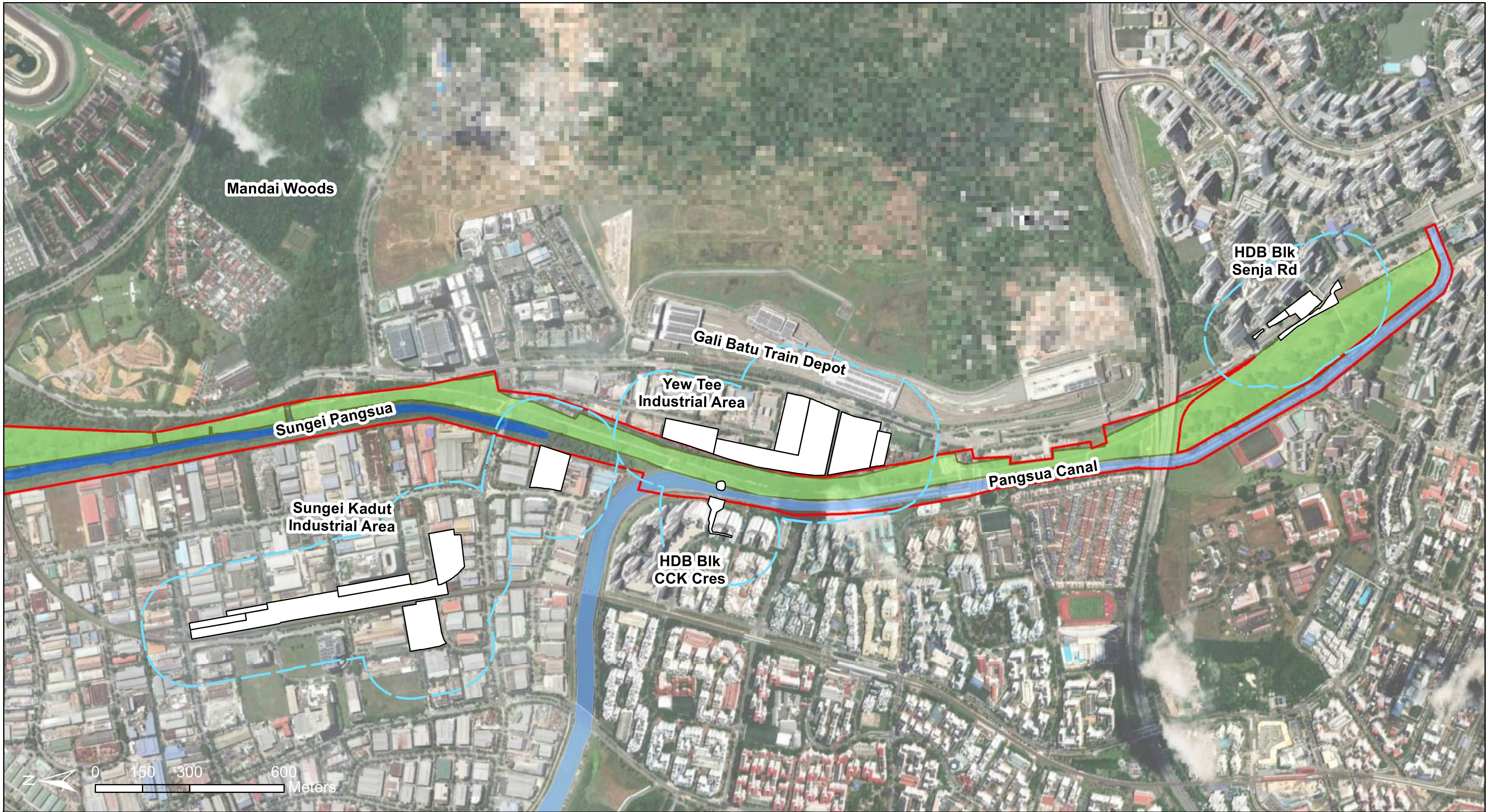

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

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Project Title :

CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

CONSTRUCTION PHASE, ASSESSMENT SCENARIOS (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)

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Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

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Project Title :

CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

CONSTRUCTION PHASE, ASSESSMENT SCENARIOS (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
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10.3.1.3 Noise Prediction Methodology

The noise levels generated from the assessment scenarios for the construction phase were predicted through noise modelling using SoundPLAN ver. 8.2. Information on the effective SWL of the assessment scenarios, proposed development areas constituting as area sources, ecological and human NSRs as receivers, and topography were input into the noise model to determine the predicted noise levels experienced by the NSRs.

Where topography is not available, a flat terrain based non the nearest spot height from topographic survey has been taken within the Project site and Airborne Noise Study Area. The NSRs were then assessed in accordance with the impact evaluation matrix in Section 6.4.2. Noise contours have been provided to the extent where topography is available. Based on the impact evaluation, mitigation to reduce airborne noise impacts has been recommended for the affected NSRs where necessary.

10.3.1.4 Noise Impact Evaluation Methodology

As detailed in the assessment methodology (see Section 10.2.1.1), NSRs were first identified and classified as reflected in Table 6-2. Then, Impact Intensity was determined by the magnitude of noise exceedances predicted as shown in Table 6-6. The magnitude of noise exceedances was predicted through noise modelling with SoundPLAN ver. 8.2.

For the assessment of construction noise impacts on ecological NSRs, the recorded average baseline noise levels are added to predicted noise levels to account for pre-existing baseline conditions. Thereafter, the adjusted predicted noise levels were compared against the average baseline noise levels established as the no-worse-off than the average of baseline criterion for ecological NSRs adopted in this ES (refer to Section 10.2.5.1.1). Noise exceedances derived from this comparison were then used to deduce Impact Intensity.

While for human NSRs, noise impacts experienced by the NSRs from the worst-case scenario were similarly predicted using SoundPLAN ver. 8.2. However, as the current baseline noise levels are already accounted for as part of corrected noise criterion where the maximum permissible noise levels are adjusted according to baseline noise levels, no further addition of baseline noise levels to predicted noise levels was conducted. The predicted noise levels experienced by human NSRs were then compared to the corrected noise criteria adjusted using average baseline noise levels recorded near the human NSRs where exceedance found would contribute to the deduction of Impact Intensity.

By considering both Impact Intensity and Receptor Sensitivity, Impact Consequence can be obtained as per the matrix in Table 6-7. Thereafter, Likelihood of the impact from the construction activities of this Project were calculated based on the active duration of the proposed PMEs over the daily work period, detailed as the frequency of exposure (e.g., a frequency of exposure of < 5% results in an Unlikely/ Remote Likelihood) as shown in Table 6-8. By relating both Impact Consequence and Likelihood of Occurrence, the Impact Significance of airborne noise impacts as reflected in Table 6-9 were predicted with the consideration of minimum control measures (see Section 10.6.1).

Further analysis and evaluation were then conducted to recommend additional mitigation measures (e.g., noise barriers, etc.) where necessary. At the end a monitoring plan was established and triggers for action determined so that the impacts can be controlled within acceptable limits or ALARP.

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10.3.1.5 Likelihood of Occurrence

The Likelihood of Occurrence of construction noise impacts were determined based on the active duration of the proposed PMEs provided by the AES Design Team over the daily working period (i.e., 7am – 7pm, 7pm – 7am, 7pm – 10pm, and 10pm – 7am) associated to the $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ dB descriptor in accordance with EPM, 2008 [R-22] for the three (3) respective assessment scenarios (refer to Section 10.3.1.2), detailed as frequency of exposure in Table 10-15.

Table 10-15 Likelihood of evaluation for airborne noise impact assessment (construction phase)

Assessment Scenario(s)	L_{Aeq}, dB	NEA Construction Work Schedule	Frequency of Exposure	Likelihood of Occurrence
Scenario 1: Advanced Works	$L_{Aeq(12\ hours)}$	7am – 7pm	Daily working period over 24 hours = 0.5 Active duration of equipment = 0.5 Frequency of exposure = 0.5 x 0.5 = 0.25 (≈ 25.0%)	Possible/ Occasional
	$L_{Aeq(5\ mins)}$	7am – 7pm	Daily working period over 24 hours = 0.5 Active duration of equipment = 1.0 Frequency of exposure = 1.0 x 0.5 = 0.5 (≈ 50.0%)	Likely/ Regular
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction	$L_{Aeq(12\ hours)}$	7am – 7pm	Daily working period over 24 hours = 0.5 Active duration of equipment = 0.5 Frequency of exposure = 0.5 x 0.5 = 0.25 (≈ 25.0%)	Possible/ Occasional
	$L_{Aeq(5\ mins)}$	7am – 7pm	Daily working period over 24 hours = 0.5 Active duration of equipment = 1.0 Frequency of exposure = 1.0 x 0.5 = 0.5 (≈ 50.0%)	Likely/ Regular
	$L_{Aeq(12\ hours)}$	7pm – 7am	Daily working period over 24 hours = 0.5 Active duration of equipment = 0.5 Frequency of exposure = 0.5 x 0.5 = 0.25 (≈ 25.0%)	Possible/ Occasional
	$L_{Aeq(1\ hour)}$	7pm – 10pm	Daily working period over 24 hours = 0.135 Active duration of equipment = 0.7 Frequency of exposure = 0.135 x 0.7 = 0.095 (≈ 9.5%)	Less Likely/ Rare
		10pm – 7am	Daily working period over 24 hours = 0.33 Active duration of equipment = 0.7 Frequency of exposure = 0.33 x 0.7 = 0.231 (≈ 23.1%)	Possible/ Occasional

Assessment Scenario(s)	L_{Aeq}, dB	NEA Construction Work Schedule	Frequency of Exposure	Likelihood of Occurrence
	$L_{Aeq(5\ mins)}$	7pm – 10pm	Daily working period over 24 hours = 0.135 Active duration of equipment = 1.0 Frequency of exposure = 0.135 x 1.0 = 0.135 (≈ 13.5%)	Less Likely/ Rare
		10pm – 7am	Daily working period over 24 hours = 0.33 Active duration of equipment = 1.0 Frequency of exposure = 0.33 x 1.0 = 0.33 (≈ 33.0%)	Likely/ Regular
Note: The colour of the cells corresponds to that of the assessment matrices in Section 6.4.2.				

10.3.1.6 Rock Breaking and Air Overpressure Impact Prediction and Assessment Methodology

Where common excavation techniques are not able to break down hard rocks, rock breaking, and excavation can be proposed as an effective and efficient method to break down and remove rocks. For the Sungei Kadut Cut and Cover Station, the rock levels are expected to be above the required formation level based on the available boreholes data from site investigation results. The depth of rock breaking, and excavation is proposed to break down at around 15 m below ground level.

As a product of rock breaking and excavation, the major side effects on the environment includes air overpressure. When a maximum instantaneous charge (MIC) of any magnitude is discharged, air which acts as a fluid radiates from the rock breaking location outwards towards the surrounding environment. This radiation of energy compresses the air with diminishing pressure over distance. Air overpressure is usually measured in the form of dB (Lin). Frequency of rock breaking and excavation at Sungei Kadut Station was assumed to be 1 time per day and 5 times per week over a span of 8 weeks.

10.3.1.6.1 Noise Prediction Methodology

During the writing of this report, information on rock breaking was not available. Rock breaking and excavation could only be carried out by an appointed Contractor at a later stage. Hence, the approach taken in this section will provide a guideline to the criteria as set out in BS5228-2:2009+A1:2014 [R-84]. Based on assumptions made (rock breaking location, depth, breaking method) and known information (distance to nearest receptors), this assessment will provide an estimate on the maximum amount of MIC (explosive charge mass, kg) that should be permitted in order to keep air overpressure within the stated criteria. Predictive methods in AS 2187.2-2006 Explosive – Storage and Use Part 2 [R-91] will be used to predict air overpressure based on constants recommended within the guideline with formula (1) below:

$$\boldsymbol{P = K_a(\frac{R}{Q^{\frac{1}{3}}})^a} \text{ ----------------- (1)}$$

Where

P = pressure in kilopascals
Q = explosives charge mass, in kilograms
R = distance from charge, in meters
Ka = site constant (assumed to be 100)
a = site exponent (assumed to be -1.45)

Due to the lack of information for rock breaking and excavation specific to Singapore, the site constant was assumed based on AS 2187.2-2006 [R-91R-91]. The site constant Ka is commonly ranging from 10 – 100 for confined blasthole charges and hence was conservatively assumed to be 100 for the purpose of the calculation.

The site exponent, a, was assumed to be -1.45 for confined blasthole charges. The alternative to confined explosion hole charges would be unconfined surface charges which is usually employed in mine breaking.

The distance from charge to the NSRs, R, measured from the centre of the Sungei Kadut Station Cut and Cover Station to the nearest boundary of the human NSRs – JTC Trendspace, is approximately 61 m.

It is to be noted that rock breaking and excavation and air overpressure was not considered for noise modelling and will only be assessed semi-qualitatively due to the instantaneous nature of the noise generated from rock breaking and excavation.

10.3.1.6.2 Noise Impact Evaluation Methodology

As detailed in the assessment methodology (see Section 10.2.1.1), NSRs were first identified and classified as reflected in Table 6-2. Then, Impact Intensity was determined by the magnitude of noise exceedances predicted as shown in Table 6-6. The magnitude of noise exceedances was predicted through the predictive methods detailed in AS 2187.2-2006 [R-91] and assessed against the criteria as set out in BS5228-2:2009+A1:2014 [R-84] for both ecological and human NSRs where exceedance found would contribute to the deduction of Impact Intensity.

By considering both Impact Intensity and Receptor Sensitivity, Impact Consequence can be obtained as per the matrix in Table 6-7. Thereafter, Likelihood of the impact from the rock breaking and excavation activity of this Project were calculated based on the active duration of the rock breaking and excavation event over the daily work period, detailed as the frequency of exposure (e.g., a frequency of exposure of < 5% results in an Unlikely/ Remote Likelihood) as shown in Table 6-8. By relating both Impact Consequence and Likelihood of Occurrence, the Impact Significance of airborne noise impacts as reflected in Table 6-9 were predicted with the consideration of minimum control measures (see Section 10.6.1).

Further analysis and evaluation were then conducted to recommend additional mitigation measures (e.g., noise barriers, etc.) where necessary. At the end a monitoring plan was established and triggers for action determined so that the impacts can be controlled within acceptable limits or ALARP.

10.3.1.6.3 Likelihood of Occurrence

The Likelihood of Occurrence of construction noise impacts during rock breaking and excavation was determined based on the active duration of the rock breaking and excavation event over the daily work period of 24 hours, detailed as frequency of exposure in Table 10-16.

Table 10-16 Likelihood of evaluation for airborne noise impact assessment (construction phase, rock breaking and excavation)

Rock Breaking and Excavation Site(s)	Frequency of Exposure	Likelihood of Occurrence
Sungei Kadut Cut and Cover Station	Daily working period over 24 hours = 1.0 Active duration of equipment = 1.0 Frequency of exposure = 1.0 x 1.0 = 1.0 (100.0%)	Certain

10.3.2 Operational Phase

This section discusses on the potential sources which potentially contribute to noise impacts during the operational phase of the Project.

10.3.2.1 Potential Sources of Operational Noise Impacts

The main sources of noise will originate from the operations of ACMV systems from non-industrial buildings within the Project site (i.e., DTL2e underground intermediate station, above-ground station Sungei Kadut, and station interchange), and vehicular noise from new traffic networks within the Project site (i.e., Potential future infrastructure and vehicular bridge).

More details on the potential sources assessed for operational noise impacts are provided in the standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. A summary table of the potential sources of operational noise impacts assessed as part of the NVS Preliminary Report is reflected in Table 10-17.

Table 10-17 Summary of Potential Source of Impacts and Associated Impacts

The potential source of impacts	Potential associated impacts
Train operations	Disturbance to ecological NSRs and annoyance to human NSRs
Elevated Vehicular Bridge operations	

10.3.2.2 Noise Prediction Methodology

The noise prediction methodology and noise impact evaluation methodology for operational noise impacts on human NSRs identified for assessment during the operational phase are detailed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report.

In line with the Inception Report [O-1], the assessment of operational noise impacts on ecological NSRs will take reference to the results determined from these standalone reports. The noise levels generated from the operations of the potential future infrastructure shall be predicted through noise modelling using SoundPLAN ver. 8.2. The ecological NSRs will then be assessed in accordance with the impact evaluation matrix in Section 6.4.2. Noise contours will be provided to the extent where topography is available. Based on the impact evaluation, mitigation to reduce airborne noise impacts will be recommended for the affected NSRs where necessary.

10.3.2.3 Noise Impact Evaluation Methodology

The noise impact evaluation methodology for ecological NSRs subjected to operational noise impacts from train operations on the potential future infrastructure and traffic noise impacts from the Elevated Vehicular Bridge shall follow the methodology outlined in Section 10.3.1.4.

10.3.2.4 Likelihood of Occurrence

10.3.2.4.1 Potential Future Infrastructure

As a means to assessment following the assessment convention detailed in Section 6.4.2, the Likelihood of Occurrence of operational noise impacts arising from the operations of the potential future infrastructure (studied as part of NVS Preliminary Report) was determined based on the active duration of train operations, limited to hours within 12am – 4am for train maintenance, over the daily work period of 24 hours and is detailed as frequency of exposure in Table 10-18.

Table 10-18 Likelihood of evaluation for airborne noise impact assessment (operational phase, potential future infrastructure)

Frequency of Exposure	Likelihood of Occurrence
Daily maintenance period over 24 hours = 4/ 24 = 0.2 Single direction passing within 4 hours = 0.23 x 0.2 = 0.05 Frequency of exposure = 0.2 x 0.05 = 0.01 (1.0%)	Unlikely

10.3.2.4.2 Elevated Vehicular bridge

While for the operations of the elevated vehicular bridge, the Likelihood of Occurrence of operational noise impacts arising from traffic on the elevated vehicular bridge was determined based on the active duration of bridge use where traffic will be live over the daily working period of 24 hours and is detailed as frequency of exposure in Table 10-19.

Table 10-19 Likelihood of evaluation for airborne noise impact assessment (operational phase, Elevated Vehicular Bridge)

Frequency of Exposure	Likelihood of Occurrence
Daily operation period over 24 hours = 24/ 24 = 1.0 Active duration of traffic on vehicular bridge = 1.0 Frequency of exposure = 1.0 x 1.0 = 1.0 (100.0%)	Certain

10.4 Identification of Sensitive Receptors

The study focused on the airborne noise impacts to the ecological and human NSRs within the Airborne Noise Study Area during the construction phase of the Project. The classification of ecological NSRs was based on the area delimited by the presence of fauna species of Conservation Significance (CS)/ non-CS, their susceptibility to airborne noise impacts, and ability to move away from the area. While human NSRs were classified based on the type of establishments/ buildings. Details on the identified ecological and human NSRs considered for assessment in the construction phase were further discussed below in Section 10.4.1.1 and Section 10.4.1.2 respectively.

Details on ecological and human NSRs identified for assessment for the operational phase has been addressed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report.

10.4.1 Construction Phase

10.4.1.1 Ecological Receptors

As discussed in Section 10.2.2, the assessment of airborne noise impacts on ecological NSRs has considered the Biodiversity Study Area, demarcating the Rail Corridor, Sungei Pang Sua, and the Pang Sua Canal, suitable in supporting the presence of fauna. Other areas such as the construction worksites, urbanized residential/ commercial/ industrial sites abutting the Rail Corridor, not suitable in supporting the presence of fauna have been deemed as “Not Assessable Areas” pertaining to the assessment of construction noise impacts on ecological NSRs (see Figure 10-10).

Based on faunistic field assessment conducted within these areas, fauna species of CS/ non-CS that use sound for communication, foraging and breeding, and are known to have their behaviours disrupted by the increase in airborne noise levels/ with the ability to move away temporarily to neighbouring areas not impacted by construction noise were recorded within the Project site. Correlating these findings and to the sensitivity categorization matrices outlined in Table 6-2, the Rail Corridor and Sungei Pang Sua were delimited as areas of Priority 1, while the Pang Sua Canal was delimited as an area of Priority 2.

This section provides an insight to the fauna species identified within the Airborne Noise Study Area as part of faunistic field assessment. The list of receptor taxon (i.e., bird and mammal (non-volant)) and their associated literature review findings detailing response behaviour of identified fauna species to airborne noise are presented in Table 10-20 below.

Table 10-20 Literature review of taxon of identified airborne noise sensitive fauna species

Receptor Taxon	Literature Findings
Bird	Birds are considered to be highly noise sensitive as most make use of sound for communication and breeding. Studies have also shown that birds are impacted negatively by anthropogenic noise [P-84].
Mammal (non-volant)	Non-volant mammals such as rodents are known to display stressed behaviour in response to sounds of heavy machinery which could be common occurrence from construction noise [P-88]. Hence, non-volant mammals are deemed to be highly noise sensitive.

Fauna species of Conservation Significance (CS) with auditory sensitivity were recorded and identified within the Airborne Noise Study Area. A total of 19 CS fauna species inclusive of 18 species of birds, and one (1) species of mammal (non-volant) were recorded as presented in Table 10-21. A list of other probable but not recorded CS fauna species and recorded non-CS fauna species are provided in Appendix U.

Table 10-21 List of recorded Ecological Receptors of Conservation Significance (CS)

No.	Receptor Taxon	Common Name	Species	Global Status	Local Status
1	Bird	*Haliaeetus ichthyaetus*	Grey-headed fish eagle	Near Threatened	Vulnerable
2	Bird	*Nisaetus cirrhatus*	Changeable hawk-eagle	Least Concern	Vulnerable
3	Bird	*Acrocephalus orientalis*	Oriental reed warbler	Least Concern	Vulnerable
4	Bird	*Alcedo atthis*	Common kingfisher	Least Concern	Vulnerable
5	Bird	*Halcyon pileata*	Black-capped kingfisher	Least Concern	Vulnerable
6	Bird	*Ardea alba*	Great egret	Least Concern	Vulnerable
7	Bird	*Ardea purpurea*	Purple heron	Least Concern	Endangered
8	Bird	*Ixobrychus sinensis*	Yellow bittern	Least Concern	Vulnerable
9	Bird	*Nycticorax nycticorax*	Black-crowned night heron	Least Concern	Endangered
10	Bird	*Corvus macrorhynchos*	Large-billed crow	Least Concern	Vulnerable
11	Bird	*Lanius cristatus*	Brown shrike	Least Concern	Vulnerable
12	Bird	*Copsychus saularis*	Oriental magpie-robin	Least Concern	Vulnerable
13	Bird	*Ploceus philippinus*	Baya weaver	Least Concern	Vulnerable
14	Bird	*Psittacula longicauda*	Long-tailed parakeet	Vulnerable	Near Threatened
15	Bird	*Pycnonotus zeylanicus*	Straw-headed bulbul	Critically Endangered	Endangered
16	Bird	*Actitis hypoleucos*	Common sandpiper	Least Concern	Vulnerable
17	Bird	*Strix seloputo*	Spotted wood owl	Least Concern	Vulnerable
18	Bird	*Zosterops simplex*	Swinhoe's white-eye	Least Concern	Vulnerable
19	Mammal	*Lutrogale perspicillata*	Smooth-coated otter	Vulnerable	Endangered

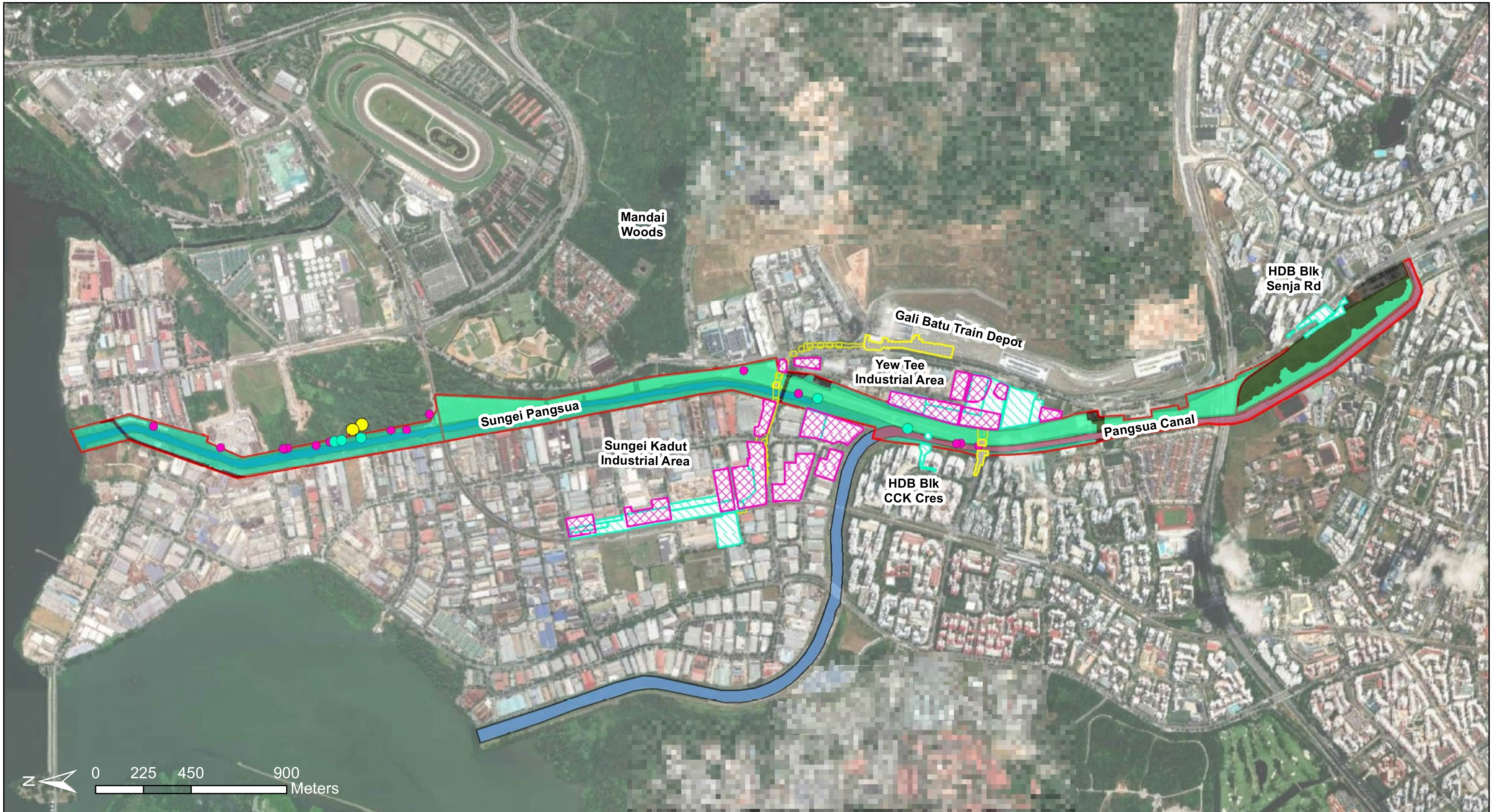
Note: This table presents the list of recorded fauna species of Conservation Significance (CS).
A list of other probable but not recorded CS fauna species and recorded non-CS fauna species are provided in Appendix U.

10.4.1.1.1 Migratory Birds

In consideration of the potential for construction noise impacts on migratory birds that may nest/ roost within areas in close proximity to the proposed construction worksites, faunistic field surveys were conducted within the Biodiversity Study Area to confirm the use of these areas by the migratory birds and document nesting/ roosting sites (if any).

Faunistic field surveys conducted within the Biodiversity Study Area revealed that of the seven (7) bird species recorded to be in close proximity to the proposed construction worksites, only two (2) species of migratory birds – common sandpiper *(Actitis hypoleucos)* and asian brown flycatcher *(Muscicapa dauurica)* were spotted with no migratory bird colonies roosting within the area. Only local bird species, such as the baya weaver *(Ploceus philippinus)* were recorded to be roosting on scrublands with the remaining species found at a range of heights.

Due to the existence of roosting birds in proximity to the proposed construction worksites, it is advised that noise impacts be reduced to as low as reasonably practicable (ALARP) and work hours be restricted to 8am – 6pm, except for safety critical works, to allow for nocturnal birds to be able to roost undisturbed within these areas during night-time if day-time noise impacts cannot be eliminated. The locations of recorded roosting sites are reflected in Figure 10-10 below.



Legend

- Roosting Birds
- Roosting Migratory Birds
- Raptor Nests
- Proposed Worksite Areas (Scenario 1)
- Proposed Worksite Areas (Scenario 2)
- Proposed Worksite Areas (Scenario 3)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Ecological Receptors

- Not Assessable
- Priority 1
- Priority 2

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Figure Title :
ECOLOGICAL RECEPTORS

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10.4.1.2 Human Receptors

According to EPM, 2008 [R-22], human NSRs potentially impacted by noise associated with the construction phase were identified as establishments/ buildings within the 150 m Airborne Noise Study Area from the proposed developments within the Project site (see Section 10.2.4.2).

As discussed in Section 10.2.2.1, the proposed construction worksites are subjected to changes in line with the assessment scenarios. Therefore, the list of human NSRs is also expected to change in line with the Airborne Noise Study Area associated with the particular assessment scenario.

The list of human NSRs identified for each of the three (3) construction stages – Scenario 1: Advanced Works; Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction; and Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (refer to Section 10.3.1.2 for information on the assessment scenarios) are presented in Table 10-22 and reflected in Figure 10-11, Figure 10-12, and Figure 10-13 respectively.

Information on the nearest SLM to the human NSRs where records of baseline noise levels are deemed representative of the current environmental noise conditions experienced by the human receptors are also provided in Table 10-22. This association plays an important role in noise impact assessment as the baseline noise levels recorded at the different SLMs will result in differing noise criterions that human receptors will be assessed against as part of quantitative noise impact assessment (refer to Section 10.5.3 for more details).

Table 10-22 Noise sensitive Human Receptors

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
Scenario 1: Advanced Works						
1	15 Sungei Kadut Street 2	Industrial	Priority 3	N2	1/ 3	52
2	15 Sungei Kadut Street 2, Worker's Dormitory	Residential	Priority 2	N2	4	49
3	16A Sungei Kadut Way	Industrial	Priority 3	N1	2	38
4	18 Sungei Kadut Way, Liannex Corporation	Industrial	Priority 3	N1	3	39
5	20 Sungei Kadut Way, Liannex Corporation	Industrial	Priority 3	N1	2	35
6	21 Sungei Kadut Street 1	Industrial	Priority 3	N1	2	8
7	35 Sungei Kadut St 1	Industrial	Priority 3	N1	4	119
8	40 The Quintet	Residential	Priority 2	N4	22	143
9	42 The Quintet	Residential	Priority 2	N4	20	142
10	566 Woodlands Road	Commercial/ Industrial	Priority 3	N3	2	131
11	Admira Pte Ltd	Industrial	Priority 3	N1	2	37
12	BHL Factories 2A	Industrial	Priority 3	N3	6	75
13	BHL Factories 2B	Industrial	Priority 3	N3	6	75
14	Brighton Furniture Display Centre, 46 Sungei Kadut Ave	Commercial/ Industrial	Priority 3	N1	2	20
15	Casco Adhesives (asia) Pte	Industrial	Priority 3	N1	2/ 3	90
16	Castilla Singapore	Industrial	Priority 3	N1	3	12
17	Chong Sun Wood Products Pte Ltd, Pan Star Wood Marketing Pte Ltd	Industrial	Priority 3	N1	2	5
18	Chop Kim Huat	Industrial	Priority 3	N1	2	7
19	Club July (Stagmont Ring) - Commercial, F&B	Commercial	Priority 3	N3	1	121
20	Da Di Glass	Industrial	Priority 3	N3	5	54
21	Durotech Industries (S) Pte Ltd, 15 Sungei Kadut Way	Industrial	Priority 3	N1	2	10
22	EDL Pte Ltd, 43 Sungei Kadut St 1	Industrial	Priority 3	N1	3	129
23	Eurokars Group	Commercial/ Industrial	Priority 3	N3	1/ 3	50
24	Ewins Pte, uberGARD	Industrial	Priority 3	N1	2	3

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
25	Gali Batu MRT Depot (SBS Transit)	Commercial	Priority 3	N3	1/ 2	64
26	Grandwork Building	Commercial/ Industrial	Priority 3	N1	1/ 5	60
27	GWT Engineering and Trading Pte Ltd, 36 Sungei Kadut St 1	Industrial	Priority 3	N1	2	129
28	HDB Block 687A, Choa Chu Kang	Residential	Priority 2	N4	22	121
29	HDB Block 687B, Choa Chu Kang	Residential	Priority 2	N4	22	120
30	HDB Block 687D, Choa Chu Kang Drive	Residential	Priority 2	N4	26	127
31	HDB Block 690B, Choa Chu Kang Crescent	Residential	Priority 2	N4	22	140
32	Heng Ann Engineering Pte Ltd	Industrial	Priority 3	N5	2	120
33	Hup Huat Glass Pte	Industrial	Priority 3	N3	2/ 3	128
34	Hup Huat Timber Co (Singapore) Pte Ltd	Industrial	Priority 3	N1	2	55
35	Ichiban Glass Construction	Industrial	Priority 3	N3	2	125
36	Jae Auto, 48A Sungei Kadut Ave	Industrial	Priority 3	N1	3	132
37	Jennings Trading Enterprise Pte	Industrial	Priority 3	N1	1/ 2	39
38	Joo Cheng Enterprise	Industrial	Priority 3	N1	3	32
39	JS Timber Pte Ltd	Industrial	Priority 3	N1	4	119
40	JSM Construction Group Pte Ltd	Industrial	Priority 3	N3	2	95
41	JTC Trendspace	Industrial	Priority 3	N1	10	12
42	KAFER Prostar Pte Ltd	Industrial	Priority 3	N1	2	54
43	Kenwood Industries Pte Ltd	Industrial	Priority 3	N1	2	47
44	Kenwood Trading (S) Pte Ltd, 1 Sungei Kadut St 3	Industrial	Priority 3	N1	1	130
45	KT&T Group of Contractors	Industrial	Priority 3	N1	2	25
46	Lam Chuan Import-Export Pte	Industrial	Priority 3	N1	2	135
47	LHT Holdings, Multiform Developments & Con Pte Ltd, 4 Sungei Kadut St 2	Industrial	Priority 3	N1	2	134
48	LHT Holdings Limited	Industrial	Priority 3	N1	2	12
49	Likok Paper Recycling, Wang Lai Construction Eng Pte Ltd, Rigger's Int Supp	Industrial	Priority 3	N1	2/ 3	65
50	Load Controls Systems Pte, Thi Foundation Equipment Pte Ltd	Industrial	Priority 3	N3	4	84

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
51	Luxx Newhouse Design Centre, 40 Sungei Kadut St 2	Commercial/ Industrial	Priority 3	N1	3	124
52	Macllord Industrial Pte Ltd	Industrial	Priority 3	N1	1/ 2/ 5	37
53	Mandai 66kV SPPG	Industrial	Priority 3	N3	3	134
54	Mandai Connection	Industrial	Priority 3	N3	1/ 9	56
55	Mandai Link Logistics	Industrial	Priority 3	N3	10	124
56	MRC Global (Singapore) Pte	Industrial	Priority 3	N3	2	94
57	MWS Nursing Home - Yew Tee, 51 CCK North 6	Welfare Home	Priority 1	N4	7	146
58	Nexxis Asia Pte	Industrial	Priority 3	N1	1/ 2	3
59	Nova Furnishing Centre, X'clusive Home Furniture’s	Commercial/ Industrial	Priority 3	N1	3	11
60	NS Trading Pte Ltd	Industrial	Priority 3	N3	3	13
61	Rattan Cane Processors Manufacturing, Unicane, 37 Sungei Kadut St 1	Industrial	Priority 3	N1	2	128
62	Redwood Interior Pte, DDG Glass Pte, Zola Design Pte Ltd	Commercial/ Industrial	Priority 3	N1	2	75
63	Samco Civil Engineering Pte Ltd, Double-Trans Pte	Industrial	Priority 3	N1	1/ 4	102
64	Sen Wan Timber (S) Pte Ltd, Ann Ta Building Materials & Wooden Pdts Supp	Industrial	Priority 3	N1	1/ 2/ /4	2
65	Seng Hin Sawmill Co (Singapore) Pte Ltd	Industrial	Priority 3	N1	1/ 2	29
66	Silverline Renovation Contractor	Industrial	Priority 3	N1	2	25
67	Sin Gee Huat Recycling Pte Ltd, 41 Sungei Kadut St 1	Industrial	Priority 3	N1	4	125
68	Sin Lian Seng Bolts & Nuts Pte Ltd, 33 Sungei Kadut St 1	Industrial	Priority 3	N1	2	135
69	SMART Recycling Pte Ltd, Ker & Ker Co, 36 Sungei Kadut St 1	Industrial	Priority 3	N1	2	89
70	Sri Arasakesari Sivan Temple, Yew Tee BalaVihar	Place of Worship	Priority 1	NM1	3	48
71	Sungei Kadut Fire Post	Fire Post	Priority 3	N1	1/ 2	33

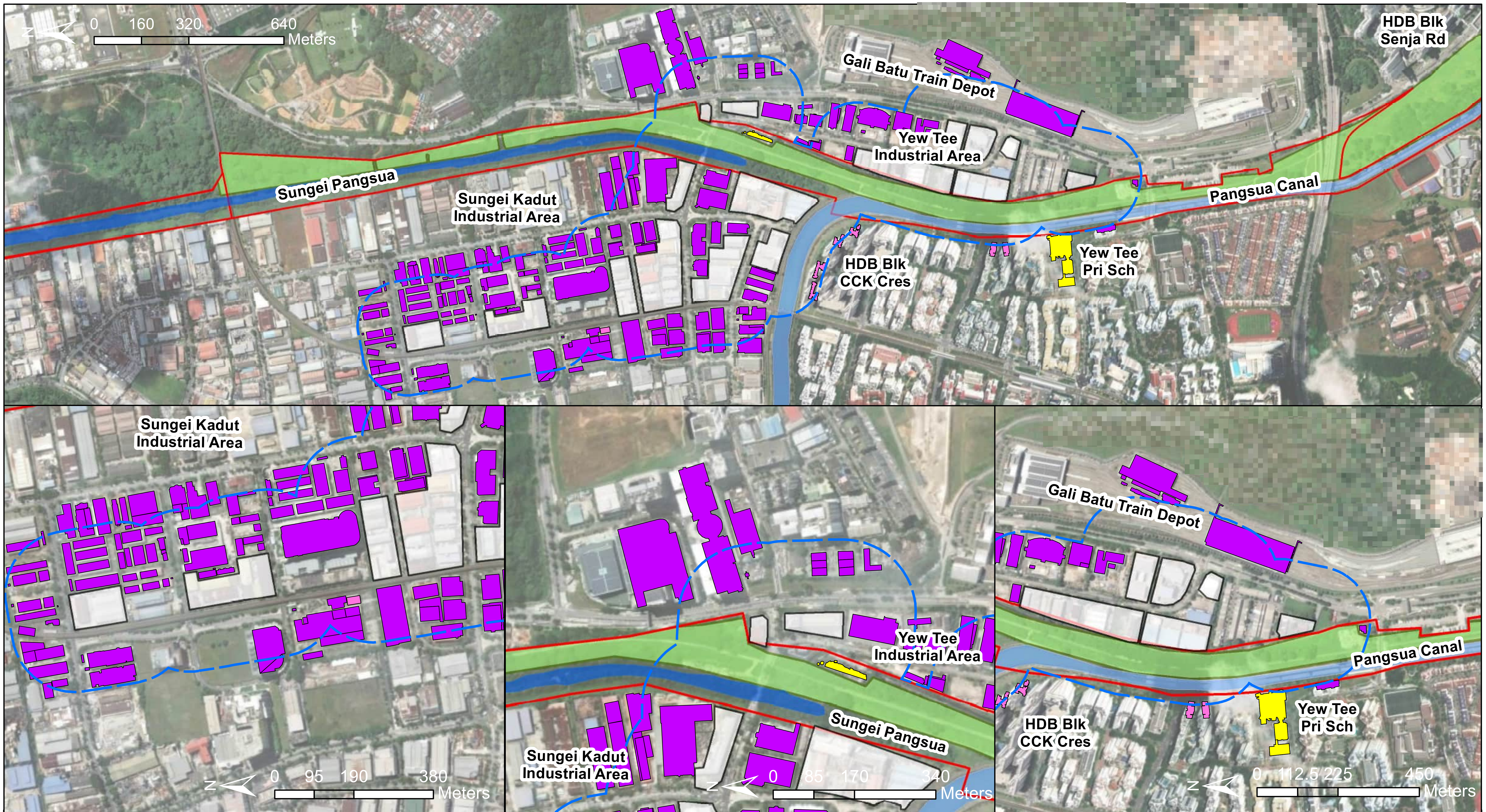
No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
72	Sunray Building	Industrial	Priority 3	N1	8	105
73	Systmz Pte Ltd	Industrial	Priority 3	N1	3	80
74	Tai Giap Pte Ltd	Industrial	Priority 3	N1	1/ 2	7
75	Tan Chiang's Brothers Marble, Hot Spring Stone Pte Ltd	Industrial	Priority 3	N1	2	0
76	Tat Hong, THT Academy, 19 Sungei Kadut Ave	Commercial/ Industrial	Priority 3	N5	2	5
77	Teck Tong Furniture Decoration Co, Yee San Interior Design & Decoration	Commercial/ Industrial	Priority 3	N1	1/ 2	1
78	The Stone Gallery by Hafary, S Power Super Mart, Sun Petgamart	Commercial/ Industrial	Priority 3	N2	8/ 12	75
79	Tien Seng Marble Pte, 38 Sungei Kadut St 1	Industrial	Priority 3	N1	2	128
80	Tong Guan Plant	Industrial	Priority 3	N3	1/ 2	26
81	Topzone E&C Pte Ltd	Industrial	Priority 3	N3	4	137
82	Venture Logistics & Engineering Pte Ltd	Industrial	Priority 3	N1	1/ 2	3
83	White Horse Ceramic (S) Pte Ltd	Industrial	Priority 3	N1	2	104
84	Wong Coco Pte, Fashion Home	Commercial/ Industrial	Priority 3	N1	2	107
85	Xiong Lue Furniture Pte Ltd	Commercial/ Industrial	Priority 3	N1	1/ 2	0
86	Yew Tee Primary School	Educational Institution	Priority 1	N4	4	145
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction						
1	15 Sungei Kadut Street 2	Industrial	Priority 3	N2	1/ 3	20
2	15 Sungei Kadut Street 2, Worker's Dormitory	Residential	Priority 2	N2	4	0
3	20 The Windermere	Residential	Priority 2	N4	24	135
4	21 Sungei Kadut Avenue, Worker's Dormitory	Residential	Priority 2	N5	3	119
5	21 Sungei Kadut Street 1	Industrial	Priority 3	N5	2	37
6	25 Sungei Kadut Street 1	Industrial	Priority 3	N1	2	74
7	25J Sungei Kadut Street 1	Industrial	Priority 3	N1	1	5
8	40 The Quintet	Residential	Priority 2	N4	22	143
9	42 The Quintet	Residential	Priority 2	N4	20	143
10	Admira Pte Ltd	Industrial	Priority 3	N1	2	137

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
11	Brighton Furniture Display Centre, 46 Sungei Kadut Ave	Commercial/ Industrial	Priority 3	N1	2	50
12	Castilla Singapore	Industrial	Priority 3	N1	3	13
13	Chong Sun Wood Products Pte Ltd, Pan Star Wood Marketing Pte Ltd	Industrial	Priority 3	N1	2	32
14	Chop Kim Huat	Industrial	Priority 3	N1	2	40
15	Da Di Glass	Industrial	Priority 3	N3	5	51
16	Durotech Industries (S) Pte Ltd, 15 Sungei Kadut Way	Industrial	Priority 3	N1	2	46
17	Eurokars Group	Commercial/ Industrial	Priority 3	N3	3	71
18	Ewins Pte, uberGARD	Industrial	Priority 3	N1	2	93
19	Gali Batu MRT Depot (SBS Transit)	Commercial	Priority 3	N3	1/ 2	54
20	Grandwork Building	Commercial/ Industrial	Priority 3	N1	1/ 5	48
21	HDB Block 627, Senja Road	Residential	Priority 2	N7a	30	134
22	HDB Block 632A, Senja Road	Residential	Priority 2	N7a	8/ 12	18
23	HDB Block 632B, Senja Road	Residential	Priority 2	N7a	7/ 15	62
24	HDB Block 633, Senja Road	Residential	Priority 2	N7a	1	73
25	HDB Block 633A, Senja Road	Residential	Priority 2	N7a	26	56
26	HDB Block 633B, Senja Road	Residential	Priority 2	N7a	32	44
27	HDB Block 633C, Senja Road	Residential	Priority 2	N7a	31	97
28	HDB Block 633D Senja Road	Residential	Priority 2	N7a	25	126
29	HDB Block 634A, Senja Road	Residential	Priority 2	N7a	24	11
30	HDB Block 634B, Senja Road	Residential	Priority 2	N7a	24	73
31	HDB Block 634C, Senja Road	Residential	Priority 2	N7a	24	38
32	HDB Block 635 Senja Road	Residential	Priority 2	N7a	34	82
33	HDB Block 635A, Senja Road	Residential	Priority 2	N7a	34	17
34	HDB Block 635B, Senja Road	Residential	Priority 2	N7a	28	77
35	HDB Block 635C, Senja Road	Residential	Priority 2	N7a	2	114
36	HDB Block 656, Choa Chu Kang	Residential	Priority 2	N4	24	100
37	HDB Block 660, Choa Chu Kang	Residential	Priority 2	N4	22	124
38	HDB Block 661, Choa Chu Kang	Residential	Priority 2	N4	24	59
39	HDB Block 662, Choa Chu Kang	Residential	Priority 2	N4	22	29

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
40	HDB Block 663 Choa Chu Kang Crescent	Residential	Priority 2	N4	20	39
41	HDB Block 664 Choa Chu Kang Crescent	Residential	Priority 2	N4	20	86
42	HDB Block 665 Choa Chu Kang Crescent	Residential	Priority 2	N4	20	115
43	HDB Block 666 Choa Chu Kang Crescent	Residential	Priority 2	N4	20	146
44	HDB Block 688C Choa Chu Kang Crescent	Residential	Priority 2	N4	20	130
45	HDB Block 689A, Choa Chu Kang	Residential	Priority 2	N4	22	140
46	HDB Block 690 Choa Chu Kang Crescent	Residential	Priority 2	N4	1	115
47	HDB Block 690A Choa Chu Kang Crescent	Residential	Priority 2	N4	24	88
48	HDB Block 690B Choa Chu Kang Crescent	Residential	Priority 2	N4	24	131
49	HDB Block 690C, Choa Chu Kang	Residential	Priority 2	N4	26	62
50	HDB Block 690D, Choa Chu Kang	Residential	Priority 2	N4	26	3
51	HDB Block 691, Choa Chu Kang	Residential	Priority 2	N4	2	40
52	HDB Block 691A, Choa Chu Kang	Residential	Priority 2	N4	26	20
53	HDB Block 691B, Choa Chu Kang	Residential	Priority 2	N4	26	1
54	HDB Block 692A, Choa Chu Kang	Residential	Priority 2	N4	26	135
55	HDB Block 692B, Choa Chu Kang	Residential	Priority 2	N4	26	49
56	Hup Huat Timber Co (Singapore) Pte Ltd	Industrial	Priority 3	N1	2	100
57	Jae Auto, 48A Sungei Kadut Ave	Industrial	Priority 3	N1	3	36
58	Jennings Trading Enterprise Pte	Industrial	Priority 3	N1	1/ 2	33
59	Joo Cheng Enterprise	Industrial	Priority 3	N1	3	26
60	JS Timber Pte Ltd, 14 Sungei Kadut St 3	Industrial	Priority 3	N1	4	150
61	JTC Trendspace	Industrial	Priority 3	N1	10	10
62	KAFER Prostar Pte Ltd	Industrial	Priority 3	N1	2	86
63	Kenwood Industries Pte Ltd	Industrial	Priority 3	N1	2	45
64	KT&T Group of Contractors	Industrial	Priority 3	N1	2	24
65	LHT Holdings Limited	Industrial	Priority 3	N1	2/ 3	96
66	Likok Paper Recycling, Wang Lai Construction Eng Pte Ltd, Rigger's Int Supp	Industrial	Priority 3	N1	2/ 3	28
67	Load Controls Systems Pte, Thi Foundation Equipment Pte Ltd	Industrial	Priority 3	N3	4	80
68	Macllord Industrial Pte Ltd	Industrial	Priority 3	N1	1/ 2/ 5	71
69	MRC Global (Singapore) Pte	Industrial	Priority 3	N3	2	92

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
70	Nexxis Asia Pte	Industrial	Priority 3	N1	1/ 2	35
71	Nova Furnishing Centre, X'clusive Home Furnitures	Commercial/ Industrial	Priority 3	N1	3	86
72	Pan-United Concrete Pte Ltd 15 Sungei Kadut St 3	Industrial	Priority 3	N1	2	150
73	Redwood Interior Pte, DDG Glass Pte, Zola Design Pte Ltd	Commercial/ Industrial	Priority 3	N1	2	86
74	Samco Civil Engineering Pte Ltd, Double-Trans Pte	Industrial	Priority 3	N1	1/ 4	150
75	Sen Wan Timber (S) Pte Ltd, Ann Ta Building Materials & Wooden Pdts Supp	Industrial	Priority 3	N1	1/ 2/ 4	33
76	Seng Hin Sawmill Co (Singapore) Pte Ltd	Industrial	Priority 3	N1	1/ 2	45
77	Soon Timber Trading Pte	Industrial	Priority 3	N1	2/ 4	109
78	Sri Arasakesari Sivan Temple, Yew Tee BalaVihar	Place of Worship	Priority 1	NM1	3	126
79	STAR Living 52 Sungei Kadut Drive	Commercial/ Industrial	Priority 3	N1	4	64
80	Sungei Kadut Fire Post	Fire Post	Priority 3	N1	1/ 2	44
81	Sunray Building	Commercial/ Industrial	Priority 3	N1	8	92
82	Tai Giap Pte Ltd	Industrial	Priority 3	N1	1/ 2	7
83	Tat Hong Training Centre, 19 Sungei Kadut Ave	Commercial/ Industrial	Priority 3	N5	2	7
84	The Stone Gallery by Hafary, S Power Super Mart, Sun Petgamart	Commercial/ Industrial	Priority 3	N2	8/ 12	63
85	Thong Huat Brothers Pte Ltd	Industrial	Priority 3	N3	1	83
86	Tiong Aik Building	Industrial	Priority 3	N1	4	107
87	Tong Guan Plant	Industrial	Priority 3	N3	1/ 2	72
88	Topzone E&C Pte Ltd	Industrial	Priority 3	N3	4	137
89	Welead Pte Ltd. 81 Sungei Kadut Drive	Industrial	Priority 3	N1	2	100
90	West View Primary School	Educational Institution	Priority 1	N7a	3/ 4	85
91	Xiong Lue Furniture Pte Ltd	Commercial/ Industrial	Priority 3	N1	1/ 2	0
92	Yew Tee Primary School	Educational Institution	Priority 1	N4	3/ 4	141

No	Noise Sensitive Receptors	Receptor Type/ Nature of Business	Receptor Sensitivity	Nearest Sound Level Meter (SLM)	Number of Storeys	Distance from nearest Proposed Construction Worksite
Scenario 3: Potential Future Infrastructure, Reception Track Cut and Cover Areas, and Vehicular Bridge Construction						
1	20 The Windemere	Residential	Priority 2	N4	24	134
2	28 The Windemere	Residential	Priority 2	N4	24	141
3	30 The Windemere	Residential	Priority 2	N4	8	114
4	32 The Windemere	Residential	Priority 2	N4	23	107
5	36 The Quintet	Residential	Priority 2	N4	18	81
6	38 The Quintet	Residential	Priority 2	N4	22	68
7	40 The Quintet	Residential	Priority 2	N4	22	39
8	42 The Quintet	Residential	Priority 2	N4	20	15
9	44 The Quintet	Residential	Priority 2	N4	22	28
10	46 The Quintet	Residential	Priority 2	N4	18	35
11	88 Mandai Estate	Industrial	Priority 3	N3	3	104
12	Da Di Glass	Industrial	Priority 3	N3	5	50
13	Eurokars Group	Commercial/ Industrial	Priority 3	N3	3	69
14	Gali Batu MRT Depot (SBS Transit)	Residential	Priority 2	N3	1/ 2/ 9	1
15	HDB Block 656, Choa Chu Kang	Residential	Priority 2	N1	24	80
16	HDB Block 657, Choa Chu Kang	Residential	Priority 2	N1	22	118
17	HDB Block 661, Choa Chu Kang	Residential	Priority 2	N1	24	111
18	HDB Block 691, Choa Chu Kang	Residential	Priority 2	N1	2	143
19	HDB Block 692A, Choa Chu Kang	Residential	Priority 2	N1	26	53
20	HDB Block 692B, Choa Chu Kang	Residential	Priority 2	N1	26	96
21	Hup Huat Glass Pte	Industrial	Priority 3	N3	2/ 3	94
22	Ichiban Glass Construction	Industrial	Priority 3	N3	2	93
23	Immedia Tower 4, Seidensha Singapore Pte Ltd, Suites Technologies Pte	Industrial	Priority 3	N3	8	114
24	JSM Construction Group Pte Ltd	Industrial	Priority 3	N3	2	15
25	KT&T Group of Contractors	Industrial	Priority 3	N1	2	27
26	Load Controls Systems Pte, Thi Foundation Equipment Pte Ltd	Industrial	Priority 3	N3	4	65
27	Mandai 66kV SPPG	Industrial	Priority 3	N3	1/ 3	45
28	MRC Global (Singapore) Pte	Industrial	Priority 3	N3	2	47
29	NS Trading Pte Ltd	Industrial	Priority 3	N3	3	55



Legend

- Scenario 1: Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Pang Sua Canal
- Sungei Pang Sua
- Biodiversity Study Area
- Existing Vegetated Area

Human Receptors

- Priority 1
- Priority 2
- Priority 3

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement :
N/A

LTA Endorsement :
N/A

Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

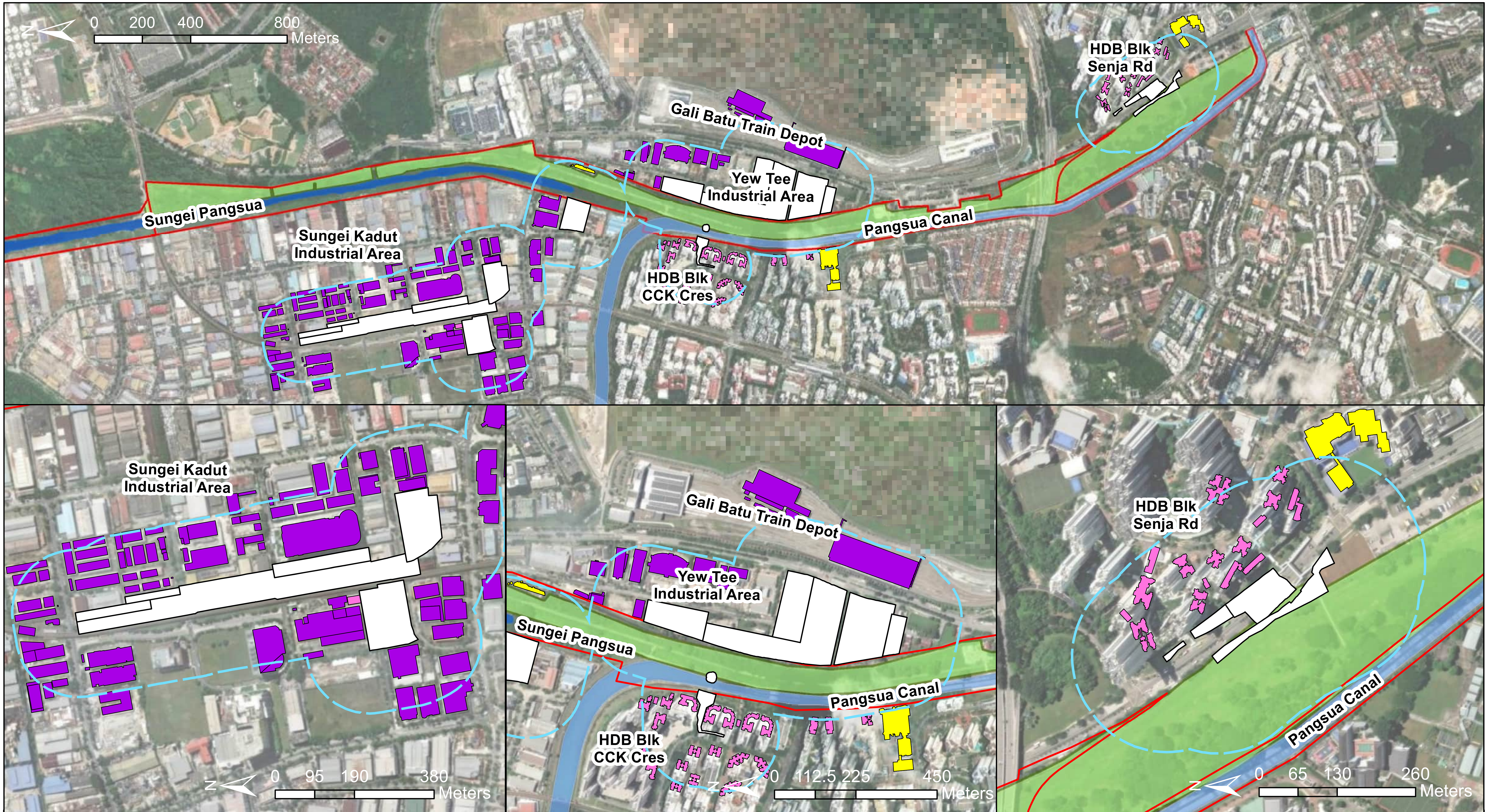
Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
HUMAN RECEPTORS (SCENARIO 1: ADVANCED WORKS)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-11	B	1 of 1

	Drawn	Date	CAD File Name	Size
	SYT	MAY 2023	N/A	A3

Note: Source of basemap - OneMap and Open Street Map



Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Human Receptors

- Priority 1
- Priority 2
- Priority 3

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

Project Title :

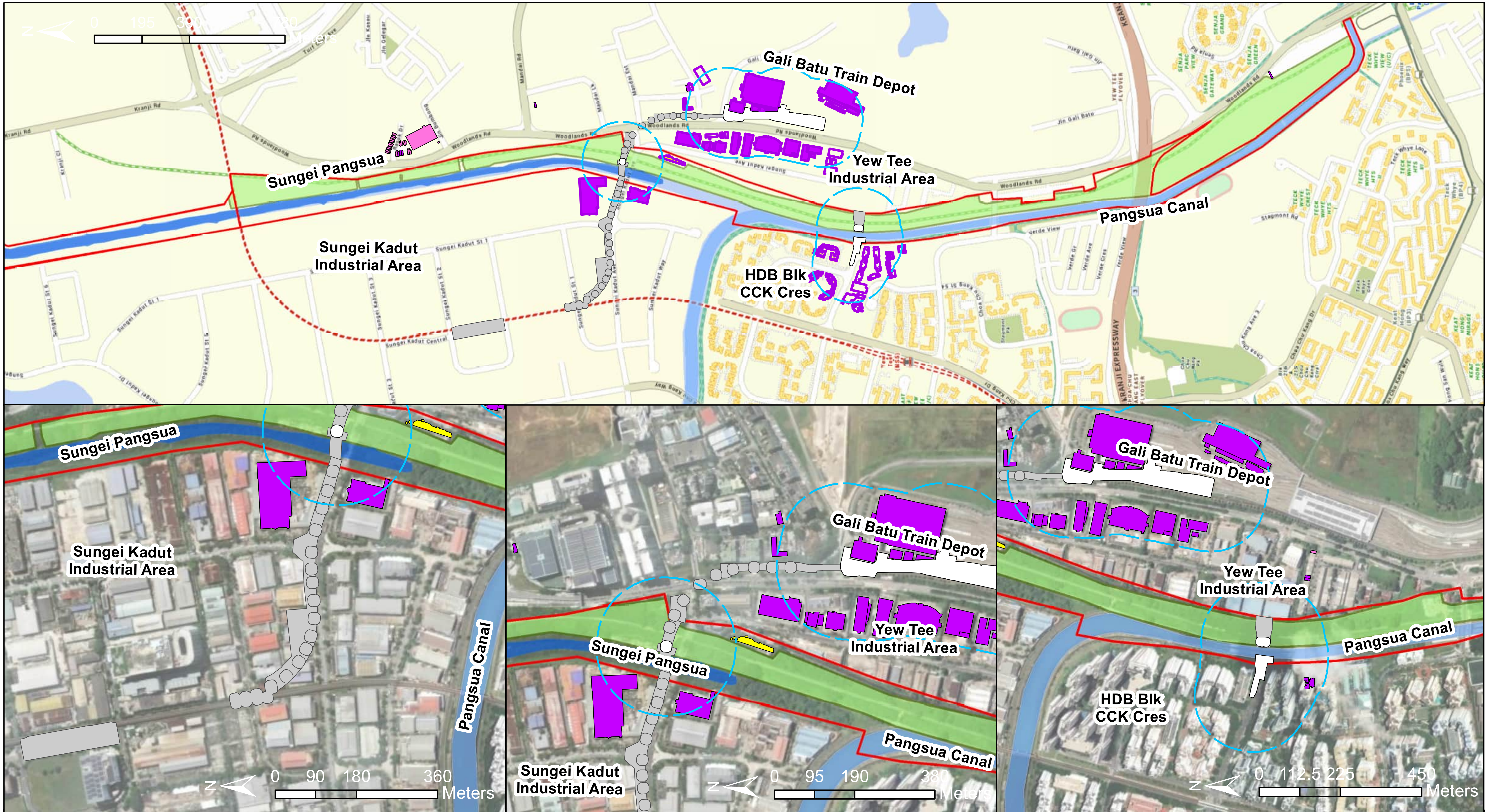
CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

HUMAN RECEPTORS (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-12	B	1 of 1
	Drawn: SYT	Date: MAY 2023	CAD File Name :N/A	-	A3

Note: Source of basemap - GoogleEarth Maps



Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Human Receptors

- Priority 1
- Priority 2
- Priority 3

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

Land Transport Authority
We Keep Your World Moving

Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
HUMAN RECEPTORS
(SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION)

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-13	B	1 of 1
	Drawn: SYT	Date: MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps

10.4.2 Operational Phase

10.4.2.1 Ecological Receptors

Ecological receptors considered for assessment of noise impacts arising from the operational phase are similar to ecological NSRs within the Biodiversity Study Area identified for the construction phase as discussed in Section 10.4.1.1 above. With necessary and adequate mitigation measures implemented for the construction phase to reduce noise impacts on the ecological receptors, similar fauna species identified surrounding the proposed construction worksites and within/ surrounding the Project site prior to construction works, should continue to inhabit the surrounding areas.

It is advised that faunistic survey and baseline noise monitoring be conducted upon completion of the construction phase and commencement of the operational phase to determine the new baseline conditions and fauna species that remain in the vicinity of the proposed construction worksites to determine actual operational noise impacts.

10.4.2.2 Human Receptors

The human NSRs identified for assessment for operational noise impacts are detailed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. Table 10-23 and Table 10-24 shows the summary of number of NSRs identified as part of the Traffic NIA Study Report and NVS Preliminary Report.

Table 10-23 Summary of Airborne Noise Receptors (Traffic NIA)

No.	Noise Sensitive Receptors
01	40 The Quintet
02	42 The Quintet
03	44 The Quintet
04	HDB Block 692A Choa Chu Kang Crescent

Table 10-24 Summary of Airborne Noise Receptors (NVS)

Classification of Ground-borne Noise and Ground-borne Vibration Receptors	Number of Receptors Considered for Prediction
Sensitive	0
Least Sensitive	Industrial – 7 Reserved Site – 5
Total	12

10.5 Airborne Noise Baseline Findings

This section discusses on the locations where baseline airborne noise monitoring was conducted within the respective study areas for construction and operational noise impact assessment established around the above-ground Project sites (refer to Section 3).

The baseline airborne noise monitoring survey dates were as follows:

- 14 July 2021 – 20 July 2021;
- 08 November 2021 – 14 November 2021; and
- 03 December 2021 – 16 December 2021.

10.5.1 Construction Phase

Noise monitoring was conducted within the bounds of the Airborne Noise Study Area to develop an understanding of the existing natural ambient noise conditions experienced by the NSRs and to develop the specific construction noise criteria for the Project to analyse the impacts on the NSRs later in Section 10.7.

The baseline airborne noise monitoring locations are presented in Figure 10-3, distributed across areas near noise sensitive premises such as educational institutions (i.e., Teck Whye Secondary School), residential estates (i.e., HDB at Senja residential subzone, Choa Chu Kang Crescent), commercial/ industrial estates (i.e., Sungei Kadut Industrial Area, industrial/ commercial sites along Woodlands Road), and green/ forested sites used by both human and ecological NSRs (i.e., Rail Corridor, Sungei Pang Sua and Pang Sua Canal).

The human and ecological NSRs at these areas also presents as existing ambient noise sources along with noise arising from the interlacing traffic networks (i.e., road networks, elevated viaduct of NSL MRT) within the 150 m Airborne Noise Study Area. As such the existing baseline noise profiles can be studied based on the NSRs in proximity to the noise monitoring locations.

For baseline noise monitoring locations N6, N8 and NM1 sited near more noise sensitive sites such educational institution, green/ forested sites such as Rail Corridor along Sungei Pang Sua and the Pang Sua Canal, baseline noise levels were observed to be relatively lower in general. This is because these areas are generally away from the sight of traffic networks and noisy industrial/ commercial establishments, with the noise contributors likely from patrons on foot/ wheels to the Rail Corridor or fauna traversing the area.

While for noise levels captured at locations N7a – N7c, situated near the residential estates, noise levels near the Senja residential subzone were observed to be relatively high, dominated by traffic noise arising from Woodlands Road. On the contrary, while location N4 is sited near the Choa Chu Kang Crescent residential estate, baseline noise levels captured were observed to be lower as N4 is abutting the Rail Corridor and at a distance from noisy establishments or traffic networks.

For baseline noise monitoring locations sited near industrial/ commercial sites such as N1, N2 located within the Sungei Kadut Industrial Area, N3 and N5 located along Woodlands Road, it was observed that noise levels captured at these sites are generally higher due to noise contributions from industrial related activities and traffic noise. Baseline noise levels captured at N1 and N2 are dominated by the NSL MRT trains passing overhead, as well as traffic noise from Sungei Kadut Street 2 and Sungei Kadut Central. While for baseline noise levels captured at N3, the noise levels are influenced by noise arising from nearby commercial activities as well as traffic noise along Woodlands Road. Location N5 on the other hand, while not located along any traffic networks with the location fronting the Rail Corridor, is dominated by high levels of noise arising from nearby industrial activities.

Table 10-25 below summarizes the $L_{Aeq(12\ hour)}$, $L_{Aeq(1\ hour)}$ and $L_{Aaq(5\ min)}$ baseline airborne noise results captured for Weekdays (Monday – Saturday) and Weekend/ Public Holidays (Sundays/ Public Holidays) at the locations near the above-ground Project sites, within the 150 m Airborne Noise Study Area for the construction phase.

As mentioned in Section 10.2.3.2.1 baseline airborne noise information collected for the HDB CCK N1 EIS Project [R-92] have also been referenced and adopted in this study. The baseline airborne noise levels captured at the two (2) monitoring locations representative ambient noise levels experienced by ecological NSRs found in the green area within the Biodiversity Study Area (South of KJE) are reflected in Table 10-26.

Table 10-25 Summary of Baseline Noise Monitoring Results (Construction Phase)

Location		Date	Type of Affected Buildings^ (if applicable)	$L_{Aeq(12 hours)}$, dB		$L_{Aeq(1 hour)}$, dB						$L_{Aeq(5 mins)}$, dB								
				7am – 7pm	7pm – 7am	7pm – 10pm			10pm – 7am			7am – 7pm			7pm – 10pm			10pm – 7am		
				Overall		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Overall (Monday – Sunday/ Public Holiday) – applicable to Ecological Receptors																				
N6	Along Rail Corridor on side opposite and facing Windermere Residences	9 December 2021 – 15 December 2021	N/A – applicable to Ecological NSRs#	53	51	48	58	51	49	52	51	43	68	51	46	**61**	51	48	**56**	51
NM1	Along Rail Corridor near Sungei Kadut Avenue	3 December 2021 – 9 December 2021	N/A – applicable to Ecological NSRs#	55	**51**	51	55	53	48	53	51	49	**59**	55	49	**57**	53	47	55	51
Weekdays (Monday – Saturday) – applicable to Human Receptors																				
N1	Vicinity of Nexxis Asia Pte. Ltd., Sungei Ka dut Street 3	14 July 2021 – 20 July 2021	(c) Industrial, Commercial	65	60	56	69	63	45	62	54	44	74	65	47	**74**	62	42	70	52
N2	JTC Lot No. MK11-00541K near The Stone Gallery by Hafary, Sungei Kadut Central	14 July 2021 – 20 July 2021	(c) Industrial, Commercial	62	57	59	63	61	42	59	50	53	74	61	55	69	61	41	66	49
N3	Vicinity of JSM Construction Group Pte Ltd facing Woodlands Road	3 December 2021 – 9 December 2021	(c) Industrial, Commercial	63	59	60	63	61	53	61	57	57	70	63	58	65	61	50	66	57
N4	Vicinity of HDB Block 691B facing Pang Sua Canal	10 December 2021 – 16 December 2021	(b) Residential	54	51	47	59	51	46	**62**	49	46	64	53	46	60	51	45	**67**	49
N5	Vicinity of commercial buildings such as Chong Timber Pte Ltd, along Rail Corridor	9 December 2021 – 15 December 2021	(c) Industrial, Commercial	**66**	**67**	49	**82**	56	47	**87**	57	46	**99**	58	45	**89**	54	46	**92**	53
N7a	HDB Block 632A Senja Road – Ground Level	8 November 2021 – 14 November 2021	(b) Residential	66	62	63	**67**	64	55	**64**	**60**	60	73	65	62	67	64	51	**66**	**60**
N7b	HDB Block 632A Senja Road – Mid-level	8 November 2021 – 14 November 2021	(b) Residential	67	64	65	**68**	**66**	**58**	**66**	**62**	63	76	68	64	69	66	54	**68**	**62**
N7c	HDB Block 632A Senja Road – Top-level	8 November 2021 – 14 November 2021	(b) Residential	67	63	64	**67**	65	**57**	**65**	**61**	63	73	67	63	68	65	53	**67**	**61**
N8	Near Teck Whye Secondary School, facing the Pang Sua Canal	14 July 2021 – 20 July 2021	(a) Educational Institution	52	49	49	52	51	46	51	48	47	64	51	48	**58**	51	45	53	48
NM1*	Along Rail Corridor near Sungei Kadut Avenue	3 December 2021 – 9 December 2021	(a) Place of Worship; (c) Industrial, Commercial	55	**51**	52	55	53	48	53	51	51	59	55	51	**57**	53	47	55	51
Weekend (Sunday/ Public Holidays) – applicable to Human Receptors																				
N1	Vicinity of Nexxis Asia Pte. Ltd., Sungei Kadut Street 3	14 July 2021 – 20 July 2021	(c) Industrial, Commercial	61	56	N/A	N/A	N/A	N/A	N/A	N/A	54	69	61	49	64	57	43	66	57
N2	JTC Lot No. MK11-00541K near The Stone Gallery by Hafary, Sungei Kadut Central	14 July 2021 – 20 July 2021	(c) Industrial, Commercial	62	55	N/A	N/A	N/A	N/A	N/A	N/A	51	69	60	56	61	58	41	59	54
N3	Vicinity of JSM Construction Group Pte Ltd facing Woodlands Road	3 December 2021 – 9 December 2021	(c) Industrial, Commercial	60	58	N/A	N/A	N/A	N/A	N/A	N/A	57	65	60	58	63	60	49	62	56
N4	Vicinity of HDB Block 691B facing Pang Sua Canal	10 December 2021 – 16 December 2021	(b) Residential	51	48	N/A	N/A	N/A	N/A	N/A	N/A	47	61	50	47	51	48	45	51	47
N5	Vicinity of commercial buildings such as Chong Timber Pte Ltd, along Rail Corridor	9 December 2021 – 15 December 2021	(c) Industrial, Commercial	49	**73**	N/A	N/A	N/A	N/A	N/A	N/A	46	53	49	47	51	49	48	92	51
N7a	HDB Block 632A Senja Road – Ground Level	8 November 2021 – 14 November 2021	(b) Residential	63	60	N/A	N/A	N/A	N/A	N/A	N/A	61	65	63	**60**	**64**	**63**	52	**64**	**58**

Location		**Date**	**Type of Affected Buildings^ (if applicable)**	**$L_{Aeq(12\ hours)}$, dB**		**$L_{Aeq(1\ hour)}$, dB**						**$L_{Aeq(5\ mins)}$, dB**								
				7am – 7pm	**7pm – 7am**	**7pm – 10pm**			**10pm – 7am**			**7am – 7pm**			**7pm – 10pm**			**10pm – 7am**		
				Overall		**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**
N7b	HDB Block 632A Senja Road – Mid-level	8 November 2021 – 14 November 2021	(b) Residential	65	63	N/A	N/A	N/A	N/A	N/A	N/A	63	68	65	**63**	**66**	**65**	53	**66**	**61**
N7c	HDB Block 632A Senja Road – Top-level	8 November 2021 – 14 November 2021	(b) Residential	65	62	N/A	N/A	N/A	N/A	N/A	N/A	61	68	65	63	67	65	54	**66**	**60**
N8	Near Teck Whye Secondary School, facing the Pang Sua Canal	14 July 2021 – 20 July 2021	(a) Educational Institution	52	48	N/A	N/A	N/A	N/A	N/A	N/A	48	64	51	48	51	50	45	52	49
NM1*	Along Rail Corridor near Sungei Kadut Avenue	3 December 2021 – 9 December 2021	(a) Place of Worship; (c) Industrial, Commercial	52	**51**	N/A	N/A	N/A	N/A	N/A	N/A	49	58	52	49	52	51	49	54	51

Note: N/A – Not Applicable
^ Refer to Section 10.2.5, detailing the Type of Affected Buildings and the relevant construction noise criteria.
** Baseline noise data captured at NM1 will be used for assessment of construction noise impacts of the construction of the potential future infrastructure to the nearby noise sensitive receptors.*
*Baseline noise levels exceeding the most stringent construction noise criteria associated with the type of affected buildings are indicated in **Bold**.*
*# Baseline noise levels captured at locations representative of ecological NSRs (see Table 10-1 and Table 10-2 for justification) are compared against the most-stringent NEA construction noise criteria with exceedances indicated in **Bold**.*

Table 10-26 Summary of Baseline Noise Monitoring Results (Secondary Data, Construction Phase)

Location		**Date**	**Type of Affected Buildings^ (if applicable)**	**$L_{Aeq(12\ hours)}$, dB**		**$L_{Aeq(1\ hour)}$, dB**						**$L_{Aeq(5\ mins)}$, dB**								
				7am – 7pm	**7pm – 7am**	**7pm – 10pm**			**10pm – 7am**			**7am – 7pm**			**7pm – 10pm**			**10pm – 7am**		
				Overall		**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**	**Min**	**Max**	**Ave**
Overall (Monday – Sunday/ Public Holiday) – applicable to Ecological Receptors																				
R01	Green Area within HDB CCK N1 EIS Study Area (Northern)	09 September – 16 September 2022	N/A – applicable to Ecological NSRs	60	**60**	59	62	61	53	69	58	**57**	**70**	**60**	**59**	**68**	**60**	52	**71**	**58**
R02	Green Area within HDB CCK N1 EIS Study Area (Southern)	11 August – 17 August 2022	N/A – applicable to Ecological NSRs	54	**54**	50	60	55	49	60	53	46	**69**	52	49	**62**	54	48	**62**	53

Note: N/A – Not Applicable
*# Baseline noise levels captured at locations representative of ecological NSRs (see Table 10-3 for justification) are compared against the most-stringent NEA construction noise criteria with exceedances indicated in **Bold**.*

10.5.1.1 Traffic Count Survey

Traffic count was conducted for roads abutting baseline noise monitoring locations near traffic namely: N1; N2; N3; and N7 for the time periods of 7am – 8am, 12pm – 1pm, and 6pm – 7pm representative of AM Peak, PM Peak, and OFF Peak periods respectively.

Table 10-27 below presents the total volume of traffic captured of four (4) classes – cars/ taxis; trucks, motorcycles, and buses. More details on the distribution of traffic volume based on the four (4) classes are provided in Appendix EE.

Woodlands Road is a major arterial road connecting Kranji to Bukit Panjang. As observed, traffic volume on Woodlands Road serving industrial/ commercial and residential areas N3 and N7 remains relatively high throughout the day with the heaviest traffic observed during the AM Peak and PM Peak.

While for roads serving industrial/ commercial areas such as N1 and N2, traffic volumes remain relatively low throughout the day, with higher recorded volumes during PM Peak and OFF Peak likely attributed to work related transportation required (e.g., delivery of items, receiving of deliveries such as raw material for manufacturing industries).

Table 10-27 Summary of Traffic Count Findings (Construction Phase) – Hourly Data

Location		Date	Direction/ Movement	Time Period			Remarks
				7am – 8am	12pm – 1pm	6pm – 7pm	
N1	Vicinity of Nexxis Asia Pte. Ltd., Sungei Kadut Street 3	24 May 2023	Eastbound	96	119	127	Fine weather
			Westbound	76	107	67	
N2	JTC Lot No. MK11-00541K near The Stone Gallery by Hafary, Sungei Kadut Central	24 May 2023	Northbound	33	57	62	Fine weather
			Southbound	54	43	49	
N3	Vicinity of JSM Construction Group Pte Ltd facing Woodlands Road	24 May 2023	Northbound	1276	609	1480	Fine weather
			Southbound	2196	996	2909	
N7	HDB Block 632A Senja Road	24 May 2023	Eastbound	2180	1134	1912	Fine weather
			Westbound	1684	964	1690	

10.5.2 Operational Phase

Table 10-28 below reflects the overall $L_{Aeq(1\ hour)}$ baseline airborne noise results captured at 25E Sungei Kadut Street 1 with the purpose of gathering existing noise levels and identifying current noise sources within the study area to understand airborne noise emissions from train operations conducted at direct line of sight of the NSL MRT trains passing overhead.

As observed, the baseline noise levels are generally higher during Daytime (7am – 7pm) and Evening-time (7pm –10pm) corresponding to train operational hours. Baseline noise levels captured at 25E Sungei Kadut Street 1 is also dominated by traffic noise from Sungei Kadut Street 1 and operations of nearby commercial/ industrial establishments.

Table 10-28 Summary of Baseline Noise Monitoring Results (Operational Phase)

Location		Date	$L_{Aeq(1\ hour)}$, dB								
			7am – 7pm			7pm – 10pm			10pm – 7am		
			Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
1	25E Sungei Kadut Street 1	11 November 2021 – 14 November 2021	54	68	62	53	64	58	38	62	50
Note: $L_{Aeq(1\ hour)}$ noise levels captured reflects operational train noise from existing NSL MRT and current noise sources such as traffic noise and noise from nearby commercial/ industrial establishments (refer to standalone NVS Preliminary Report for more details)											

While Table 10-29 below reflects the $L_{Aeq(1\ hour)}$ baseline airborne noise levels captured to determine the ambient noise levels corresponding to peak traffic period (6:00pm – 7:00pm) from traffic count conducted on Choa Chu Kang North 7 (LTA Category 3 Road – Minor Arterial Road) and Choa Chu Kang Crescent (LTA Category 4 Road – Primary Access) (refer to separate standalone Traffic NIA Study Report for more information) near the elevated vehicular bridge proposed and under planning to connect Choa Chu Kang North 7 on the West of Pang Sua Canal and Woodlands Road on the East of Pang Sua Canal. The baseline noise levels captured were similarly dominated by traffic noise from Choa Chu Kang North 7 and Choa Chu Kang Crescent.

Table 10-29 Summary of Baseline Noise Monitoring Results (Operational Phase) – extracted from Traffic NIA report

Location		Date	Traffic Peak Period $L_{Aeq(1\ hour)}$, dB*
NMT01	HDB Block 656 Choa Chu Kang Crescent	28 July 2021	60
NMT02	HDB Block 692A Choa Chu Kang Crescent	28 July 2021	61
*Note: * $L_{Aeq(1\ hour)}$ noise level captured corresponds to peak traffic from 6:00pm – 7:00pm (refer to standalone Traffic NIA report for more details)*			

10.5.3 Corrected Noise Criteria

Based on the baseline airborne noise monitoring results and noise correction factor detailed in Section 10.5.1, the corrected noise criteria for airborne noise impact assessment were deduced respectively for the ecological and human receptors in this section for the construction phase.

As discussed in Section 10.5.1.1, the corrected noise criteria for the operational phase were not deduced and omitted from this report due to the lack of detailed design information necessary to capture the appropriate baseline noise levels required for the establishment of the corrected noise criterion.

10.5.3.1 Construction Phase

10.5.3.1.1 Ecological Receptors

As mentioned in Section 10.2.5.1.1, there are currently no guidelines or standards available to assess construction noise impacts on the ecological receptors. Thus, an average baseline noise criteria of $L_{Aeq(5\ mins)}$ 54dB was derived from the logarithmic average of overall baseline noise levels captured at N6 and NM1 (see Table 10-25) representative of ambient noise levels experienced by ecological NSRs within the Biodiversity Study Area (North of KJE).

Furthermore, as discussed in Section 10.5.1 baseline airborne noise information collected for the HDB CCK N1 EIS Project were referenced and adopted in this study representative of ambient noise levels experienced by ecological NSRs found in the green area within the Biodiversity Study Area (South of KJE). Based on the overall baseline noise levels captured at R01 and R02 (see Table 10-26), $L_{Aeq(5\ mins)}$ 60dB and 52dB were adopted respectively for the green area next to KJE and further from KJE.

Unlike human receptors which are defined as fixed establishments/ buildings, it is difficult to pinpoint the exact locations of mobile ecological receptors to conduct construction noise impact assessment. As such, $L_{Aeq(5\ mins)}$ baseline noise monitoring results at N6, NM1, R01, and R02 were selected as representative of the noise levels experienced by the ecological NSRs residing/ traversing through the various patches within the Project site as discussed in Section 10.5.1.

This approach was taken as part of a conservative means that if no noise exceedances is predicted when compared to these stringent criteria, the airborne noise impact on fauna in the vicinity is also not expected to experience noise levels exceeding the established criteria.

It should be noted that only ground-dwelling fauna found at heights of up to 0.5 m was assessed in this ES under the assumption that ground-dwelling fauna will face the most severe impacts due to noise emissions arising from the construction phase while arboreal fauna typically found at height are likely to flee the area during periods of high noise disturbances.

Table 10-30 Noise criteria established for Ecological Receptors

Location	Noise Criteria for $L_{Aeq(5\ mins)}$, dB
Biodiversity Study Area (North of KJE)	54
Biodiversity Study Area (South of KJE), next to KJE	60
Biodiversity Study Area (South of KJE), further from KJE	52

10.5.3.1.2 Human Receptors

The corrected construction noise criteria for human receptors was deduced using the average recorded baseline noise levels for $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ at N1, N2, N3, N4, N5, N7a – N7c, N8, and NM1 to calculate the adjusted maximum permissible noise levels in accordance with the EPM, 2008 [R-22]. Table 10-31 below reflects the corrected construction noise criteria for Weekdays (Monday – Saturday) and Weekends (Sunday/ Public Holidays).

Detailed calculations on the derivation of the corrected construction noise criteria from the correction factors (refer to Section 10.2.5.1.2) are provided in Appendix V.

Table 10-31 Corrected noise criteria for construction phase

Location		Noise Criteria for $L_{Aeq(12\ hours)}$, dB		Noise Criteria for $L_{Aeq(1\ hour)}$, dB		Noise Criteria for $L_{Aeq(5\ mins)}$, dB		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
Weekdays (Monday – Saturday)								
N1	(c) Industrial, Commercial	76	66	NA	NA	90	71	70
N2	(b) Residential	75	66	NA	NA	90	71	70
	(c) Industrial, Commercial	75	66	NA	NA	90	71	70
N3	(c) Industrial, Commercial	75	66	NA	NA	90	71	70
N4	(a) Educational Institution	61	54	NA	NA	75	57	56
	(b) Residential	75	NA	65	56	90	70	56
	(c) Industrial, Commercial	75	65	NA	NA	90	70	70
N5	(b) Residential	76	NA	66	59	90	70	58
	(c) Industrial, Commercial	76	69	NA	NA	90	70	70
N7a	(a) Welfare Home	67	62	NA	NA	76	65	61
	(b) Residential	76	NA	68	61	90	71	61
	(c) Industrial, Commercial	76	67	NA	NA	90	71	70
N7b	(b) Residential	76	NA	69	63	90	72	63
N7c	(b) Residential	76	NA	68	62	90	71	62
N8	(a) Educational Institution	61	53	NA	NA	75	56	56
NM1*	(a) Place of Worship	61	54	NA	NA	75	58	56
	(c) Industrial, Commercial	75	65	NA	NA	90	70	70
Weekend (Sunday/ Public Holidays)								
N1	(c) Industrial, Commercial	75	66	NA	NA	90	70	70
N2	(b) Residential	75	NA	67	56	75	60	60
	(c) Industrial, Commercial	75	65	NA	NA	90	70	70
N3	(c) Industrial, Commercial	75	66	NA	NA	90	70	70
N4	(a) Educational Institution	61	52	NA	NA	75	56	56
	(b) Residential	75	NA	65	56	75	56	56
	(c) Industrial, Commercial	75	65	NA	NA	90	70	70

Location		Noise Criteria for $L_{Aeq(12\ hours)}$, dB		Noise Criteria for $L_{Aeq(1\ hour)}$, dB		Noise Criteria for $L_{Aeq(5\ mins)}$, dB		
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am
N5	(b) Residential	75	NA	66	59	75	56	56
	(c) Industrial, Commercial	75	74	NA	NA	90	70	70
N7a	(a) Welfare Home	65	60	NA	NA	75	64	60
	(b) Residential	75	NA	68	61	75	64	60
	(c) Industrial, Commercial	75	66	NA	NA	90	71	70
N7b	(b) Residential	75	NA	69	63	76	66	62
N7c	(b) Residential	75	NA	68	62	75	66	61
N8	(a) Educational Institution	61	52	NA	NA	75	56	56
NM1*	(a) Place of Worship	61	54	NA	NA	75	56	56
	(c) Industrial, Commercial	75	65	NA	NA	90	70	70

Note: N/A – Not Applicable
In accordance with the EPM 2008 Regulation, $L_{Aeq(1\ hour)}$ is not assessed for Weekends and is hence indicated as NIL.

10.5.3.2 Operational Phase

The applicable corrected noise criterion for the assessment of operational noise impacts on human NSRs is detailed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report.

10.5.3.2.1 Ecological Receptors

As addressed in Section 10.2.5.2.1, due to an absence of adequate research data on criterions applicable for the assessment of operational noise impacts on ecological NSRs, with no current existing established guidelines or standards, a more-stringent criterion of no-worse-off than the average of baseline was adopted for the purpose of assessment in this ES. Thus, the average baseline monitoring results in Table 10-25 were used to establish the assessment criteria for operational noise impact on ecological receptors as reflected in Table 10-30, same as that established for construction noise impact assessment.

10.5.3.2.2 Human Receptors

The noise criteria extracted from the NVS Preliminary Report is $L_{Aeq(1\ hour)}$ 71 dB for industrial receptors, applicable to human NSRs and determined based on the baseline findings for the operational phase.

While the noise criteria extracted from the Traffic NIA Report is $L_{Aeq(1\ hour)}$ 67 dB at the façade of residential human NSRs based on the TNIA Guidelines, 2016.

10.6 Minimum Control Measures

This section proposes minimum controls or standard practices commonly implemented in Singapore for the purposes of impact assessment. Generally, the minimum control has also considered design optimization detailed in Section 3.2.1.

10.6.1 Construction Phase

The list below is non-exhaustive and should be practiced as minimum control to reduce noise levels during the construction phase of the Project:

- All machinery and equipment used shall be labelled with a weather-proof sticker clearly indicating its noise emission level (at source) under normal operating conditions;
- All machinery and equipment used on site should be sound reduced, as far as is practicable;
- Stationary noisy equipment should be housed in enclosures on site where necessary;
- Machine operators and workers must be trained and briefed on quieter work techniques;
- Ad-hoc noise monitoring must be carried out when work progresses during noisy operations;
- Additional noise measures should be implemented when noise monitoring indicates the noise levels are approaching or exceeding permissible noise levels;
- Avoid shouting, whistling, sirens, or similar loud intermittent noises especially near ecologically sensitive receptors which can be impacted by them;
- Minimize noise disturbances by restricting construction activities that are not safety critical to 8am – 6pm;
- Concrete walls along boundary of premises selected for building demolition (if any) shall not be removed until demolition is complete; and
- Apply noise reduction netting of a rating of STC18 or higher on all façades of buildings selected for demolition

10.6.2 Operational Phase

No minimum control measures were proposed as part of the NVS Preliminary Report and Traffic Noise Impact Assessment Report.

10.7 Prediction and Evaluation of Airborne Noise Impacts

This section discusses on the predicted noise impacts arising from noise emissions associated with activities of the construction and operational phases proposed for this Project on the ecological and human NSRs.

10.7.1 Construction Phase

In this section, construction noise impacts arising from Scenario 1: Advanced Works, Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction, and Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction, identified for assessment in Sections 10.7.1.1 and 10.7.1.1.6, and rock breaking and excavation, identified for assessment in Section 10.7.1.2.6, are presented for the NSRs.

10.7.1.1 Ecological Receptors

As discussed in Section 10.4.1.1, the assessment of airborne noise impacts on ecological NSRs have considered areas within the Biodiversity Study Area suitable in supporting the presence of fauna. These areas include the Rail Corridor, Sungei Pang Sua, and the Pang Sua Canal. Based on faunistic field findings, the Rail Corridor and Sungei Pang Sua were delimited as areas of Priority 1, while the Pang Sua Canal was delimited as an area of Priority 2.

It should be noted that only ground-dwelling fauna found at heights of up to 0.5 m were assessed in this ES under the assumption that ground-dwelling fauna will face the most severe impacts due to noise emissions arising from the construction phase. While arboreal fauna typically found at heights are likely to flee the area during periods of high noise disturbances. Ecological NSRs within the proposed construction worksites will not be assessed for airborne noise impacts as they are directly impacted by the habitat removal which takes precedence over airborne noise impacts.

Impact Significance of **Moderate** and **Major** are of concern as high noise levels could render the area uninhabitable for noise sensitive fauna species forcing them to flee and abandon the area. Adaptation to a higher ambient noise levels during construction works could occur but is not determinable at this stage. As such, it is recommended that faunistic field surveys be conducted during the construction phase to study the behavioural impacts on fauna species within the Biodiversity Study Area.

10.7.1.1.1 Scenario 1: Advanced Works

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of 4.0 – 27.0 dB(A) arising from construction works proposed for Scenario 1: Advanced Works (see Table 10-32) during the time period of 7am – 7pm.

The resulting Impact Intensity of **High** – **Medium** (refer to Table 6-6) within the Rail Corridor and Sungei Pang Sua due to the maximum predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Low** – **High** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with Scenario 1 would range from **Moderate** – **Major** (refer to Table 6-9).

10.7.1.1.2 Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of 16.0 – 35.0 dB(A) arising from construction works proposed for Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction (see Table 10-32) during the time period of 7am – 7pm.

The resulting Impact Intensity of **High** (refer to Table 6-6) within the Rail Corridor and Sungei Pang Sua due to the maximum predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Medium** – **High** (refer to Table 6-7). When relating the Impact Consequence to a

Likelihood of Occurrence of **Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with Scenario 2 would range from **Moderate** – **Major** (refer to Table 6-9) during the day time.

10.7.1.1.3 Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of 8.0 – 30.0 dB(A) for construction works proposed for Scenario 2: Main Civil Works (see Table 10-32) during the time period of 7pm – 7am.

The resulting Impact Intensity of **High** (refer to Table 6-6) within the Rail Corridor and Sungei Pang Sua due to the maximum predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Medium** – **High** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with Scenario 2 would range from **Moderate** – **Major** (refer to Table 6-9) during the night time.

10.7.1.1.4 Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of 34.0 – 36.0 dB(A) for construction works proposed for Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (see Table 10-32) during the time period of 7am – 7pm.

The resulting Impact Intensity of **High** (refer to Table 6-6) within the Rail Corridor and Sungei Pang Sua due to the maximum predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Medium** – **High** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with Scenario 2 would range from **Moderate** – **Major** (refer to Table 6-9) during the day time.

10.7.1.1.5 Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)

Based on the results predicted by the noise models, ecological NSRs are not predicted to experience noise exceedances for construction works proposed for Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (see Table 10-32) during the time period of 7pm – 7am.

The resulting Impact Intensity of **Negligible** (refer to Table 6-6) within the Rail Corridor and Sungei Pang Sua due to the no predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Imperceptible** – **Very Low** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with Scenario 2 would range from **Negligible** – **Minor** (refer to Table 6-9) during the night time.

Table 10-32 Summary of Construction Noise Impacts for Ecological Receptors, Base Scenario

Assessment Scenario(s)	Ecological Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
Scenario 1: Advanced Works							
Scenario 1: Advanced Works	Priority 1	81.0	27.0	High	High	Likely	Major
	Priority 2	58.0	4.0	Medium	Low	Likely	Moderate
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction							
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day)	Priority 1	89.0	35.0	High	High	Likely	Major
	Priority 2	70.0	16.0	High	Medium	Likely	Moderate
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night)	Priority 1	84.0	30.0	High	High	Likely	Major
	Priority 2	62.0	8.0	High	Medium	Likely	Moderate
Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction							
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day)	Priority 1	90.0	36.0	High	High	Likely	Major
	Priority 2	88.0	34.0	High	Medium	Likely	Moderate
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)	Priority 1	49.0	-	Negligible	Very Low	Likely	Minor
	Priority 2	46.0	-	Negligible	Imperceptible	Likely	Negligible

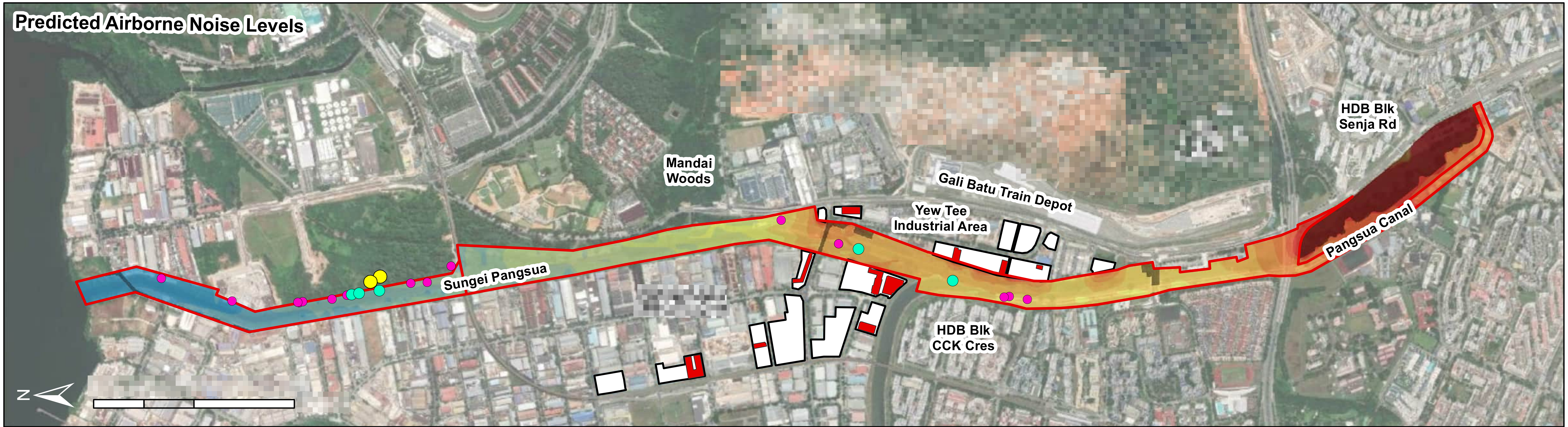
Table 10-33 below reflects the distribution of areas of respective Unmitigated Impact Significance within the Biodiversity Study Area, studied for airborne noise impacts on ecological NSRs. As observed, without any mitigation measures, while the highest recorded Impact Significance is determined to be **Major** for all three (3) assessment scenarios, the distribution of Impact Significance by area reflects that there remains a significant amount of area subjected to less severe noise impacts open for use by more mobile fauna.

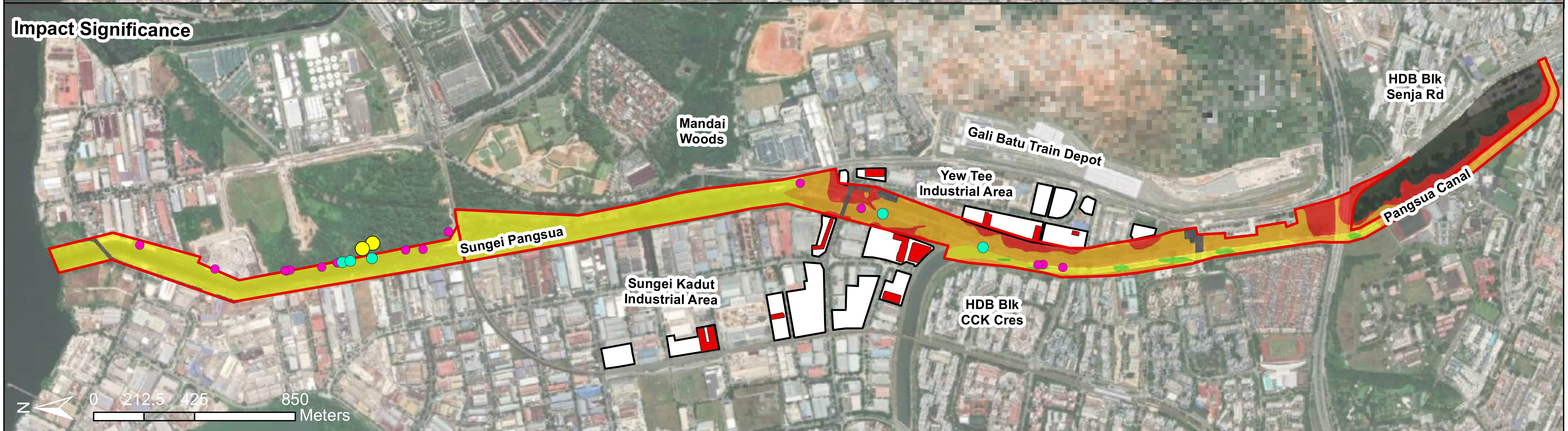
While there is a possibility that more mobile fauna will likely experience lower levels of Impact Significance from airborne construction noise due to their ability to flee to areas less impacted by severe noise levels, in consideration for less mobile fauna potentially traversing in close proximity to these noise sources, noise mitigation measures were proposed to mitigate the noise impacts on ecological NSRs to as low as reasonably practicable (ALARP) and are discussed later below in Section 10.8.

Table 10-33 Distribution of area of Unmitigated Impact Significance within Biodiversity Study Area for $L_{Aeq(5 mins)}$, dB

Assessment Scenario(s)	Distribution of Impact Significance by area, ha			
	Negligible	Minor	Moderate	Major
Scenario 1: Advanced Works				
Scenario 1: Advanced Works	7.6	50.5	12.9	6.6
Distribution of area, ha	58.1		19.5	
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction				
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day)	0	36.8	17	23.8
Distribution of area, ha	36.8		40.8	
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Night)	0	44.1	19.1	14.5
Distribution of area, ha	44.1		33.6	
Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction				
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day)	0	35.7	21.0	20.9
Distribution of area, ha	35.7		41.9	
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)	9.5	68.3	0	0
Distribution of area, ha	77.8		0	

The resulting predicted airborne noise levels and Impact Significance map representative of the three (3) assessment scenarios are visualized in Figure 10-14 to Figure 10-18 for $L_{Aeq(5 mins)}$.





Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area

Predicted Airborne Noise Levels

LAeq(5 mins), dB

<= 36	54 - 57
36 - 39	57 - 60
39 - 42	60 - 63
42 - 45	63 - 66
45 - 48	66 - 69
48 - 51	>= 69
51 - 54	

Impact Significance

- Negligible
- Minor
- Moderate
- Major

N

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B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm (SCENARIO 1: ADVANCED WORKS) BASE SCENARIO

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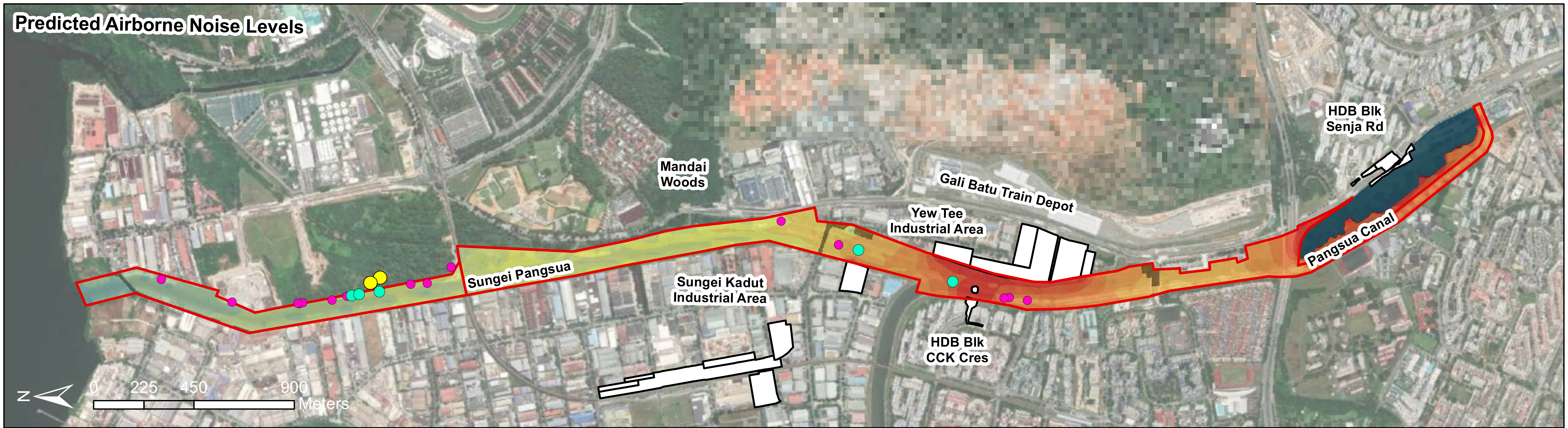
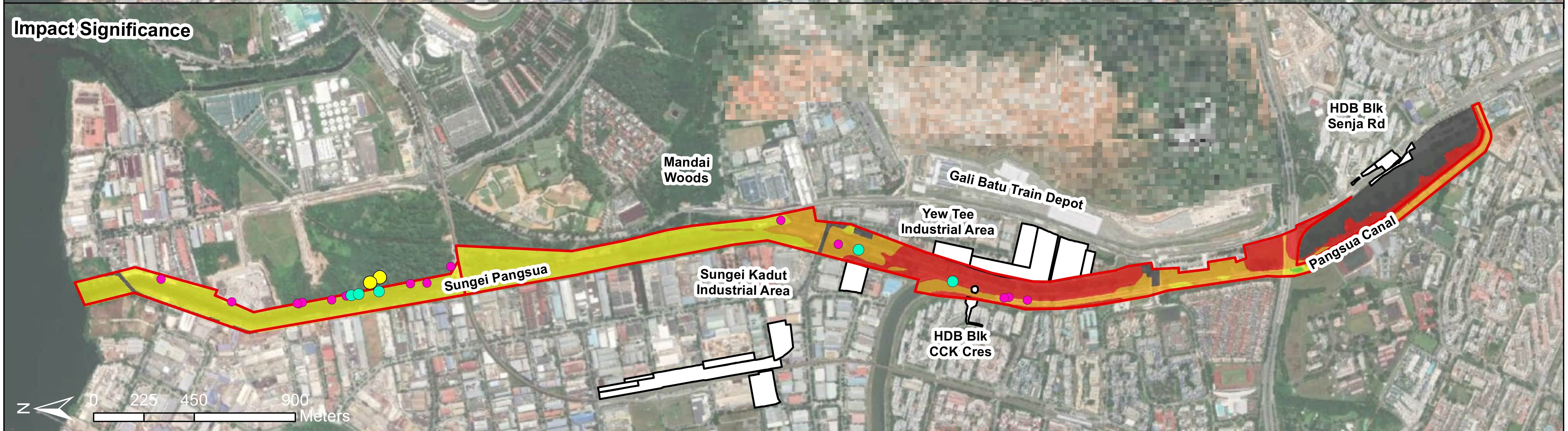
Figure No.	Rev.	Sheet
10-14	B	1 of 1

CAD File Name :N/A | A3

Note: Source of basemap - GoogleEarth Maps





Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area

Predicted Airborne Noise Levels

LAeq(5 mins), dB

- <= 36
- 36 - 39
- 39 - 42
- 42 - 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- >= 69

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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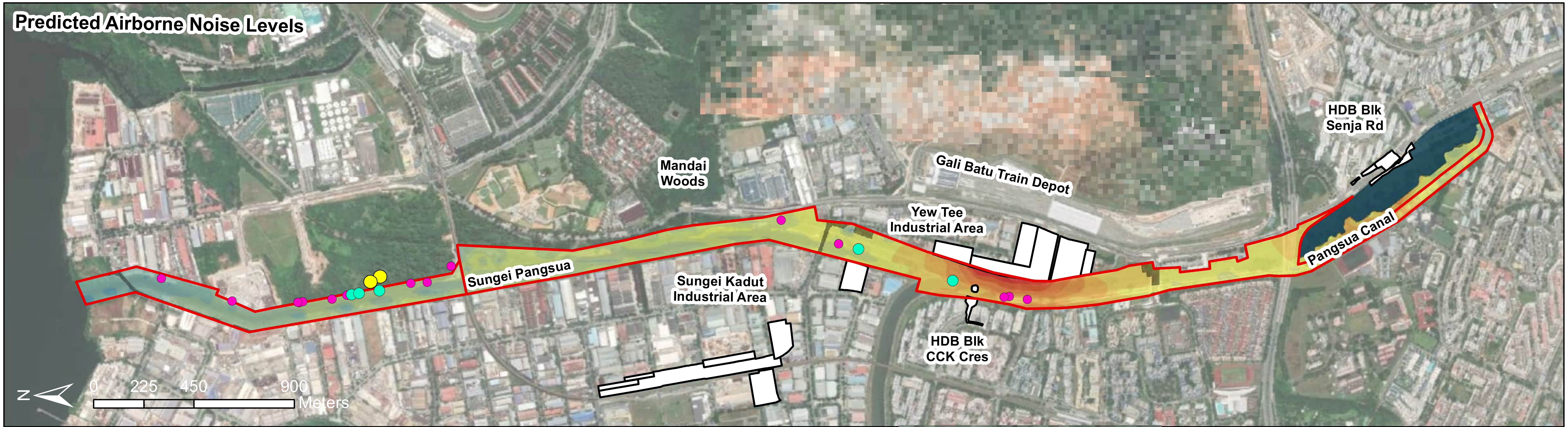
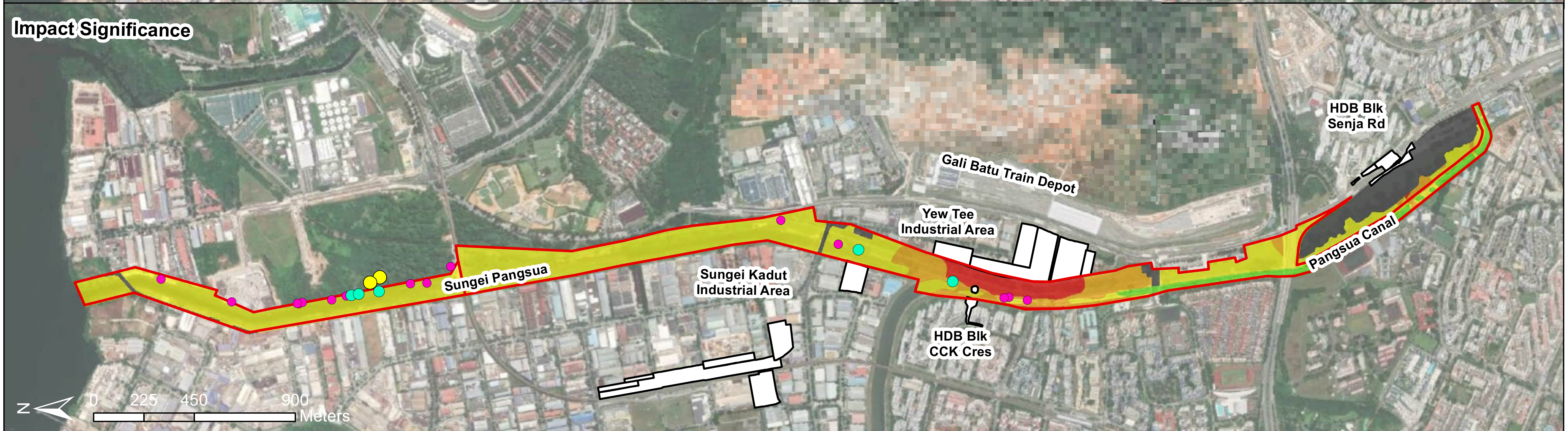
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm, (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-15	B	1 of 1
	Drawn SYT	Date MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps





Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area

Other Concurrent Projects

- HDB CCK N1 Worksite Areas (Concurrent Development)*

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier (HDB CCK N1)
- Proposed 12m Vertical Noise Barrier (HDB CCK N1)

Note: *No night-works for HDB CCK N1.

Predicted Airborne Noise Levels
LAeq(5 mins), dB

- <= 36
- 36 - 39
- 39 - 42
- 42 - 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- >= 69

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7pm - 10pm, 10pm - 7am (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
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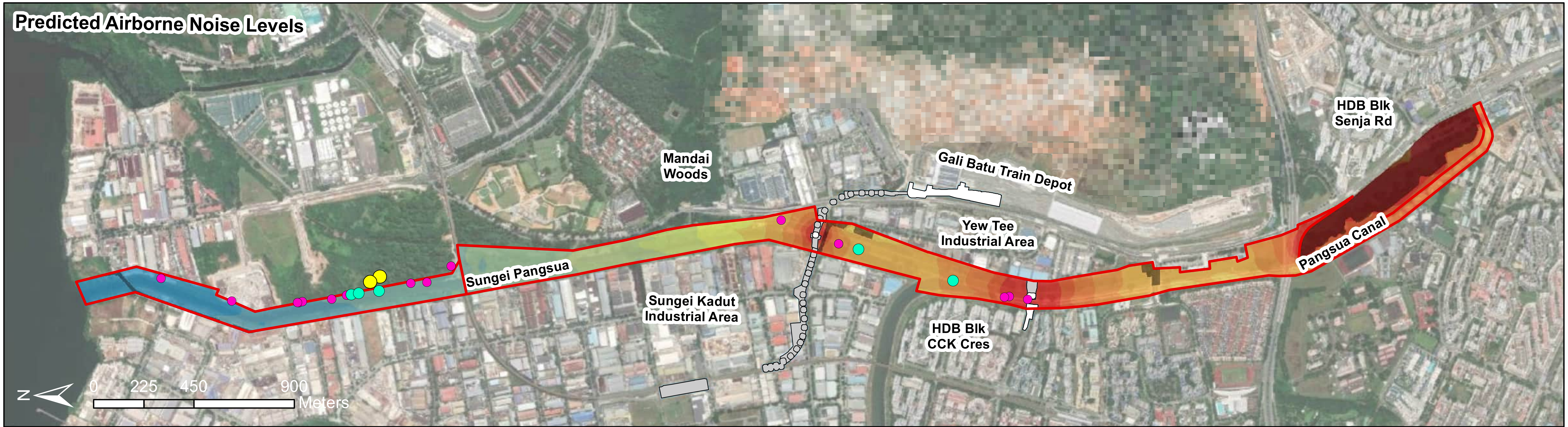

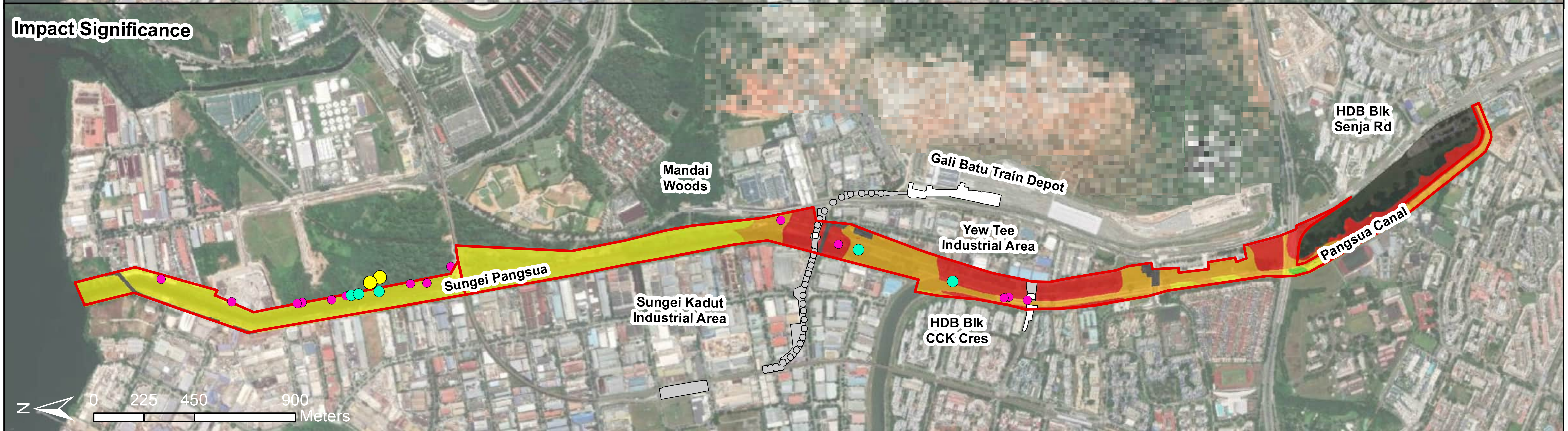

Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area

Predicted Airborne Noise Levels
LAeq(5 mins), dB

<= 36	54 - 57
36 - 39	57 - 60
39 - 42	60 - 63
42 - 45	63 - 66
45 - 48	66 - 69
48 - 51	>= 69
51 - 54	

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK CUT AND COVER AREAS, AND VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-17	B	1 of 1
	Drawn: SYT	Date: MAY 2023	CAD File Name :N/A		A3

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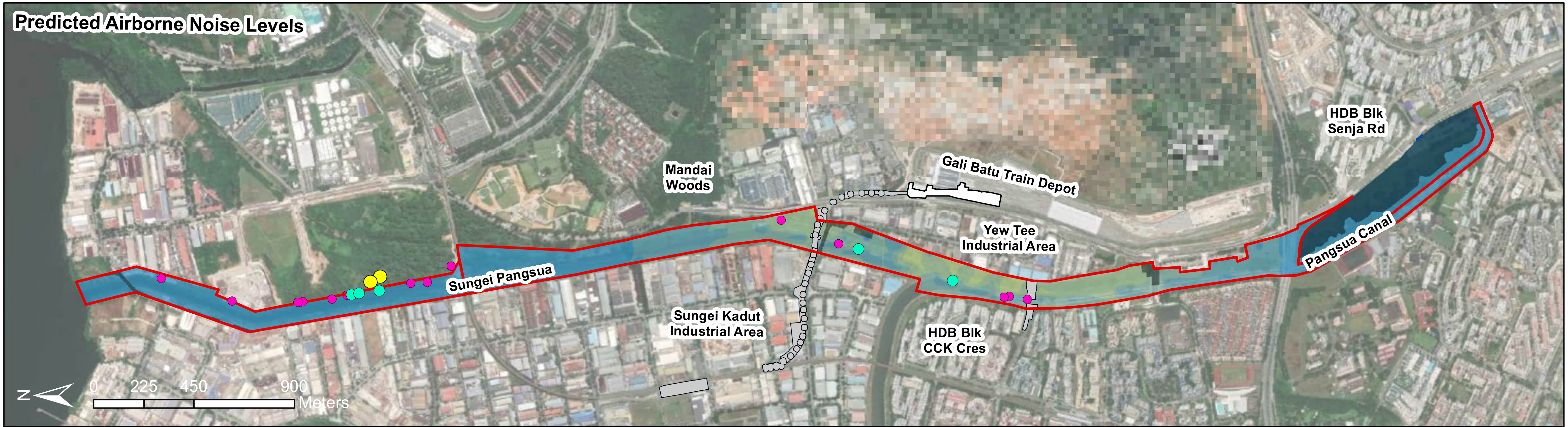

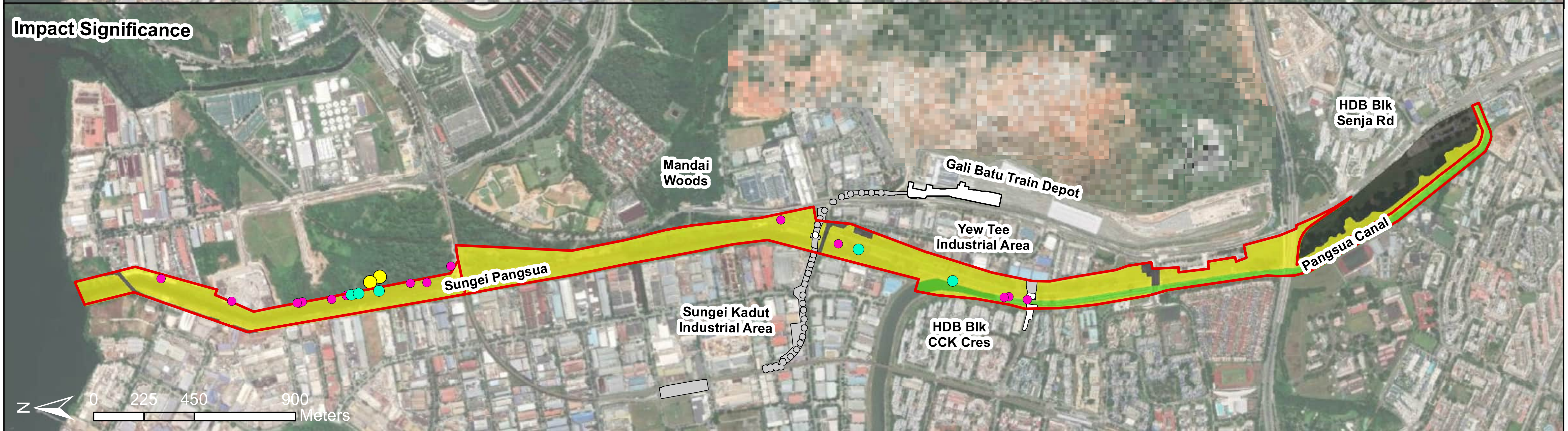

Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Cut and Cover Areas, and Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area

Predicted Airborne Noise Levels
LAeq(5 mins), dB

- <= 36
- 36 - 39
- 39 - 42
- 42 - 45
- 45 - 48
- 48 - 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- >= 69

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7pm - 7am (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK CUT AND COVER AREAS, AND VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

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A3

Note: Source of basemap - GoogleEarth Maps

10.7.1.1.6 Rock Breaking and Excavation

The approximate distance from Sungei Kadut Cut and Cover Station to the nearest boundary of the ecological NSRs, demarcated by the Biodiversity Study Area, is 535.0 m. Based on the approach mentioned in Section 10.3.1.6, the air overpressure for an MIC of 5.8 kg from Sungei Kadut Cut and Cover Station is 122 dB at a distance of 535.0 m from ecological NSRs based on formula (2). The summary of the prediction and evaluation of airborne noise – rock breaking and excavation impacts at less than 150 m from the Sungei Kadut Cut and Cover Station is presented in Table 10-34.

Due to air overpressure from rock breaking and excavation from the Sungei Kadut Cut and Cover Station, the Priority 1 ecological NSRs were predicted to experience **Low** Impact Intensity (see Table 6-6) with a corresponding Impact Consequence of **Low** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Certain** (see Table 10-16), an Impact Significance of **Moderate** (refer to Table 6-9) was determined to arise from the proposed activity. With an Impact Significance of **Moderate**, mitigation measures were proposed to mitigate these impacts to ALARP as part of ground-borne noise and vibration management, detailed in Section 11.9.

Table 10-34 Summary of Prediction and Evaluation of Airborne Noise – Rock Breaking and Excavation Impacts at nearest Ecological Receptor from Sungei Kadut Cut and Cover Station, Base Scenario

Location of proposed rock breaking and excavation	Horizontal distance from worksite, m	Ecological Receptor Sensitivity	Discharge Mass (up to), kg	SPL	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Impact Significance
Sungei Kadut Cut and Cover Station	535.0	Priority 1	5.8	122	Low	Low	Certain	Moderate*
*Note: * This measure reduces the impact significance after applying the mitigation measures refer to Section 11.9, resulting in Moderate.*								

10.7.1.2 Human Receptors

This section presents the predicted noise impacts on human NSRs subjected to airborne noise from the proposed construction works.

10.7.1.2.1 Scenario 1: Advanced Works

Based on the results predicted by the noise models, human NSRs are predicted to experience noise exceedances of up to 6.8 – 7.6 dB(A) arising from construction works proposed for Scenario 1: Advanced Works for $L_{Aeq(12\ hours)}$, 7am – 7pm. No noise exceedances were predicted for $L_{Aeq(5\ mins)}$, 7am – 7pm for the Weekday.

The resulting overall Impact Intensity ranging from **Negligible** – **High** (refer to Table 6-6) due to the predicted noise exceedances, corresponds to an overall Impact Consequence ranging from **Imperceptible** – **High** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** – **Moderate** (refer to Table 6-9). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 1 to ALARP.

10.7.1.2.2 Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)

Based on the results predicted by the noise models, human NSRs are predicted to experience noise exceedances of up to 5.8 – 10.0 dB(A) arising from construction works proposed for Scenario 2: Main Civil Works for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend, and $L_{Aeq(5\ mins)}$ 7am – 7pm only on the Weekend. No noise exceedances were predicted for $L_{Aeq(5\ mins)}$, 7am – 7pm on the Weekday.

The resulting overall Impact Intensity ranging from **Negligible** – **High** (refer to Table 6-6) due to the predicted noise exceedances, corresponds to an overall Impact Consequence ranging from **Imperceptible** – **Medium** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** – **Moderate** (refer to Table 6-9). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 2 to ALARP.

10.7.1.2.3 Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)

Based on the results predicted by the noise models, human NSRs are predicted to experience noise exceedances of up to 6.2 – 22.7 dB(A) arising from construction works proposed for Scenario 2: Main Civil Works for $L_{Aeq(12\ hours)}$, 7pm – 7am, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ 7pm – 10pm, 10pm – 7am for both Weekday and Weekend.

The resulting overall Impact Intensity of **High** (refer to Table 6-6) due to the predicted noise exceedances, corresponds to an overall Impact Consequence ranging from **Low** – **High** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Minor** – **Major** (refer to Table 6-9). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 2 to ALARP.

10.7.1.2.4 Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)

Based on the results predicted by the noise models, human NSRs are predicted to experience noise exceedances of up to 1.4 – 8.9 dB(A) arising from construction works proposed for Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend, and $L_{Aeq(5\ mins)}$ 7am – 7pm only on the Weekend. No noise exceedances were predicted for $L_{Aeq(5\ mins)}$, 7am – 7pm on the Weekday.

The resulting overall Impact Intensity ranging from **Negligible** – **High** (refer to Table 6-6) due to the predicted noise exceedances, corresponds to an overall Impact Consequence ranging from **Imperceptible** – **Medium** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** – **Moderate** (refer to Table 6-9). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 3 to ALARP.

10.7.1.2.5 Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)

Based on the results predicted by the noise models, human NSRs are predicted to experience noise exceedances of up to 4.1 – 8.1 dB(A) arising from construction works proposed for Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction for $L_{Aeq(12\ hours)}$, 7pm – 7am, and $L_{Aeq(5\ mins)}$ 7pm – 10pm, 10pm – 7am for both Weekday and Weekend.

The resulting overall Impact Intensity of **High** (refer to Table 6-6) due to the predicted noise exceedances, corresponds to an overall Impact Consequence ranging from **Imperceptible** – **Low** (refer to Table 6-7). When relating the Impact Consequence to a Likelihood of Occurrence of **Occasional/ Likely** (see Table 10-15), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** – **Minor** (refer to Table 6-9).

Table 10-35 Construction Noise Impacts for Human Receptors, Base Scenario

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
Scenario 1: Advanced Works (Day Time)							
$L_{Aeq(12 hours)}$, dB (7am – 7pm)	Priority 1	68.6	7.6	High	High	Occasional	Moderate
	Priority 2	68.0	-	Negligible	Imperceptible	Occasional	Negligible
	Priority 3	82.8	6.8	High	Low	Occasional	Minor
$L_{Aeq(5 mins)}$, dB (7am – 7pm)	Priority 1	68.6	-	Negligible	Very Low	Likely	Minor
	Priority 2	68.0	-	Negligible	Imperceptible	Likely	Negligible
	Priority 3	82.8	-	Negligible	Imperceptible	Likely	Negligible
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)							
$L_{Aeq(12 hours)}$, dB, Weekday (7am – 7pm)	Priority 1	66.8	5.8	Medium	Medium	Occasional	Moderate
	Priority 2	84.6	9.6	High	Medium	Occasional	Moderate
	Priority 3	85.1	9.1	High	Low	Occasional	Minor
$L_{Aeq(5 mins)}$, dB, Weekday (7am – 7pm)	Priority 1	70.0	-	Negligible	Very Low	Likely	Minor
	Priority 2	85.0	-	Negligible	Imperceptible	Likely	Negligible
	Priority 3	85.0	-	Negligible	Imperceptible	Likely	Negligible
$L_{Aeq(12 hours)}$, dB, Weekend (7am – 7pm)	Priority 1	66.8	5.8	Medium	Medium	Occasional	Moderate
	Priority 2	84.6	9.6	High	Medium	Occasional	Moderate
	Priority 3	85.1	9.1	High	Low	Occasional	Minor
$L_{Aeq(5 mins)}$, dB, Weekend (7am – 7pm)	Priority 1	70.0	-	Negligible	Very Low	Likely	Minor
	Priority 2	85.0	10.0	High	Medium	Likely	Moderate
	Priority 3	85.0	-	Negligible	Imperceptible	Likely	Negligible
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)							
$L_{Aeq(12 hours)}$, dB, Weekday (7pm – 7am)	Priority 1	60.4	6.4	High	High	Occasional	Moderate
	Priority 2	NA	NA	NA	NA	NA	NA
	Priority 3	82.6	16.4	High	Low	Occasional	Minor
$L_{Aeq(1 hour)}$, dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	NA	NA	NA	NA	NA	NA
	Priority 2	78.7	22.7	High	Medium	Occasional	Moderate
	Priority 3	NA	NA	NA	NA	NA	NA
$L_{Aeq(5 mins)}$, dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	62.2	6.2	High	High	Likely	Major
	Priority 2	78.7	22.7	High	Medium	Likely	Moderate

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
	Priority 3	84.4	14.4	High	Low	Likely	Moderate
$L_{Aeq(12\ hours)}$, dB, Weekend (7pm – 7am)	Priority 1	60.4	8.4	High	High	Occasional	Moderate
	Priority 2	NA	NA	NA	NA	NA	NA
	Priority 3	77.6	12.6	High	Low	Occasional	Minor
$L_{Aeq(5\ mins)}$, dB, Weekend (7pm – 10pm, 10pm – 7am)	Priority 1	66.3	6.3	High	High	Likely	Major
	Priority 2	78.7	18.7	High	Medium	Likely	Moderate
	Priority 3	84.4	14.4	High	Low	Likely	Moderate
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)							
$L_{Aeq(12\ hours)}$, dB, Weekday (7am – 7pm)	Priority 1	62.4	1.4	Low	Low	Occasional	Minor
	Priority 2	83.9	8.9	High	Medium	Occasional	Moderate
	Priority 3	80.1	5.1	Medium	Very Low	Occasional	Minor
$L_{Aeq(5\ mins)}$, dB, Weekday (7am – 7pm)	Priority 1	62.4	-	Very Low	Very Low	Likely	Minor
	Priority 2	83.9	-	Negligible	Imperceptible	Likely	Negligible
	Priority 3	80.1	-	Negligible	Imperceptible	Likely	Negligible
$L_{Aeq(12\ hours)}$, dB, Weekend (7am – 7pm)	Priority 1	62.4	1.4	Low	Low	Occasional	Moderate
	Priority 2	83.9	8.9	High	Medium	Occasional	Moderate
	Priority 3	80.1	5.1	High	Low	Occasional	Minor
$L_{Aeq(5\ mins)}$, dB, Weekend (7am – 7pm)	Priority 1	62.4	-	Negligible	Very Low	Likely	Minor
	Priority 2	83.9	8.9	High	Medium	Likely	Moderate
	Priority 3	80.1	-	Negligible	Imperceptible	Likely	Negligible
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)							
$L_{Aeq(12\ hours)}$, dB, Weekday (7pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Occasional	Minor
	Priority 2	NA	NA	NA	NA	NA	NA
	Priority 3	74.1	8.1	High	Low	Occasional	Minor
$L_{Aeq(1\ hour)}$, dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	NA	NA	NA	NA	NA	NA
	Priority 2	54.0	-	Negligible	Imperceptible	Occasional	Negligible
	Priority 3	NA	NA	NA	NA	NA	NA
$L_{Aeq(5\ mins)}$, dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Likely	Minor
	Priority 2	54.0	-	Negligible	Imperceptible	Likely	Negligible
	Priority 3	74.1	4.1	Medium	Very Low	Likely	Minor
$L_{Aeq(12\ hours)}$, dB, Weekend	Priority 1	51.0	-	Negligible	Very Low	Occasional	Minor

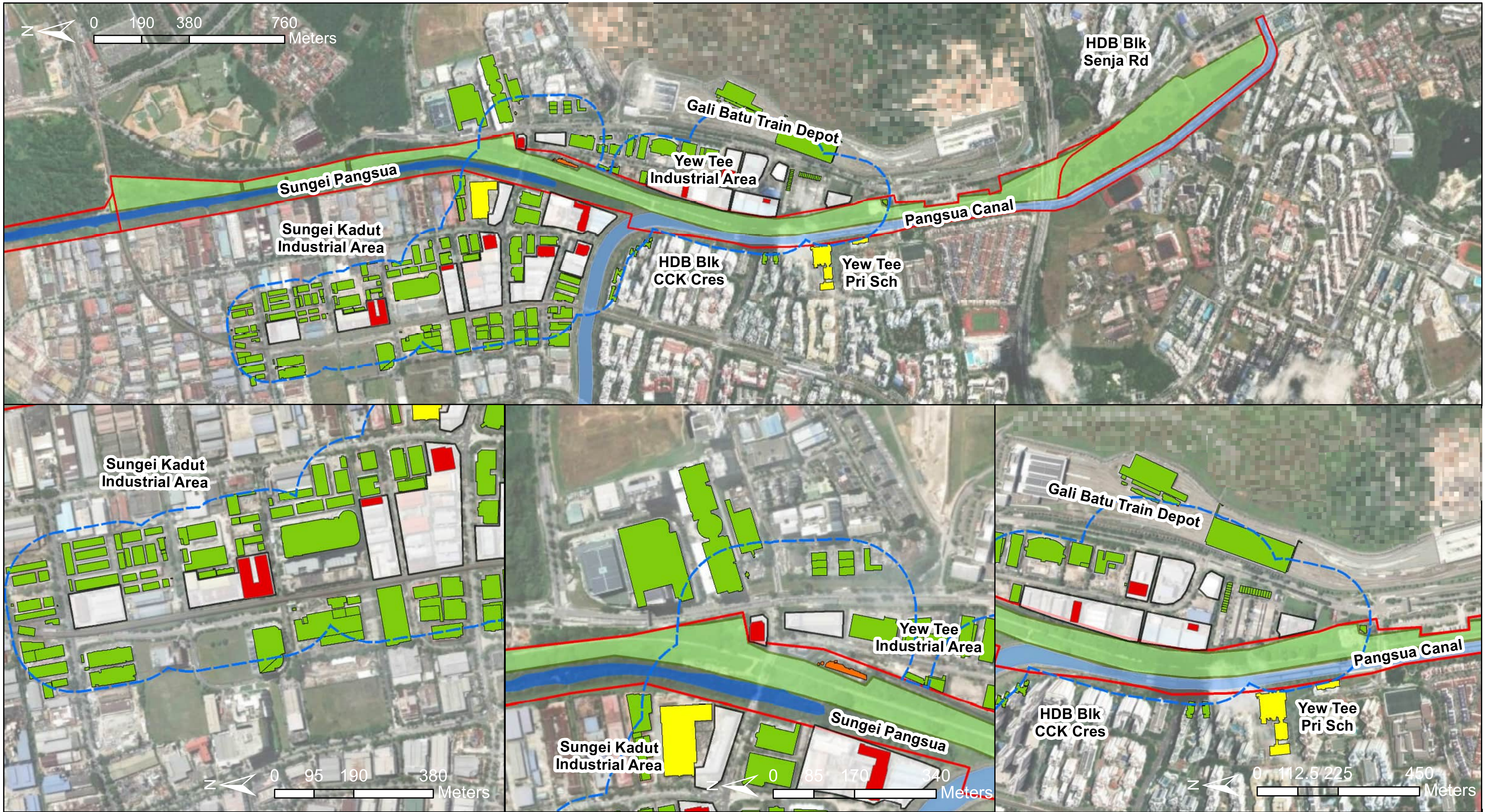
Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
(7pm – 7am)	Priority 2	NA	NA	NA	NA	NA	NA
	Priority 3	74.1	8.1	High	Low	Occasional	Minor
$L_{Aeq(5\ mins)}$, dB, Weekend (7pm – 10pm, 10pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Likely	Minor
	Priority 2	54.0	-	Negligible	Imperceptible	Likely	Negligible
	Priority 3	74.1	4.1	Medium	Very Low	Likely	Minor
Note: The detailed list of predicted noise levels for each human NSR subjected to airborne noise impacts from the three (3) assessment scenarios are presented in Appendix W.							

Table 10-36 below reflects the distribution Impact Significance by number of human NSRs studied for the three (3) respective scenarios. As observed, human NSRs subjected to airborne noise impacts from all three (3) assessment scenarios were predicted to experience **Negligible** – **Major** Impact Significance. Hence, noise mitigation measures were proposed to mitigate the noise impacts on human NSRs to ALARP and shall be discussed in Section 10.8.

Table 10-36 Distribution of Impact Significance by number of Human Receptor

Assessment Scenario(s)	Distribution of Impact Significance by number of Human Receptor				
	Negligible	Minor	Moderate	Major	Not Applicable
Scenario 1: Advanced Works					
$L_{Aeq(12\ hours)}$, dB (7am – 7pm), Weekday	197	3	4	0	0
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday	198	6	0	0	0
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)					
$L_{Aeq(12\ hours)}$, dB (7am – 7pm), Weekday and Weekend	134	30	4	0	0
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	151	11	6	0	0
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)					
$L_{Aeq(12\ hours)}$, dB (7pm – 7am), Weekday and Weekend	101	24	1	0	42
$L_{Aeq(1\ hour)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	10	10	22	0	126
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	118	20	28	2	0
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)					
$L_{Aeq(12\ hours)}$, dB (7am – 7pm), Weekday and Weekend	45	12	2	0	0
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	50	4	5	0	0
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)					
$L_{Aeq(12\ hours)}$, dB (7pm – 7am), Weekday and Weekend	30	9	0	0	20
$L_{Aeq(1\ hour)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	20	0	0	0	39
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	51	8	0	0	0

The predicted noise levels for each individual human NSRs are detailed in Appendix W and the Impact Significance of each individual building reflected respectively in Figure 10-19 and Figure 10-20, Figure 10-21 to Figure 10-25, and Figure 10-26 to Figure 10-30 for the three (3) assessment scenarios.



Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7am - 7pm, Weekday Only (SCENARIO 1: ADVANCED WORKS) BASE SCENARIO

Designed	Checked	Approved	Figure No.	Rev.	Sheet
HHL	HHL	JAG	10-19	B	1 of 1

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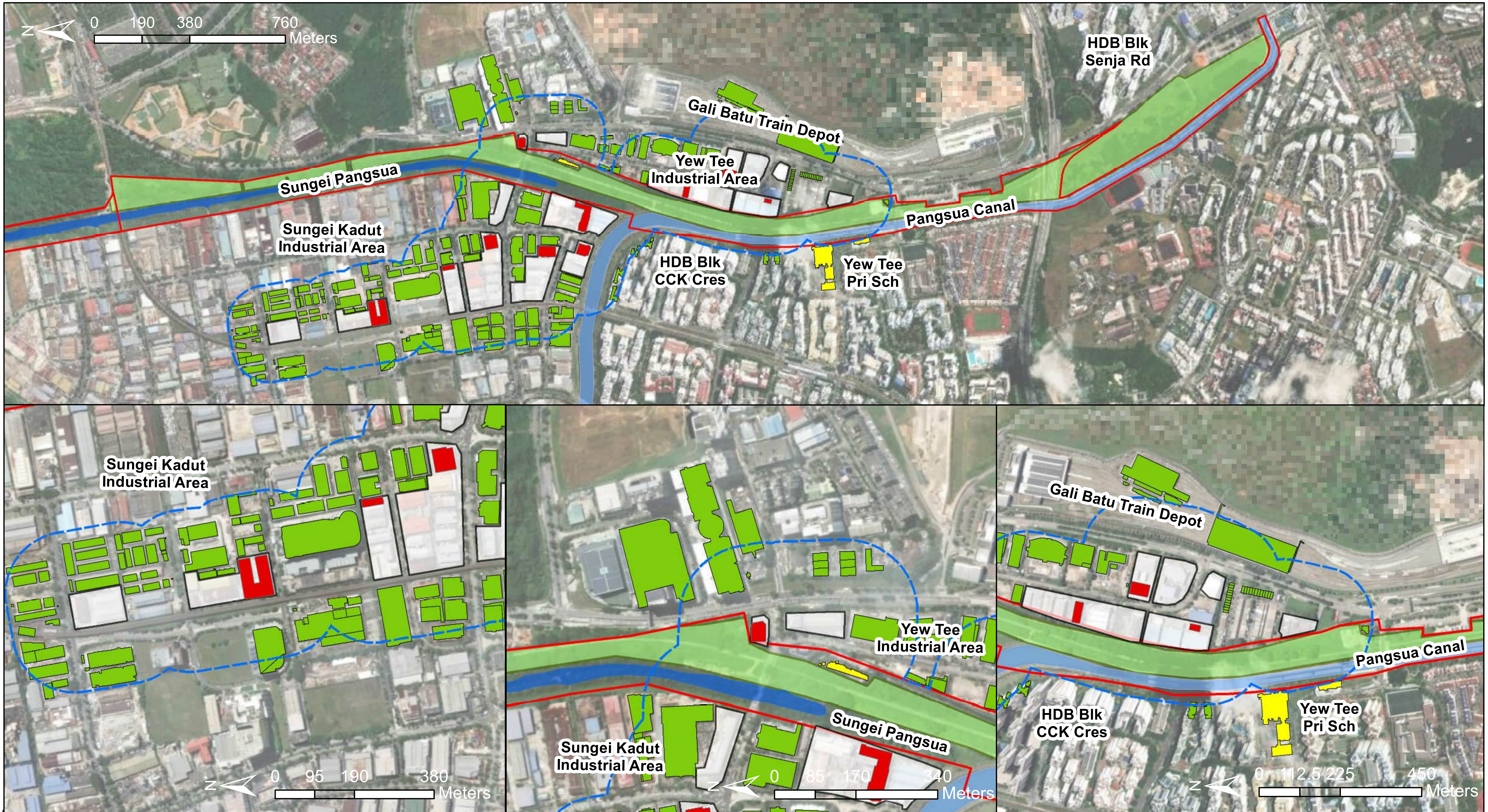
Note: Source of basemap - GoogleEarth Maps



Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7am - 7pm, Weekday Only (SCENARIO 1: ADVANCED WORKS) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-20	B	1 of 1

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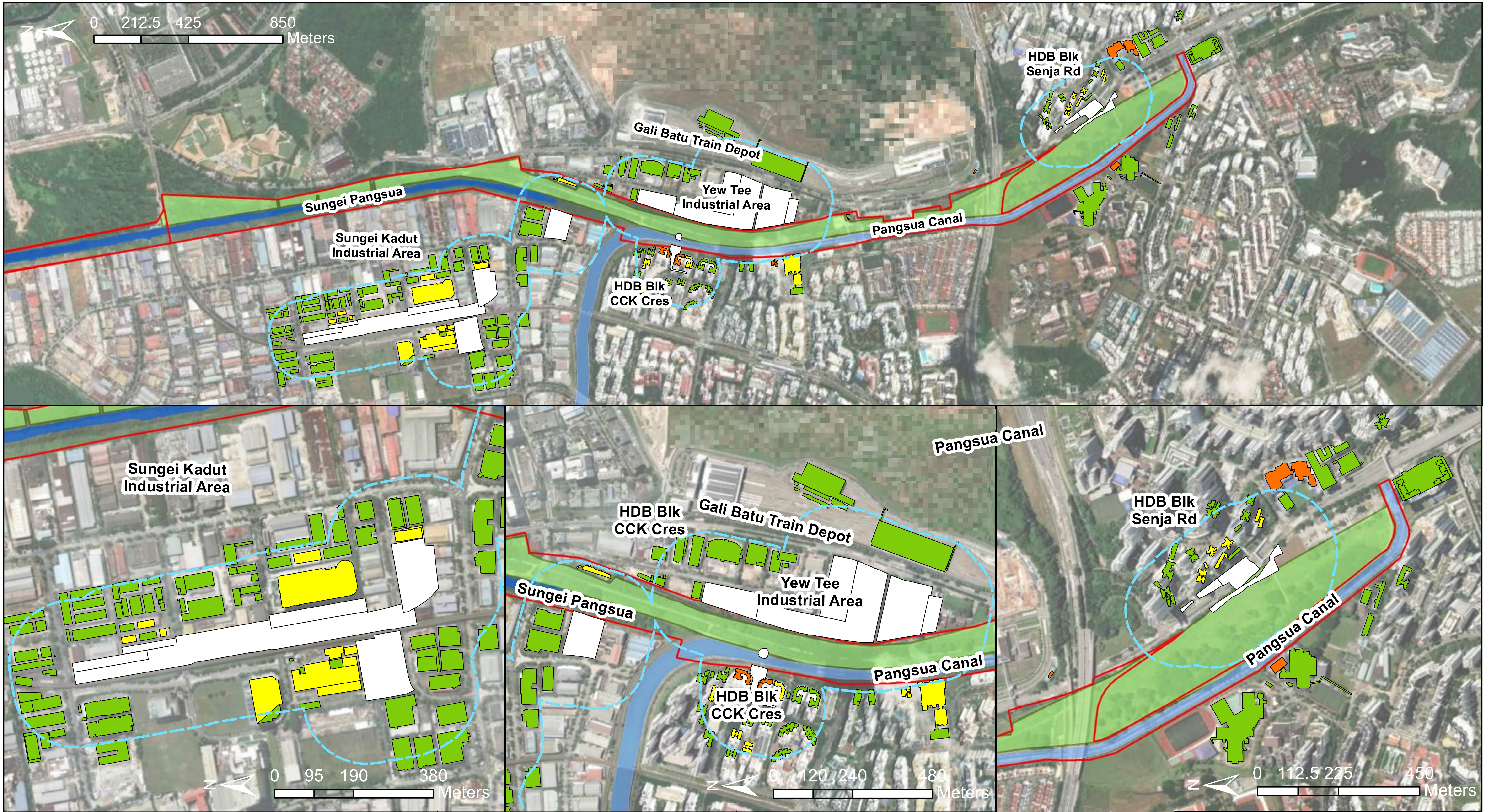

Legend

Legend	
Scenario 2: Main Civil Works (150m Study Area)	
Proposed Worksite Areas (Scenario 2: Main Civil Works)	
Biodiversity Study Area	
Pang Sua Canal	
Sungei Pang Sua	
Existing Vegetated Area	

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

Project Title :

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

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HHL	HHL	JAG
	Drawn SYT	Date MAY 2023

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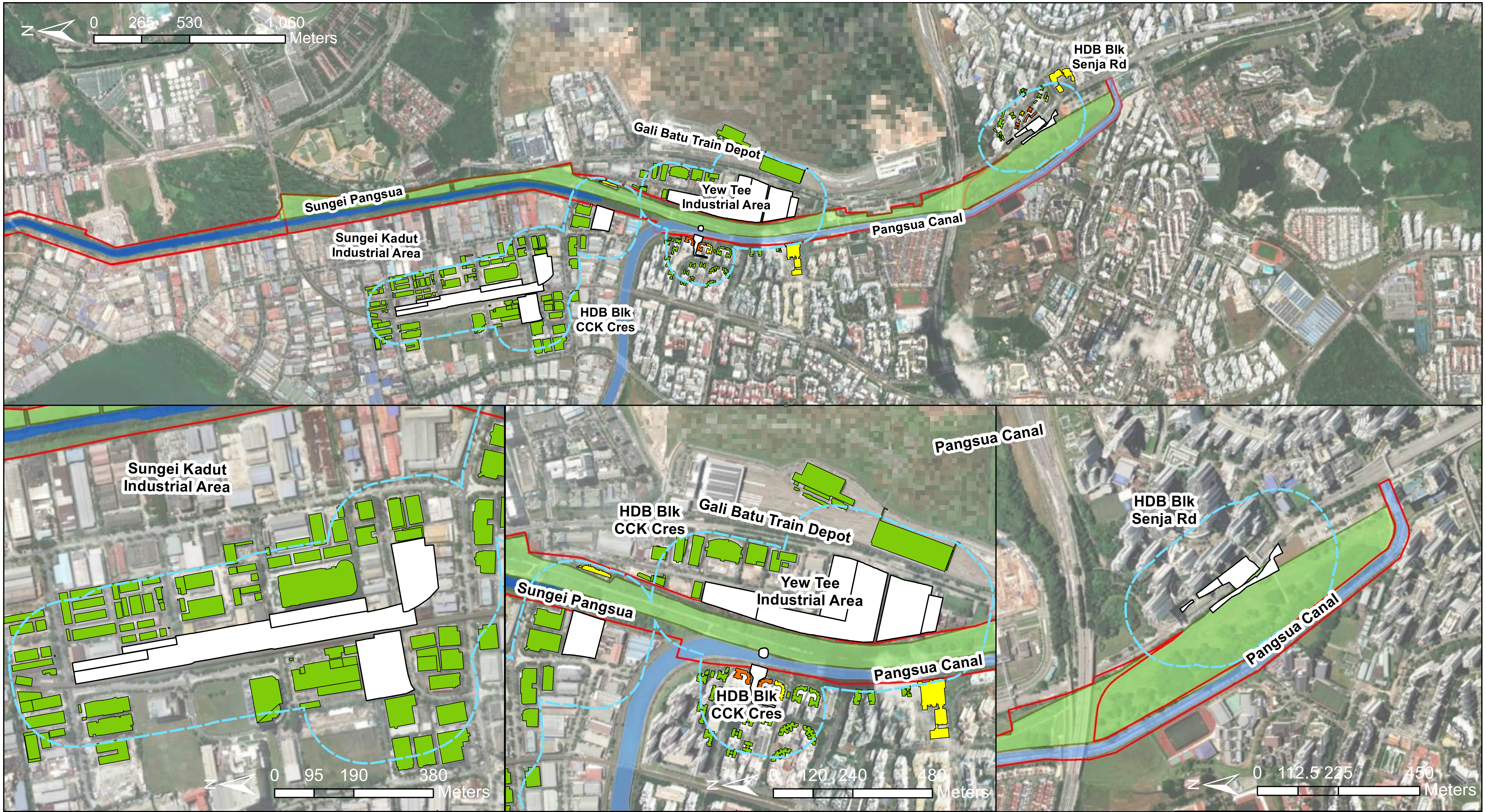
Figure Title :

PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7am - 7am, Weekday and Weekend (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) BASE SCENARIO

Figure No. :	Rev.	Sheet
10-21	B	1 of 1

CAD File Name :N/A | A3

Note: Source of basemap - OneMap and Open Street Map



Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Designed	Checked	Approved
HHL	HHL	JAG
	Drawn: SYT	Date: MAY 2023

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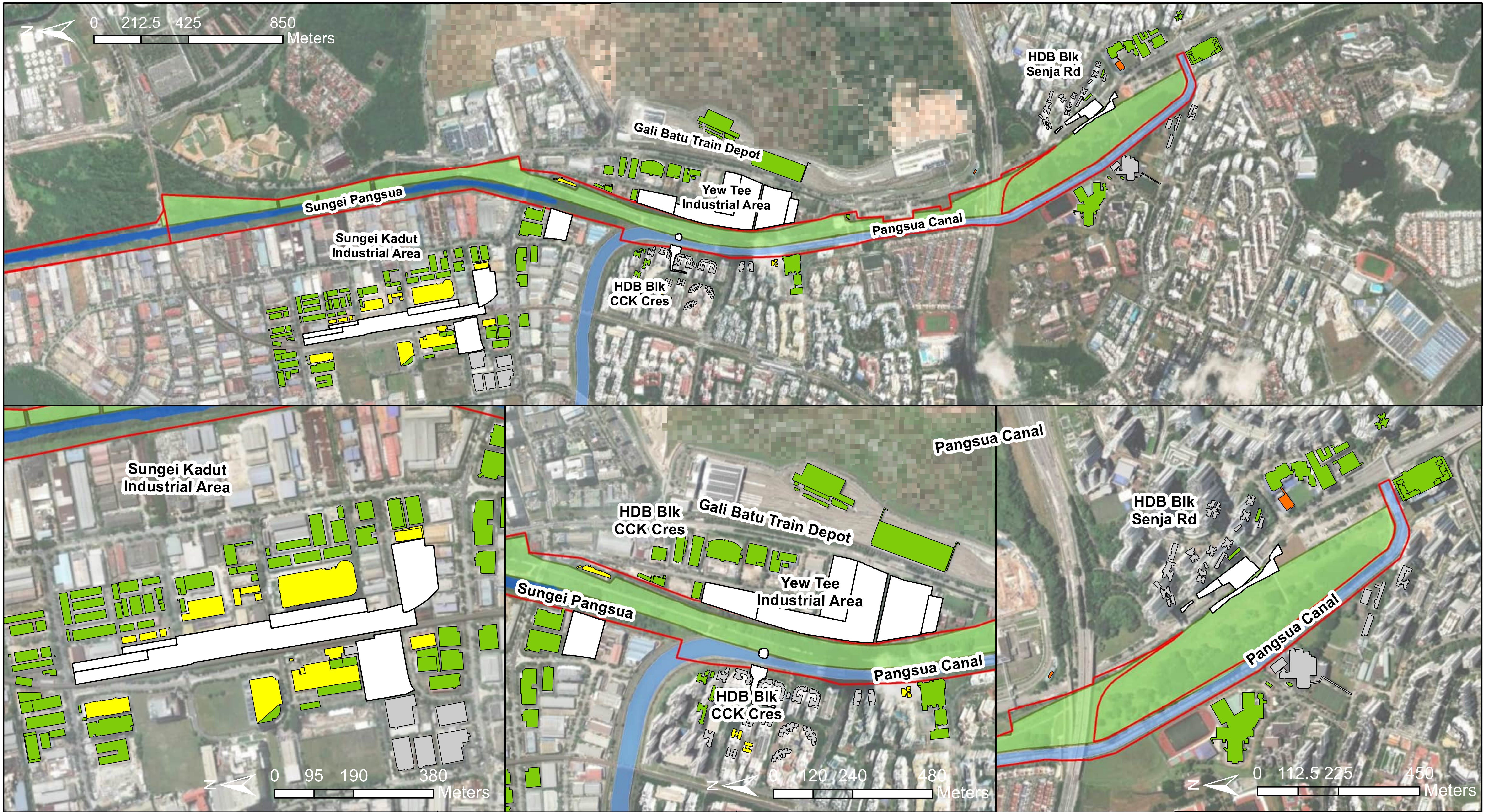
Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(5 mins), 7am - 7pm, Weekday and Weekend
(SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)
BASE SCENARIO

Figure No. :	Rev.	Sheet
10-22	B	1 of 1

CAD File Name :N/A — A3

Note: Source of basemap - OneMap and Open Street Map



Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

Project Title :

CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Designed	Checked	Approved
HHL	HHL	JAG
	Drawn: SYT	Date: MAY 2023

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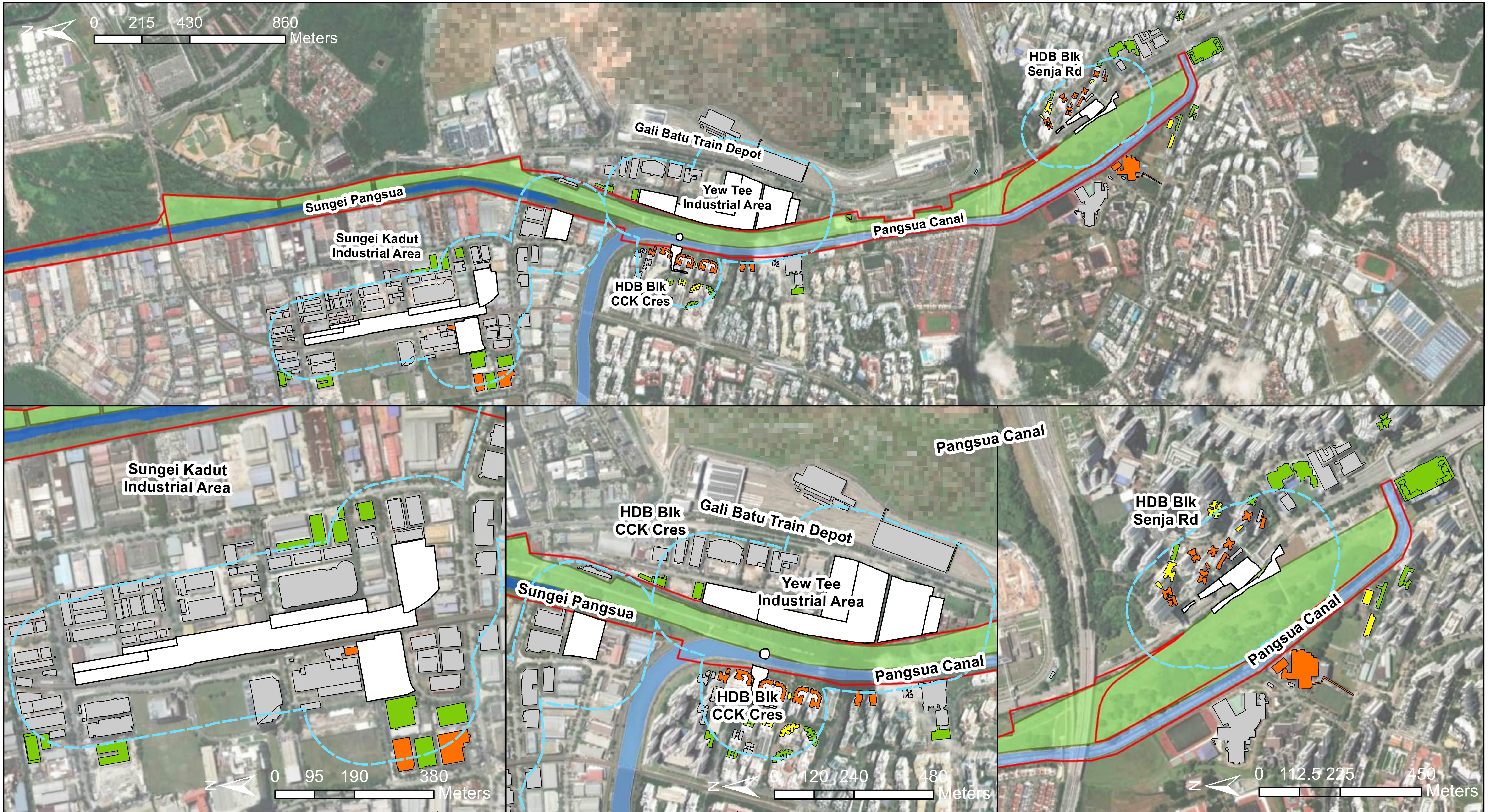
Figure Title :

PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7pm - 7am, Weekday (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) BASE SCENARIO

Figure No. :	Rev.	Sheet
10-23	B	1 of 1

CAD File Name :N/A | A3

Note: Source of basemap - Google Earth Maps



Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(1 hour), 7pm - 10pm, 10pm - 7am, Weekday Only
(SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)
BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-24	B	1 of 1

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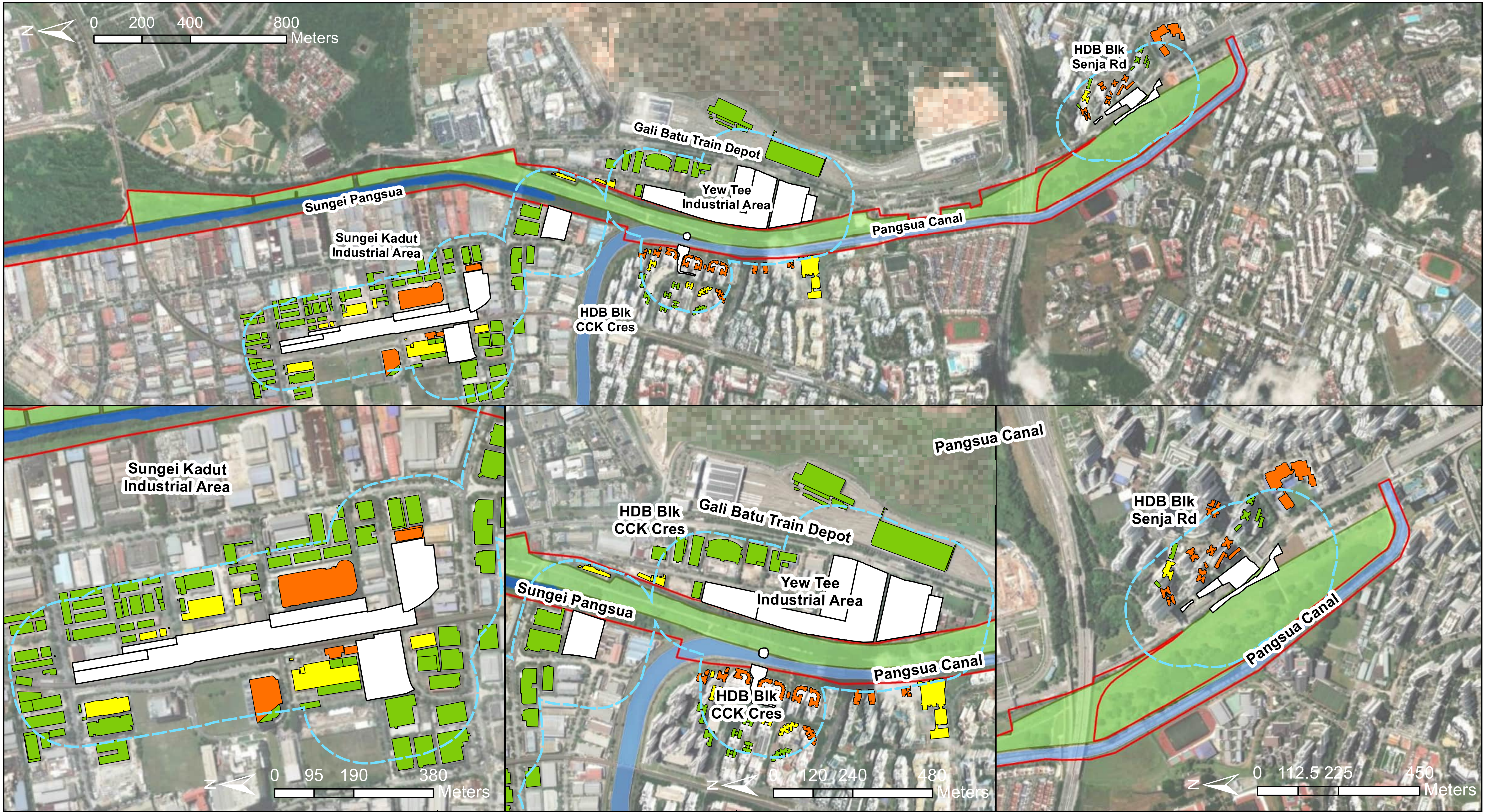
SYT	MAY 2023	N/A	A3

Note: Source of basemap - Google Earth Maps



Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

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HHL	HHL	JAG

Drawn	Date
SYT	MAY 2023

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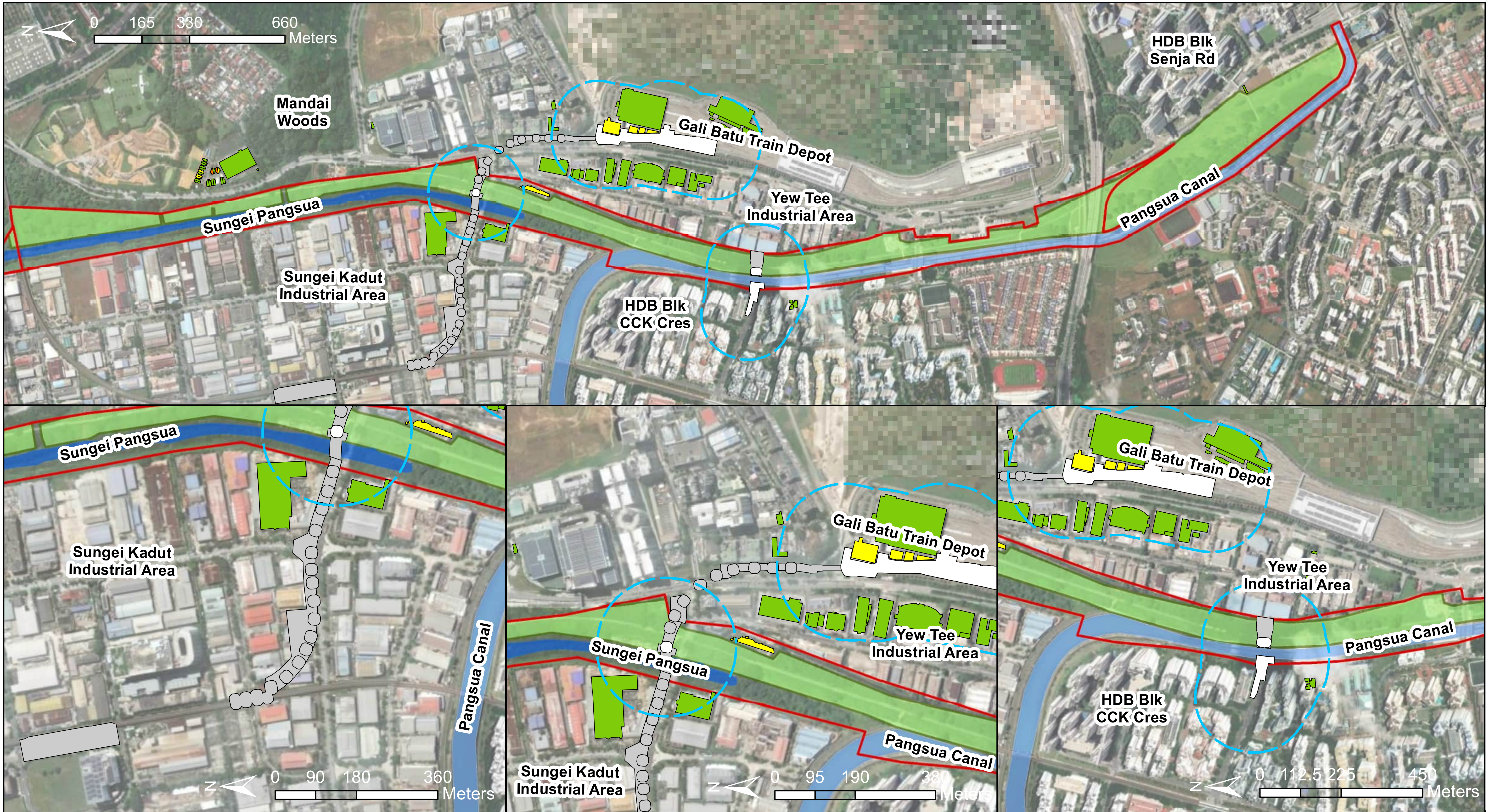
Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7pm - 10pm, 10pm - 7am, Weekday and Weekend (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) BASE SCENARIO

Figure No. :	Rev.	Sheet
10-25	B	1 of 1

CAD File Name :N/A — A3

Note: Source of basemap - Google Earth Maps / OpenStreet Map



Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7am - 7pm, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-26	B	1 of 1

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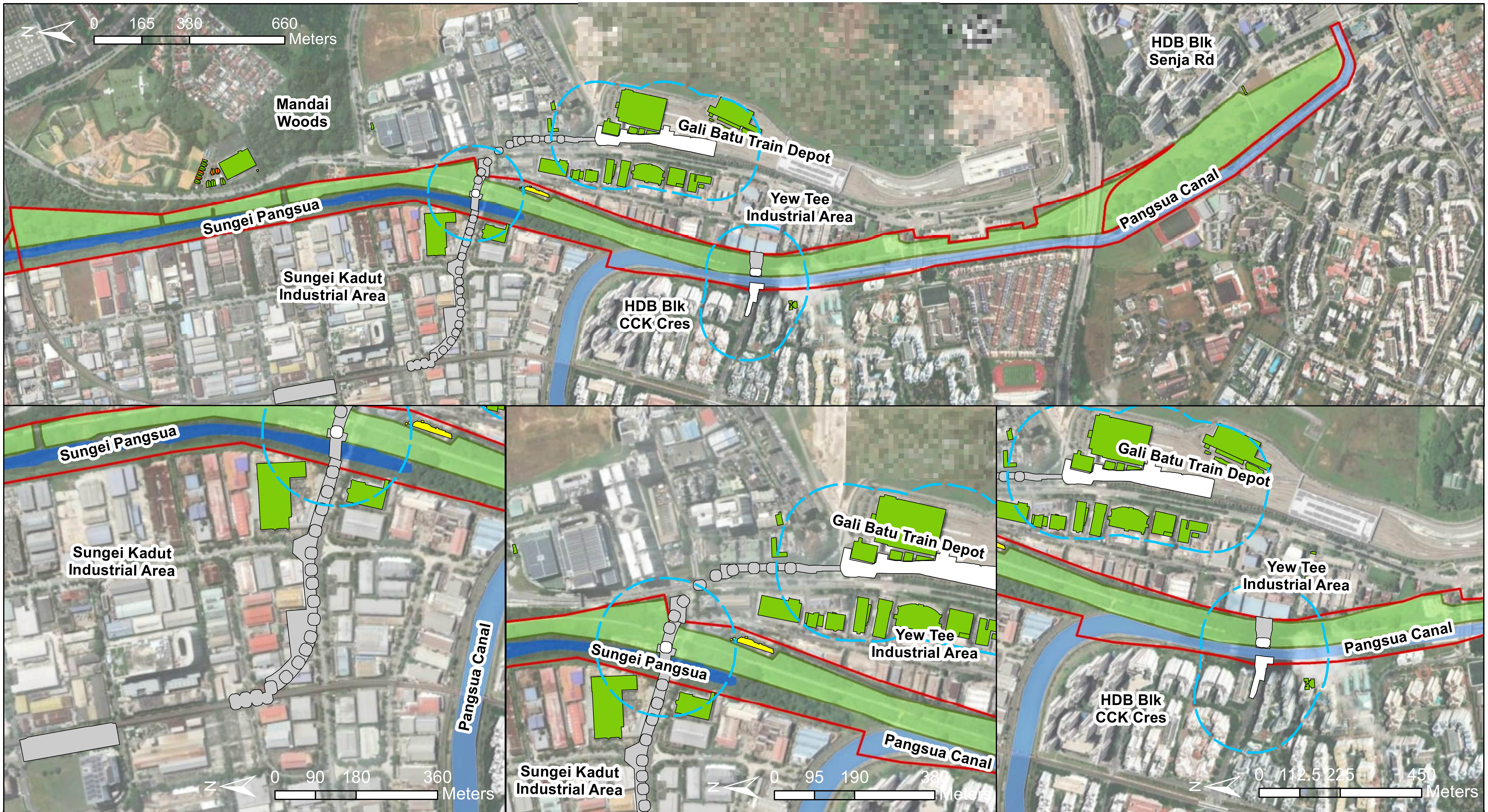
Note: Source of basemap - GoogleEarth Maps



Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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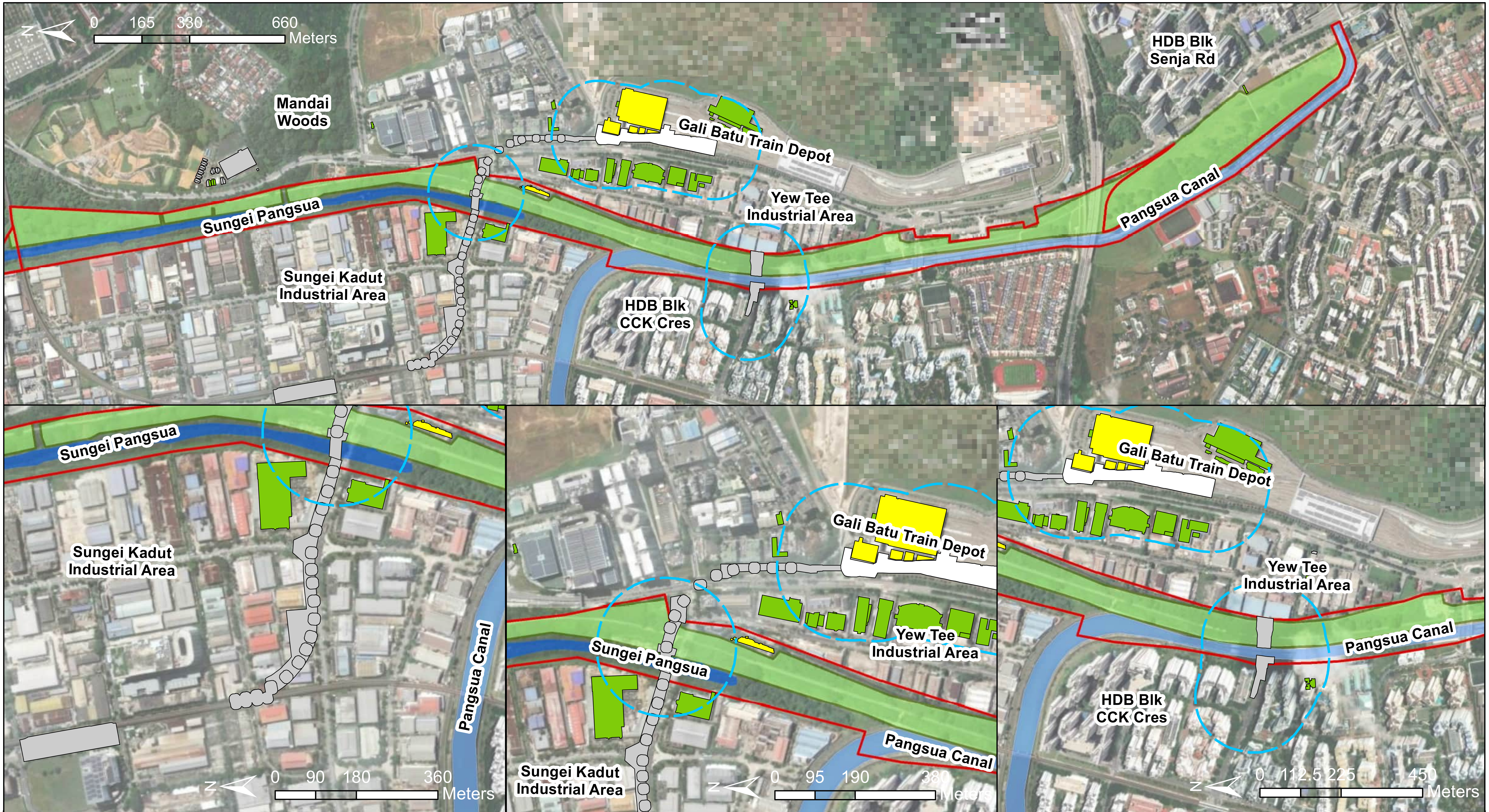
Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7am - 7pm, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No.	Rev.	Sheet
HHL	HHL	JAG	10-27	B	1 of 1

Drawn	Date	CAD File Name	
SYT	MAY 2023	N/A	A3

Note: Source of basemap - GoogleEarth Maps



Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Note:
Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7pm - 7am, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-28	B	1 of 1

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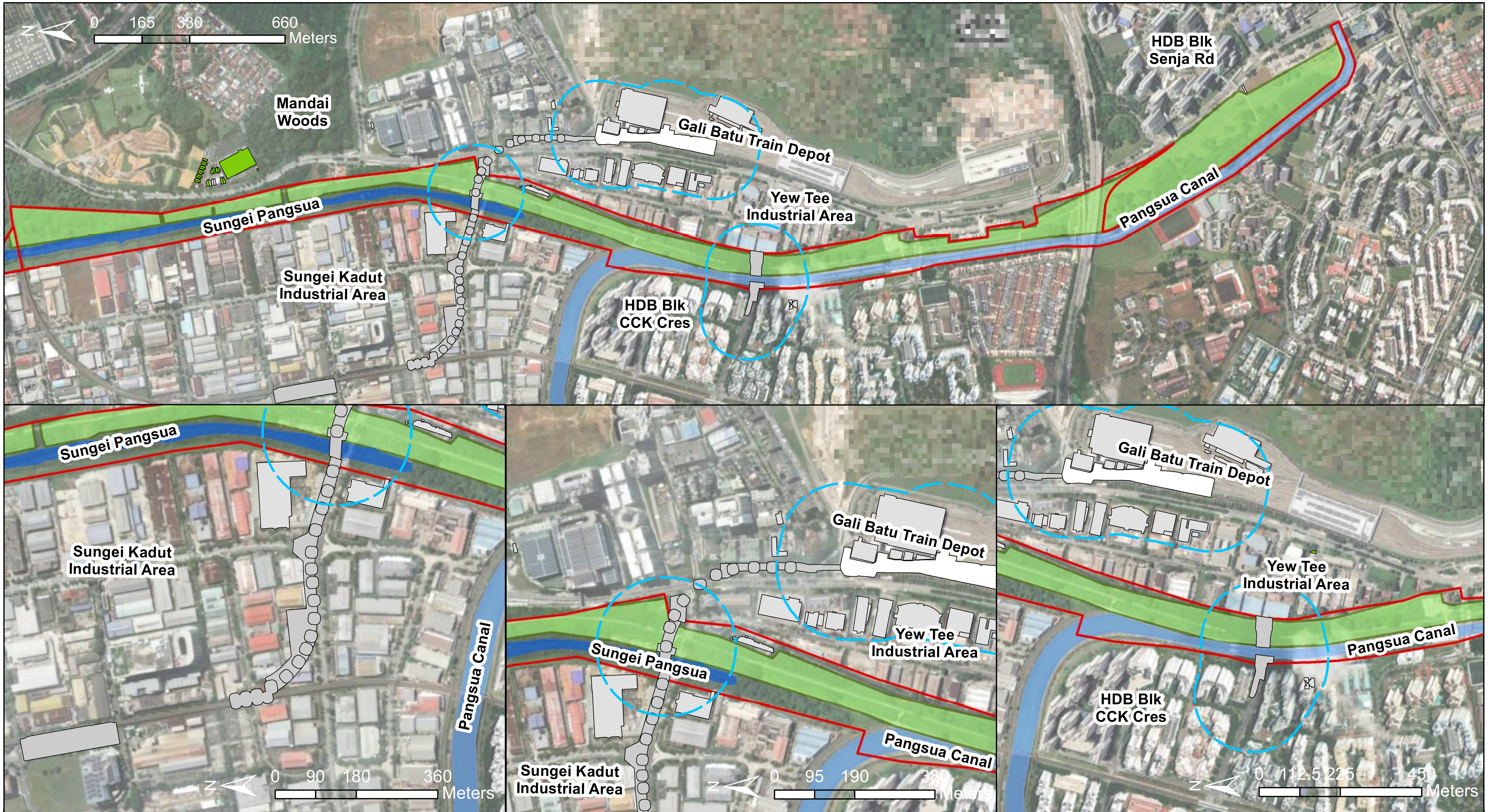

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Green Corridor

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(1 hour), 7pm - 10pm, 10pm - 7am, Weekday Only (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved
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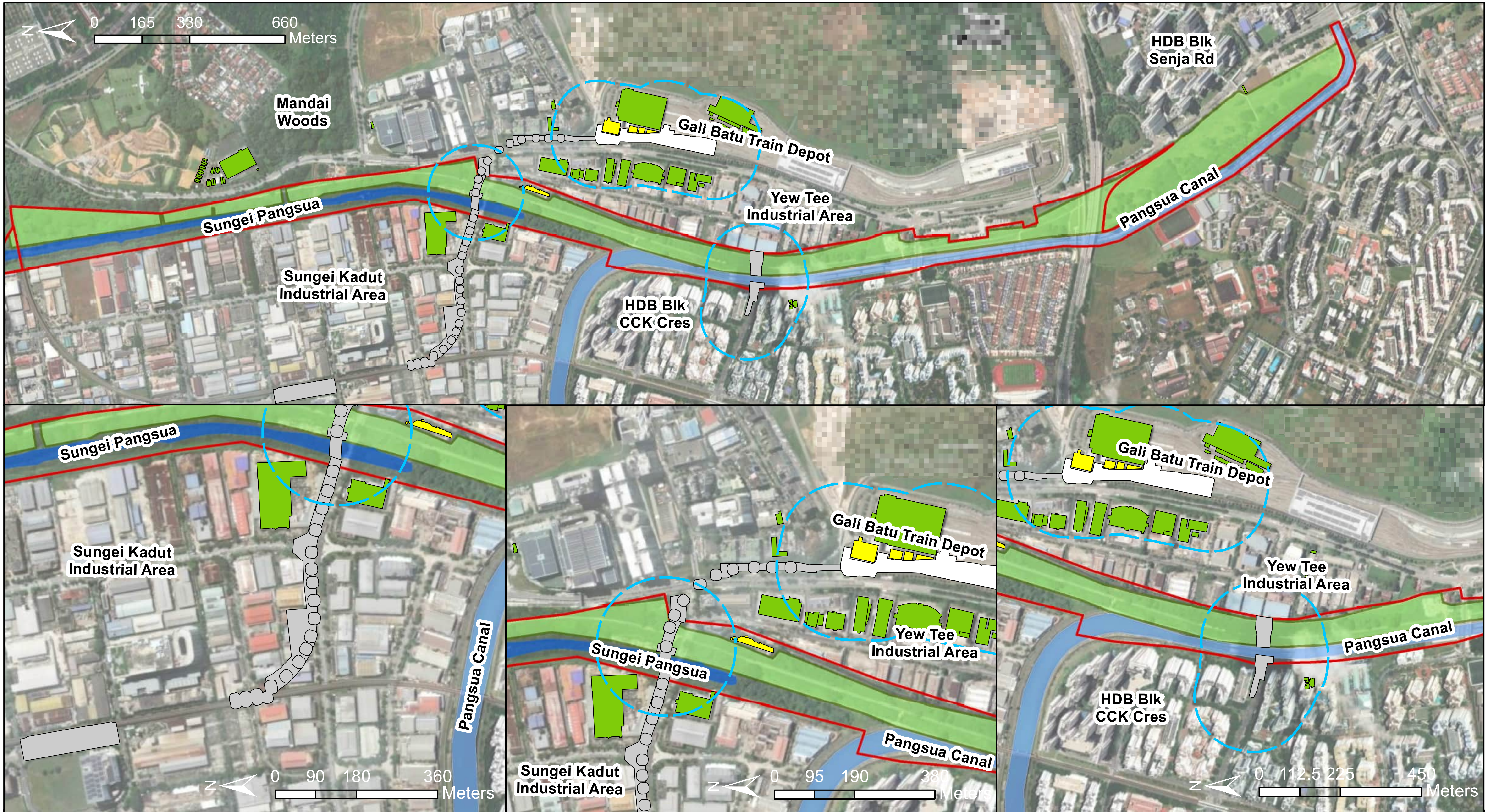
Figure No. :	Rev.	Sheet
10-29	B	1 of 1

CAD File Name :N/A | A3

Note: Source of basemap - GoogleEarth Maps



Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Note:
Refer to Appendix X for the full list of construction noise results for individual human receptors.

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(5 mins), 7pm - 10pm, 10pm - 7am,
Weekday and Weekend
(SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) BASE SCENARIO

Designed	Checked	Approved	Figure No.	Rev.	Sheet
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Note: Source of basemap - GoogleEarth Maps

10.7.1.2.6 Rock Breaking and Excavation

Rock breaking and excavation are proposed at Sungei Kadut Station with the closest NSRs demarcated by the Biodiversity Study Area and JTC Trendspace as reflected in Table 10-37.

The approximate distance from Sungei Kadut Cut and Cover Station to the boundary of nearest human NSR, JTC Trendspace, is 61m. Based on the approach mentioned in Section 10.3.1.6, the air overpressure for an MIC of 5.8 kg from the Sungei Kadut Cut and Cover Station is 150 dB at a distance of 61m from JTC Trendspace based on formula (2). The summary of the prediction and evaluation of airborne noise – rock breaking and excavation impacts at less than 150 m from the Sungei Kadut Cut and Cover Station are presented in Table 10-37.

Table 10-37 Summary of Prediction and Evaluation of Airborne Noise – Rock Breaking and Excavation Impacts at ≤ 150 m for Human Receptors from Sungei Kadut Cut and Cover Station and Docking Shaft, Base Scenario

Horizontal distance from worksite, m	Noise Sensitive Receptor	Human Receptor Sensitivity	Discharge Mass (up to), kg	SPL	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Impact Significance
Sungei Kadut Cut and Cover Station								
61	JTC Trendspace	Priority 3	5.8	150	Medium	Very Low	Certain	Minor
55	Eastern Pretech Pte Ltd	Priority 3		151	Medium	Very Low	Certain	Minor
123	Redwood Interior Pte Ltd	Priority 3		141	Low	Very Low	Certain	Minor
*Note: * This measure reduces the impact significance after applying the mitigation measures refer to Section 11.9, resulting in Negligible to Minor from Moderate and Negligible to Moderate from Major respectively.*								

Due to air overpressure from rock breaking and excavation from Sungei Kadut Cut and Cover Station, the Priority 2 and Priority 3 human NSRs were predicted to experience an Impact Intensity of ranging from **Low** – **Medium** with a corresponding Impact Consequence of **Very low**. When assessed against a Likelihood of Occurrence of **Certain**, it was predicted that rock breaking and excavation will result in an Impact Significance of **Minor**. As such, no mitigation measures were proposed for the human NSRs subjected to airborne noise impacts from rock breaking and excavation.

10.7.2 Operational Phase

This section presents the predicted airborne noise impacts arising from the operational phase. The assessment details are addressed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. As discussed in Section 10.3.2, the findings from the separate standalone report have been extracted and presented in this report.

10.7.2.1 Ecological Receptors

10.7.2.1.1 Potential Future Infrastructure Operations

Based on the results predicted by the noise models in the NVS Preliminary Report, ecological NSRs are predicted to experience noise exceedances of up to 13.0 dB(A) when subjected to operational noise from the operations of trains on the potential future infrastructure (see Table 10-38).

The resulting Impact Intensity of **Negligible** – **High** (refer to Table 6-6) due to the maximum predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Imperceptible** – **High** (refer to Table 6-7) as reflected in Table 10-38. When relating the Impact Consequence to a Likelihood of Occurrence of **Unlikely** (see Table 10-18), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** (refer to Table 6-9).

Table 10-38 Summary of Operational Noise Impacts for Ecological Receptors, Base Scenario

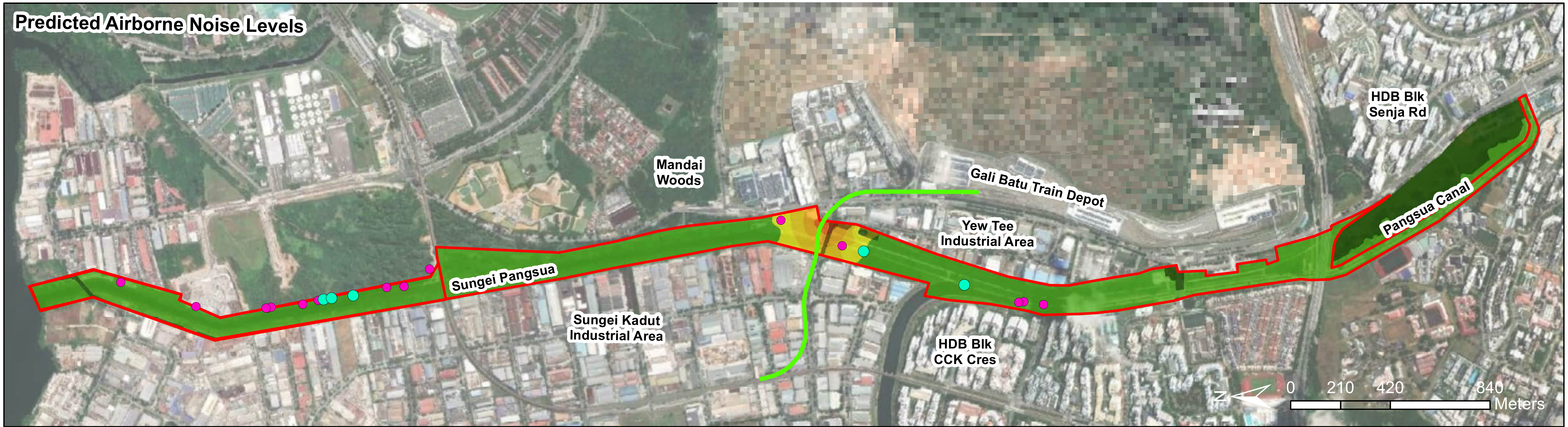
Ecological Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
Priority 1	64.0	13.0	High	High	Unlikely	Negligible
Priority 2	40.0	–	Negligible	Imperceptible	Unlikely	Negligible

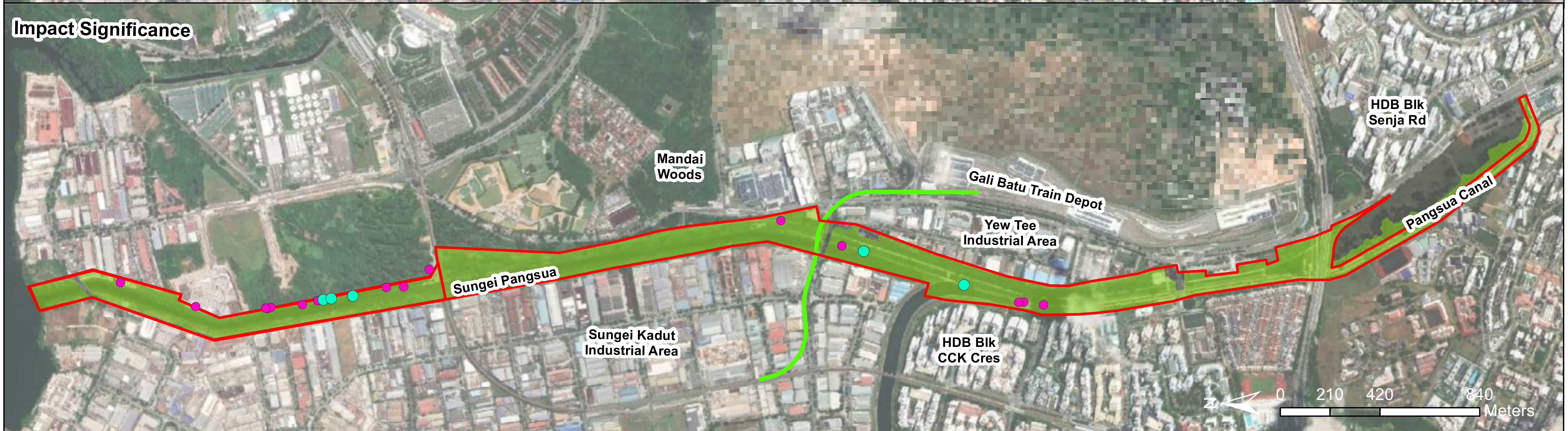
Table 10-39 below reflects the distribution of areas of respective Impact Significance within the Biodiversity Study Area, studied for airborne noise impacts on ecological NSRs. As observed, the highest recorded Impact Significance is determined to be **Negligible**. Hence, no mitigation measures were proposed for the operational phase.

Table 10-39 Distribution of area of Impact Significance within Biodiversity Study Area, ha, Base Scenario (Operational Phase)

	Distribution of Impact Significance by area, ha			
	Negligible	Minor	Moderate	Major
Distribution of area, ha	77.8	0.0	0.0	0.0

The resulting predicted airborne noise levels and Impact Significance map representative is visualized in Figure 10-31 for $L_{Aeq(1\ hour)}$.





Legend

- Roosting Birds
- Roosting Migratory Bird
- Potential Future Infrastructure
- Biodiversity Study Area

Predicted Airborne Noise Levels

LAeq(1 hour), dB

- <= 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- >= 69

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Note: The LAeq(1 hour) noise criteria is 51 dB.

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Figure Title :

PREDICTED OPERATIONAL NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(1 hour), POTENTIAL FUTURE INFRASTRUCTURE
BASE SCENARIO

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Note: Source of basemap - GoogleEarth Maps

10.7.2.1.2 Elevated Vehicular Bridge Operations

Based on the results predicted by the noise models in the Traffic Noise Impact Assessment Report, ecological NSRs are not predicted to experience noise exceedances when subjected to operational noise from the operations of vehicles on the Elevated Vehicular Bridge (see Table 10-40).

The resulting Impact Intensity of **Negligible** (refer to Table 6-6) due to no predicted noise exceedances corresponds to an overall Impact Consequence ranging from **Imperceptible** – **Very Low** (refer to Table 6-7) as reflected in Table 10-40. When relating the Impact Consequence to a Likelihood of Occurrence of **Certain** (see Table 10-18), it was determined that the maximum overall Impact Significance arising from the proposed construction activities associated with the assessment scenarios would range from **Negligible** (refer to Table 6-9).

Table 10-40 Summary of Operational Noise Impacts for Ecological Receptors, Base Scenario

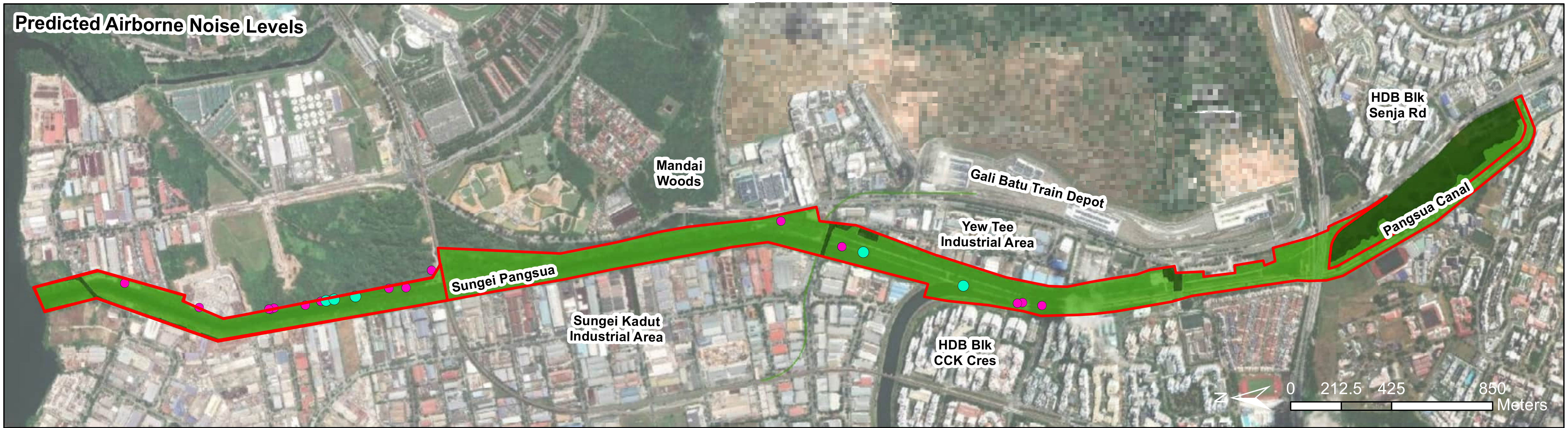
Ecological Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance
Priority 1	51.0	-	Negligible	Very Low	Certain	Negligible
Priority 2	49.0	-	Negligible	Imperceptible	Certain	Negligible

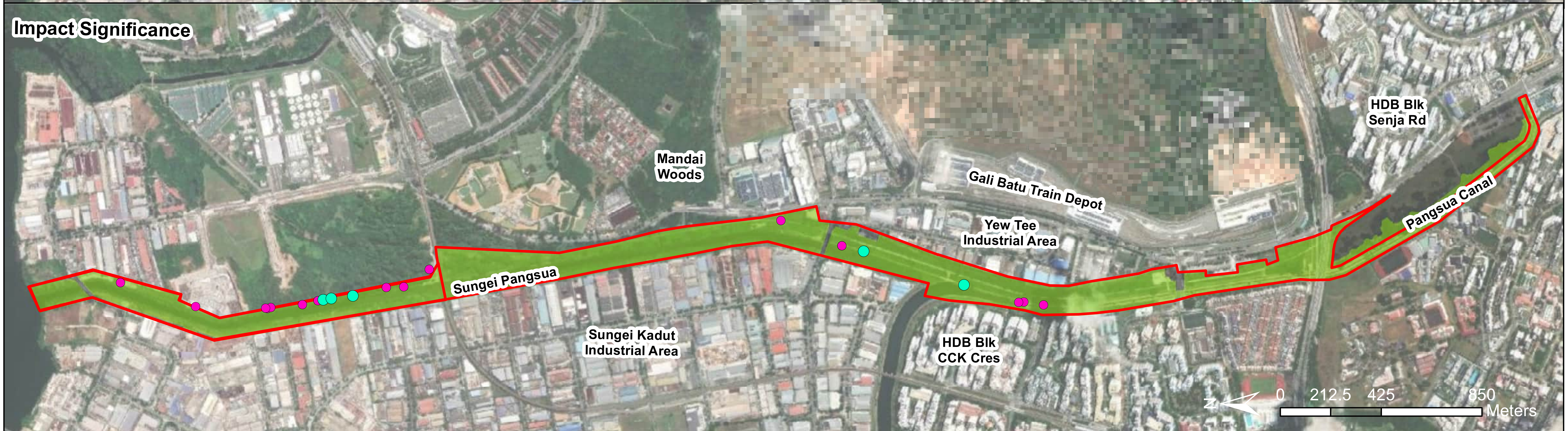
Table 10-41 below reflects the distribution of areas of respective Impact Significance within the Biodiversity Study Area, studied for airborne noise impacts on ecological NSRs. As observed, the highest recorded Impact Significance is determined to be **Negligible**. Hence, no mitigation measures were proposed for the operational phase.

Table 10-41 Distribution of area of Impact Significance within Biodiversity Study Area, ha, Base Scenario (Operational Phase)

	Distribution of Impact Significance by area, ha			
	Negligible	**Minor**	**Moderate**	**Major**
Distribution of area, ha	77.8	0.0	0.0	0.0

The resulting predicted airborne noise levels and Impact Significance map representative is visualized in Figure 10-32 for $L_{Aeq(1\ hour)}$.





Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Elevated Vehicular Bridge
- Biodiversity Study Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Predicted Airborne Noise Levels
LAeq(1 hour), dB

- <= 51
- 51 - 54
- 54 - 57
- 57 - 60
- 60 - 63
- 63 - 66
- 66 - 69
- >= 69

Note: The LAeq(1 hour) noise criteria is 51 dB.

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ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED OPERATIONAL NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(1 hour), ELEVATED VEHICULAR BRIDGE, BASE SCENARIO

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Note: Source of basemap - GoogleEarth Maps

10.7.2.2 Human Receptors

10.7.2.2.1 Potential Future Infrastructure Operations

The impact assessment on human receptors is detailed in the NVS Preliminary Report. Airborne noise modelling predicted that four (4) receptor buildings would experience noise levels that exceed the criteria of $L_{Aeq(1\ hour)}$, 71 dB. Since these buildings are not noise-sensitive or residential premises, mitigation measures were not required according to NEA's guidelines.

The predicted noise levels for each receptor building have been extracted and presented below:

Table 10-42 Summary of Predicted $L_{Aeq(1\ hour)}$, dB at each Receptor Building

No.	Address	Building Use	Horizontal Distance from the Centre of Alignment (m)	Maximum Predicted $L_{Aeq(1\ hour)}$, dB	Exceedance, dB(A)
01	34 Sungei Kadut Street 1	Industrial	27	65	-
02	BHL Factories, 2A Mandai Estate	Commercial	34	70	-
03	BHL Factories, 2B Mandai Estate	Commercial	32	67	-
04	BHL Factories, 2C Mandai Estate	Commercial	41	64	-
05	24 Sungei Kadut Avenue	Industrial	10	73	2
06	23 Sungei Kadut Street 1	Industrial	80	72	1
07	23F Sungei Kadut Street 1	Industrial	48	67	-
08	46 Sungei Kadut Avenue	Industrial	44	63	-
09	39 Sungei Kadut Avenue	Industrial	29	72	1
10	17 Sungei Kadut Way	Industrial	23	72	1
11	33 Sungei Kadut Avenue	Industrial	25	63	-
12	31 Sungei Kadut Avenue	Industrial	24	62	-

10.7.2.2.2 Elevated Vehicular Bridge Operations

The impact assessment on human receptors is detailed in the Traffic Noise Impact Assessment Report. Airborne noise modelling predicted that two (2) receptor buildings would experience noise levels that exceed the criteria of $L_{Aeq(1\ hour)}$, 67 dB. As the buildings are residential premises, mitigation measures were implemented according to NEA's guidelines.

The predicted noise levels for the projected traffic profile have been extracted and presented below:

Table 10-43 Comparison of Predicted Noise Levels for Existing Traffic Profile and Projected Traffic Profile at Noise Sensitive Receptor (Projected Traffic Profile), Base Scenario

Noise Sensitive Receptor(s) and Nearest Sound Level Meter (SLM)	Traffic Peak Period $L_{eq(1\ hour)}$, dB(A)[1]	
	Predicted Noise Level (After Callibration of Noise Model)	
	At Noise Sensitive Receptor (Maximum Predicted Noise Level)	At Noise Sensitive Receptor (Maximum Predicted Noise Level)
	Existing Traffic Profile	Projected Traffic Profile
40 The Quintet (NMT01)	29.5	59.1
42 The Quintet (NMT01)	56.4	66.8
44 The Quintet (NMT01)	59.2	67.0
HDB Block 692A, Choa Chu Kang Crescent (NMT02)	61.5	63.7

As observed from Table 10-43, no exceedances of the $L_{Aeq(1\ hour)}$ noise criteria of 67 dB expected. As such, no mitigation measures have been proposed for the operational phase of the elevated vehicular bridge.

10.8 Recommended Mitigation Measures

10.8.1 Construction Phase

Due to the proximity of the NSRs to the Project site boundary, mitigation measures for the control of noise at source were recommended as per the mitigation principles outlined in Section 6.5.

10.8.1.1 Avoid

10.8.1.1.1 High Noise Powered Mechanical Equipment

The equipment inventory list shall be analysed to check the equipment (PMEs) causing high noise levels (higher quantity and/or longer working periods of PMEs can cause higher noise levels). The use of equipment with lower noise level shall be prioritized, as this is the most effective way to mitigate the noise level at the source.

10.8.1.2 Minimize

10.8.1.2.1 Erect Noise Barriers

When substitution of noisy equipment is not applicable or feasible, erection of noise barriers of a rating of STC20 or higher should be considered. The barrier height and placement position of a noise barrier are the prime factors in determining its efficiency and are as follows:

- Noise barriers should be placed as close as possible to either the source, or the receiver position for maximum effectiveness; and
- Noise sensitive receptors within 150 m from construction worksites not predicted to experience exceedance will not require noise barriers.

Following the above suggestions, vertical noise barriers of 3 m and 12 m in height, and 15m noise enclosure were proposed based on the heights of the receptors in the vicinity of the construction worksites and the viability of implementation with consideration of space required to stabilize and erect the barriers.

The placement of the noise barriers are visualized in Figure 10-33, Figure 10-34, and Figure 10-35 for the three (3) assessment scenarios respectively. Contractors should note that the erection of noise barriers must not result in additional clearance to vegetation beyond the bounds of the construction worksites area.

10.8.1.2.2 Source Noise Control

As a last resort for engineering control, when noise barriers are also not so effective in mitigating noise, or in order to manage complaints if there are intermittent noisy works, Table 10-44 below provides information on methods of quietening PME to be adopted for further mitigation on construction noise impact.

The maximum reduction in sound power level in Table 10-44 is achievable when all source control measures stated in this table are adopted. Noise enclosures should be used at the locations of the noise generating equipment at the construction site. Acoustic sheds should be provided at the locations of the noise generating activity such as operation of hand-held breaker. Sound pressure levels reduction ranging from 0 – 3 dB can be achieved by using all or combination of the following measures.

Table 10-44 Control of noise source from worksites

Type of Equipment	Equipment	Reduction in Sound Power Level, dB(A)[1]	Description of Source Control
Compressors & Generators	Generators	-20	Acoustic dampening of metal casing of body shell; acoustic enclosure or screen between the generator and receptor. The acoustic casing for the generator shall be proprietary product supplied by the generator manufacturer. The screen, if used, shall be as close as possible to the generator and it shall be of a solid construction (minimum STC18) with no gaps at the bottom or in-between panels.
Hacking major structures	Excavator with Rock Breaker	-15	Use of an acoustic shed with adequate ventilation for the machine and bit.
Earth-moving Plant	Crane	-10	Manufacturers' enclosure panels to be kept closed. The engines of these vehicles shall not be exposed and clad with the manufacturers' enclosure to reduce noise break-out. Manufacturer-supplied silencers for the engine exhausts shall be installed and maintained.
	Dump Truck	-10	
	Excavator with Rock Breaker	-10	
	Excavator	-10	
	Concrete Mix Truck	-10	
	Lorry	-10	
Pumps	All Pumps	-10 to -20	Use of acoustic enclosure.
Note: [1] The noise reduction level makes reference to BS 5228-1:2009 Code of practice for noise and vibration control on construction and open sites – Part 1: Noise.			

Based on the Singapore Standards Code of Practice for Noise Control at Construction Sites, 2014 (SS602:2014) [R-21], the typical materials used for noise barriers and acoustic shed/enclosures is given below:

<u>Acoustic Shed/Enclosure:</u>

A typical machine acoustic enclosure covers the machine as fully as possible (with/without ventilation), providing adequate sound insulation that noise energy does not readily pass through it. In addition, it could also have a sound absorbing material lining, to avoid the build-up of sound energy inside. In general, an acoustic enclosure could include:

- A minimum rating of STC18 for localized portable acoustic panels;
- Outer cover material made up of brickwork, fiberboard, or plasterboard. Thickness of the insulating cover depends on the material used;
- Inner lining of sound absorbing material such as glass fiber, mineral wool, straw slabs, wood wool slabs can be used. A thickness of at least 25 mm is to be provided in case of high frequency sound, whereas a 12 mm thick lining would suffice for low frequency sound; and

- Perforated sheet coverings can be used to protect the inner lining material, especially if it is glass wool or mineral wool-based lining.

In the case of a more permanent or substantial machine enclosure or acoustic shed, concrete breezeblock and open textured blockwork can be more effective alternatives as these are known to be durable, inexpensive, and quick to assemble, and provide a useful degree of sound absorption.

Table 10-45 below presents the effective sound power levels with source noise control applied as noise model input in the assessment for residual airborne noise impacts in Section 10.9. Refer to Appendix T for list of equipment with source noise control.

Table 10-45 Effective Sound Power Level – Noise Model Input with Source Noise Control

No.	Construction Stages/ Assessment Scenarios	Effective Sound Power Level (SWL), dB from overall equipment inventory							Effective Sound Power Level (SWL), dB from overall equipment inventory with Source Noise Control (see Table 10-44)							Remarks
		$L_{Aeq(12 hours)}$		$L_{Aeq(1 hour)}$		$L_{Aeq(5 mins)}$			$L_{Aeq(12 hours)}$		$L_{Aeq(1 hour)}$		$L_{Aeq(5 mins)}$			
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am	
Scenario 1: Advanced Works																
A	Demolition (per gang) – Building Level	109	N/A	N/A	N/A	114	N/A	N/A	109	N/A	N/A	N/A	114	N/A	N/A	No application of source noise control.
B	Demolition (per gang) – Ground Level	107	N/A	N/A	N/A	115	N/A	N/A	107	N/A	N/A	N/A	115	N/A	N/A	No application of source noise control.
Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction																
A	Demolition (per gang) – Building Level	109	N/A	N/A	N/A	114	N/A	N/A	109	N/A	N/A	N/A	114	N/A	N/A	No application of source noise control.
B	Demolition (per gang) – Ground Level	107	N/A	N/A	N/A	115	N/A	N/A	107	N/A	N/A	N/A	115	N/A	N/A	No application of source noise control.
C	Temporary Work – Installation of D-Wall, Sheet Pile* (Sungei Kadut Cut and Cover Station)	124	124	125	125	125	125	125	117	117	118	118	118	118	118	Refer to Appendix T for list of equipment with source noise control.
D	Temporary Work – Installation of D-Wall, Sheet Pile* (Intermediate Station)	119	119	120	120	121	121	121	112	112	113	113	113	113	113	Refer to Appendix T for list of equipment with source noise control.
E	Foundation Work – Substructures including piles and pile caps for above-ground bridge structure (per pile cap) (Pedestrian Linkbridge)	117	N/A	N/A	N/A	119	N/A	N/A	116	N/A	N/A	N/A	118	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.
F	Site Office	114	N/A	N/A	N/A	118	N/A	N/A	113	N/A	N/A	N/A	116	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.
G	Site Dormitory	113	N/A	N/A	N/A	118	N/A	N/A	110	N/A	N/A	N/A	116	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.
H	Site Storage	115	N/A	N/A	N/A	119	N/A	N/A	113	N/A	N/A	N/A	116	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.

No.	Construction Stages/ Assessment Scenarios	Effective Sound Power Level (SWL), dB from overall equipment inventory							Effective Sound Power Level (SWL), dB from overall equipment inventory with Source Noise Control (see Table 10-44)							Remarks
		$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$			$L_{Aeq(12\ hours)}$		$L_{Aeq(1\ hour)}$		$L_{Aeq(5\ mins)}$			
		7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 7am	7pm – 10pm	10pm – 7am	7am – 7pm	7pm – 10pm	10pm – 7am	
Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction																
A	Temporary Work – Installation of D-Wall, Sheet Pile (Reception Track Cut and Cover Areas)*	114	114	115	115	116	116	116	109	109	110	110	111	111	111	Refer to Appendix T for list of equipment with source noise control.
B	Removal of Temporary Works and Re-instatement (Reception Track Cut and Cover Areas)	119	N/A	N/A	N/A	122	N/A	N/A	110	N/A	N/A	N/A	113	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.
C	Superstructure (Potential future infrastructure)	117	N/A	N/A	N/A	117	N/A	N/A	111	N/A	N/A	N/A	112	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.
D	Superstructure (Elevated Vehicular Bridge)	122	N/A	N/A	N/A	124	N/A	N/A	114	N/A	N/A	N/A	116	N/A	N/A	Refer to Appendix T for list of equipment with source noise control.

Note: *N/A – Not Applicable*
** Works involving the installation of D Wall (Diaphragm Wall) and the Tunnel Boring Machine (TBM) are safety critical activities that cannot be halted due to safety reasons. Construction activities that are not safety critical shall be restricted to 8am – 6pm.*

10.8.1.2.3 Administrative Controls to further reduce noise

It is recommended to reduce noise impact to avifauna by various administrative controls at the Airborne Noise Study Area. For example, avoid breeding seasons for the activity, or to avoid early morning daytime noisy activities between 7 – 9 am as far as possible on site. This may reduce some impacts on this fauna on behavioural aspects and communication.

Other than that, the following administrative control measures should also be observed during the construction stage to further reduce the noise levels, especially on human receptors:

- Machines (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- Only well-maintained construction plants should be utilized on-site, and construction plants should be serviced regularly during the entire construction period;
- The number of PMEs should be reduced as far as practicable when construction works are carried out at areas close to the noise sensitive receivers:
- Silencers or mufflers on construction equipment should be utilized and should be properly maintained during the construction programme;
- Behavioural practices including no shouting, no loud stereos/ radios on site, no dropping of materials from height, no throwing of metal items should be ensured;
- Construction respite: Restrict high noise generating drilling activities only in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block, if possible;
- Periodic noise monitoring by an independent third party, to establish compliance with requirements and to advise on equipment causing concern, and additional potential mitigation measures;
- Night works, apart from advance works/ site clearance if approved by Agencies, will be prohibited after 6 pm to minimise noise disturbance to nocturnal animals;
- Plan the layout of the site by considering using materials and other large structural equipment as noise barriers;
- Construction plants known to emit noise strongly in one direction should, wherever possible, be orientated so that the noise is directed away from the nearby noise sensitive receptors;
- Material stockpiles and other structures will be effectively utilized, wherever practicable, in screening noise from on-site construction activities;
- All handheld percussive breakers and air compressors used on site will comply with local legislation and requirements;
- Activities may be scheduled to minimize noise generated at certain areas during periods which may be particularly sensitive to noise;
- Works using machines or vehicles that generate noise should be prohibited in the night and the dawn;
- Appropriate hearing protectors should be used by personnel operation the plant or equipment, the hearing protector must attenuate the exposure of the user to sound pressure levels below 85dB (A). Signage to remind personnel to put on hearing protection will be put up at work areas that emit excessive noise. Choice of hearing protector such as ear plugs (for < 100 dB (A)), earmuffs (for 100 dB (A) to 120 dB (A), ear plugs and earmuffs (for > 120dB (A)) in various noise exposure level;
- Noise awareness briefing should be conducted regularly and highlighted the noise mitigation measures such as position of machinery, making use of portable noise barriers and dos and don’ts for use of machinery at night; and
- If noise remains an issue even after implementation of recommended mitigation measures such as noise barriers, contractor should consider implementation of proprietary noise barriers of high noise reduction capabilities to further reduce noise to acceptable levels.

In addition to the above measures, an EMMP with airborne noise monitoring program was proposed to assess the effectiveness of minimum control measures and recommended mitigation measures on site during construction phase of the Project, as detailed in Section 14.9.1.

Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades.

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Figure Title : PROPOSED MITIGATION MEASURES (SCENARIO 1: ADVANCED WORKS)

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Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades.

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LTA Endorsement : N/A

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Project Title :

CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

PROPOSED MITIGATION MEASURES (SCENARIO 2 STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)

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Figure No. :	Rev.	Sheet
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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

N

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Figure Title :

PROPOSED MITIGATION MEASURES (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION)

Figure No. :	Rev.	Sheet
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CAD File Name :N/A A3

Note: Source of basemap - GoogleEarth Maps

10.8.2 Operational Phase

As discussed in Section 10.7.2.2, no additional mitigation measures are expected during operational phase.

10.9 Residual Impacts

10.9.1 Construction Phase

The residual construction impact assessment assumes that the mitigation measures proposed in Section 10.8 are implemented at the construction worksites, nearest to the receptors predicted to experience significant Impact Intensity through quantitative and qualitative means of assessment as discussed in Section 10.2.1.

10.9.1.1 Ecological Receptors

The residual construction impact assessment assumed that mitigation measures proposed in Section 10.8 were implemented at the construction worksites nearest to the ecological NSRs predicted to experience noise exceedances by the noise model and the distribution of Impact Significance. Impact Significance of **Moderate** and **Major** are of concern as high noise levels could render the area uninhabitable for noise sensitive fauna species forcing them to flee and abandon the area. It is recommended that faunistic field surveys be conducted during the construction phase to study the behavioral impacts on fauna species within the Biodiversity Study Area.

10.9.1.1.1 Scenario 1: Advanced Works

As discussed in Section 10.7.1.1, Impact Significance ranging from **Moderate** – **Major** were predicted to arise from Scenario 1: Advanced Works (see Table 10-32) during the time period of 7am – 7pm for the base scenario. Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 1 to ALARP.

The following mitigation measures have been considered for Advanced Works:

- Mitigation 1: Keep buildings fronting Rail Corridor as barrier while demolishing building immediately at the back, erect 3m perimeter noise barrier of STC20 and localized noise netting of STC18; and
- Mitigation 2: For buildings fronting Rail Corridor, any 2 buildings demolished at same time shall keep distance at least 300m away, erect 3m perimeter noise barrier of STC20 and localized noise netting of STC18

Upon implementation of the abovementioned measures, the overall Impact Intensity for Pang Sua Canal was reduced from **Medium** to **Negligible** with a corresponding Impact Consequence of **Imperceptible**. When relating the overall Impact Consequence to a Likelihood of Occurrence of **Likely**, it was determined that the overall Impact Significance for Pang Sua Canal is reduced from **Moderate** to **Negligible**. While the overall Impact Significance for the Rail Corridor and Sungei Pang Sua remained as **Moderate** – **Major**. However, the distribution of area with Moderate and Major Impact Significance has reduced substantially to only up to 5.7 ha (5.4 ha Moderate and 0.3 ha Major) from 19.5 ha under base scenario as elaborated in Table 10-46 below. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse and forage from a reduction of noise impacted areas.

10.9.1.1.2 Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)

As discussed in Section 10.7.1.1, Impact Significance ranging from **Moderate** – **Major** were predicted to arise from Scenario 2 (see Table 10-32) during the time period of 7am – 7pm for the base scenario. Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 2 to ALARP.

Due to the proximity of the noise sources to the Biodiversity Study Area during stages of construction involving works within the Biodiversity Study Area, the 3 m and 12 m vertical noise barriers and noise reduction netting proposed were found to only result in reduction of noise exceedances by 5.0 dB(A) within the Rail Corridor and Sungei Pang Sua (Priority 1) (see Table 10-46).

With the implementation of mitigation measures, the overall Impact Intensity remains unchanged as **High** with the overall Impact Significance for both Rail Corridor and Sungei Pang Sua and Pang Sua Canal remained unchanged ranging from **Moderate** – **Major**. However, the residual distribution of area of Impact Significance of **Moderate** – **Major** have been significantly reduced to only up to 2.8 ha (2.5 ha Moderate and 0.3 ha Major) from 40.8 ha in base scenario as elaborated in Table 10-47 below. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse and forage from a reduction of noise impacted areas.

It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the close proximity to pedestrian linkbridge worksite. The column construction of the pedestrian linkbridge across Pang Sua Canal is expected to be completed within 6 months. After this period, the overall impact significance is expected to be reduced significantly.

10.9.1.1.3 Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)

As discussed in Section 10.7.1.1, noise exceedances of up to 8.0 – 27.0 dB(A) with an Impact Significance ranging from **Moderate** – **Major** were predicted to arise from Scenario 2 (see Table 10-32) during the time period of 7pm – 7am for the base scenario. Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 2 to ALARP.

Due to the proximity of the noise sources to the Biodiversity Study Area, the 3 m and 12 m vertical noise barriers and noise reduction netting proposed were found to only be effective in reducing noise exceedances for the Rail Corridor and Sungei Pang Sua (Priority 1) by 13.0 dB(A) with the Impact Intensity remaining unchanged as **High** (see Table 10-46).

Impact Significance within Rail Corridor and Sungei Pang Sua remained unchanged as **Major**. While for Pang Sua Canal with a residual Impact Intensity of **Negligible** and corresponding Impact Consequence of **Imperceptible**, the Impact Significance within Pang Sua Canal was assessed to be reduced from **Moderate** to **Negligible**.

It should be noted that while Impact Significance remains as **Moderate – Major** for Rail Corridor and Sungei Pang Sua, the residual distribution of area of Moderate – Major Impact Significance has been significantly minimised to up to 0.5 ha (0.3 ha Moderate and 0.2 ha Major) from 33.6 ha in base scenario as reflected in Table 10-38. The distribution of area by hectares are further elaborated in Table 10-47 below. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse, forage, or seek shelter from a reduction of noise impacted areas.

It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the immediate proximity to the station construction worksite. Only limited works will be carried out during nighttime. Night work expected at Intermediate Station and Docking Shaft for ERSS related works (installation of D-wall, sheet pile) and also TBM related works of up to 18 months. No night work expected for Pedestrian Linkbridge construction.

10.9.1.1.4 Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)

As discussed in Section 10.7.1.1, noise exceedances of up to 34.0 – 36.0 dB(A) with an Impact Significance ranging from **Moderate** – **Major** were predicted to arise from Scenario 3 (see Table 10-32) during the time period of 7am – 7pm for the base scenario. Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 3 to ALARP.

Due to the proximity of the noise sources to the Biodiversity Study Area, the 3 m and 12 m vertical noise barriers proposed for Scenario 3 were found only to be effective in reducing noise exceedances for Rail Corridor and Sungei Pang Sua (Priority 1) by 6.0 dB(A) and 10.0 dB(A) for Pang Sua Canal (Priority 2) (see Table 10-46).

The overall Impact Intensity remains unchanged as **High** with the overall Impact Significance for both Rail Corridor and Sungei Pang Sua and Pang Sua Canal remained unchanged ranging from **Moderate** – **Major**. However, the residual distribution of area of Impact Significance of **Moderate** – **Major** near the Scenario 3 proposed worksite areas have been significantly reduced to up to 5.9 ha (4.3 ha Moderate and 1.6ha Major) from 41.9 ha in base scenario as elaborated in Table 10-47 below. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse and forage from a reduction of noise impacted areas.

It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the close proximity to vehicular bridge and potential future infrastructure worksites. The column construction of the vehicular bridge across Pang Sua Canal and potential future infrastructure across Sungei Pang Sua is expected to be completed within 12 months and 3 months respectively. After this period, the overall impact significance is expected to be reduced significantly.

10.9.1.1.5 Scenario 3b: Potential future infrastructure , reception track cut and cover areas, and vehicular bridge construction (Night Time)

As discussed in Section 10.7.1.1, no noise exceedances were predicted for to arise from Scenario 3: Potential future infrastructure , reception track cut and cover areas, and vehicular bridge (see Table 10-32) during the time period of 7pm – 7am for the base scenario.

Figure 10-40 and Table 10-46 presents the distribution on area of Impact Significance for Scenario 3. Mitigation measures were not proposed for the construction phase to mitigate the noise impacts for Scenario 3 to ALARP.

Table 10-46 Summary of Construction Noise Impacts for Ecological Receptors, Mitigated Scenario

Assessment Scenario(s)	Ecological Receptor Sensitivity	Base Scenario						Assessment Scenario(s)	Mitigated Scenario						Remark(s)
		Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance		Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	
Scenario 1: Advanced Works															
Scenario 1: Advanced Works	Priority 1	81.0	27.0	High	High	Likely	Major	Scenario 1: Advanced Works	73.0	19.0	High	High	Likely	Major	No changes in maximum predicted noise levels. Impact Significance remains unchanged as **Major**.
	Priority 2	58.0	4.0	Medium	Low	Likely	Moderate		54.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 4.0 dB(A). Impact Significance reduced from **Moderate** to **Negligible**.
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)															
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day)	Priority 1	89.0	35.0	High	High	Likely	Major	Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day)	84.0	30.0	High	High	Likely	Major	Reduce in maximum predicted noise level by 5.0 dB(A). Impact Significance remains unchanged as **Major**.
	Priority 2	70.0	16.0	High	Medium	Likely	Moderate		77.0	23.0	High	Medium	Likely	Moderate	Increase in maximum predicted noise level by 7.0 dB(A). Impact Significance remains unchanged as **Moderate**.
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)															
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night)	Priority 1	84.0	30.0	High	High	Likely	Major	Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night)	71.0	17.0	High	High	Likely	Major	Decrease in maximum predicted noise level by 13.0 dB(A). Impact Significance remains unchanged as **Major**.

Assessment Scenario(s)	Ecological Receptor Sensitivity	Base Scenario						Assessment Scenario(s)	Mitigated Scenario						Remark(s)
		Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance		Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	
	Priority 2	62.0	8.0	High	Medium	Likely	Moderate		50.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 12.0 dB(A). Impact Significance reduced from **Moderate** to **Negligible**.
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)															
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day)	Priority 1	90.0	36.0	High	High	Likely	Major	Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day)	84.0	30.0	High	High	Likely	Major	Decrease in maximum predicted noise level by 6.0 dB(A). Impact Significance remains unchanged as **Major**.
	Priority 2	88.0	34.0	High	Medium	Likely	Moderate		78.0	24.0	High	Medium	Likely	Moderate	Decrease in maximum predicted noise level by 10.0 dB(A). Impact Significance remains unchanged as **Major**.
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)															
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)	Priority 1	49.0	-	Negligible	Very Low	Likely	Minor	Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)	37.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 6.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	46.0	-	Negligible	Imperceptible	Likely	Negligible		35.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 11.0 dB(A). Impact Significance remains unchanged as **Negligible**.

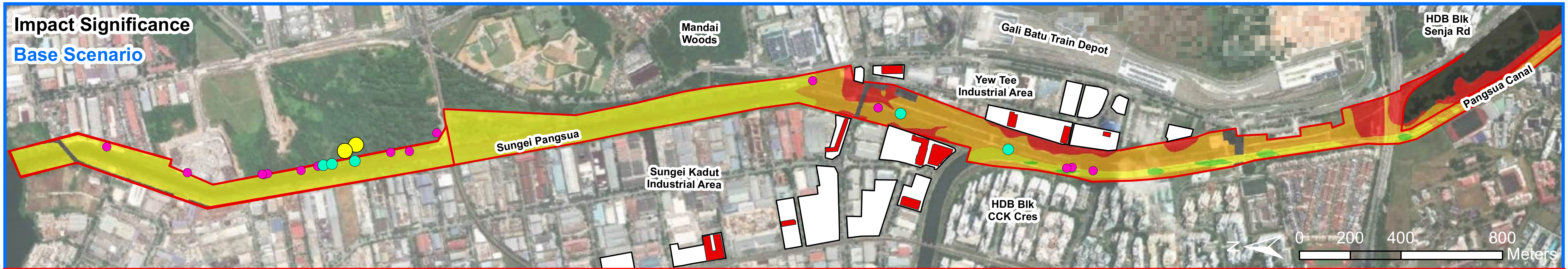
Table 10-47 Distribution of area of Impact Significance within Biodiversity Study Area, ha, Mitigated Scenario

Impact Significance	Distribution of Impact Significance by area, ha								Remark(s)
	Base Scenario				Mitigated Scenario				
	Negligible	Minor	Moderate	Major	Negligible	Minor	Moderate	Major	
Scenario 1: Advanced Works									
Scenario 1: Advanced Works	7.6	50.5	12.9	6.6	9.5	62.4	5.4	0.3	Reduction in area of **Moderate** – **Major** Impact Significance by 13.8 ha.
Distribution of area, ha	58.1		19.5		71.9		5.7		
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)									
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day)	0.0	36.8	17.0	23.8	8.9	63.6	2.5	0.3	Reduction in area of **Moderate** – **Major** Impact Significance by 30 ha. It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the close proximity to pedestrian linkbridge worksite. The column construction of the pedestrian linkbridge across Pang Sua Canal is expected to be completed within 6 months.
Distribution of area, ha	36.8		40.8		72.5		2.8		

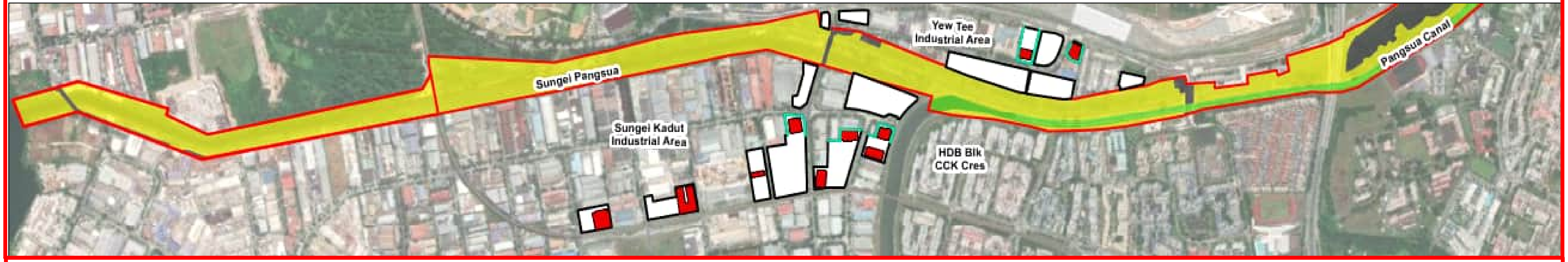
Impact Significance	Distribution of Impact Significance by area, ha								Remark(s)
	Base Scenario				Mitigated Scenario				
	Negligible	Minor	Moderate	Major	Negligible	Minor	Moderate	Major	
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)									
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night)	0.0	44.1	19.1	14.5	9.5	67.7	0.3	0.2	Reduction in area of **Moderate** – **Major** Impact Significance by 33.1 ha. It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the immediate proximity to the station construction worksite. Only limited works will be carried out during nighttime. Night work expected at Intermediate Station and Docking Shaft for ERSS related works (installation of D-wall, sheet pile) and also TBM related works of up to 18 months.
Distribution of area, ha	44.1		33.6		77.2		0.5		
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)									
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day)	0.0	35.7	21.0	20.9	8.3	60.9	4.3	1.6	Reduction in area of **Moderate** – **Major** Impact Significance by 36 ha. It is also to be noted majority of Moderate – Major impacted area is expected to be concentrated in the close proximity to vehicular bridge and the potential future infrastructure worksites. The column construction of the vehicular bridge across Pang Sua Canal and the potential future infrastructure across
Distribution of area, ha	35.7		41.9		69.2		5.9		

Impact Significance	**Distribution of Impact Significance by area, ha**								**Remark(s)**
	Base Scenario				**Mitigated Scenario**				
	Negligible	**Minor**	**Moderate**	**Major**	**Negligible**	**Minor**	**Moderate**	**Major**	
									Sungei Pang Sua is expected to be completed within 12 months and 3 months respectively. After this period, the overall impact significance is expected to be reduced significantly.
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)									
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night)	9.5	68.3	0.0	0.0	9.5	68.3	0.0	0.0	No change to distribution of area of Impact Significance.
Distribution of area, ha	77.8		0.0		77.8		0.0		

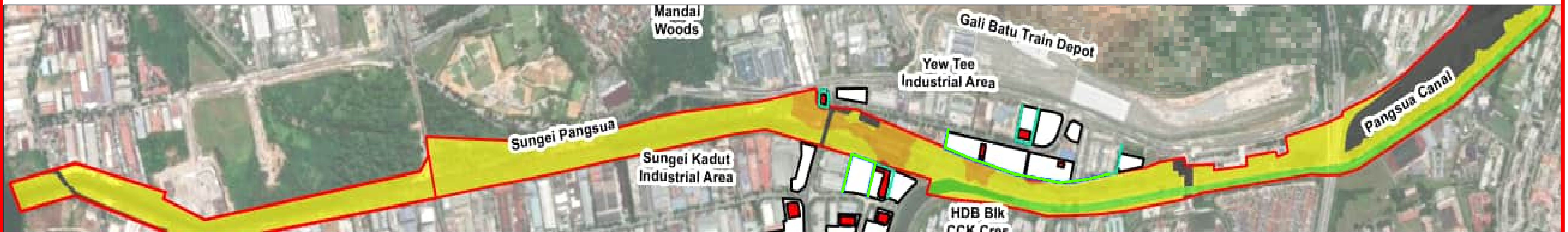
The resulting predicted residual airborne noise levels and residual Impact Significance map representative of the three (3) assessment scenarios are visualized in Figure 10-36 to Figure 10-40 for $L_{Aeq(5\ mins)}$.



Mitigated Scenario 1: Keep buildings fronting Rail Corridor as barrier while demolishing building immediately at the back, erect 3m perimeter noise barrier and localized noise netting of STC18 on facade of building to be demolished



Mitigated Scenario 2: For buildings fronting Rail Corridor, any 2 buildings demolished at same time shall keep distance at least 300m away, erect 3m perimeter noise barrier and localized noise netting of STC18 on facade of building to be demolished



Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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Figure Title : PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm, (SCENARIO 1: ADVANCED WORKS) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No.	Rev.	Sheet
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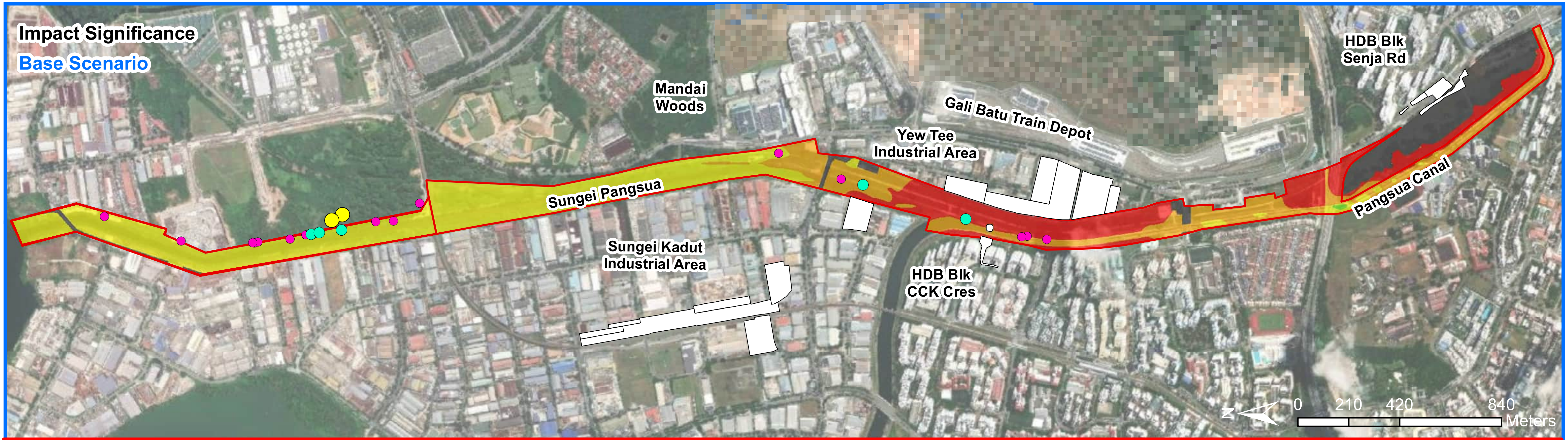
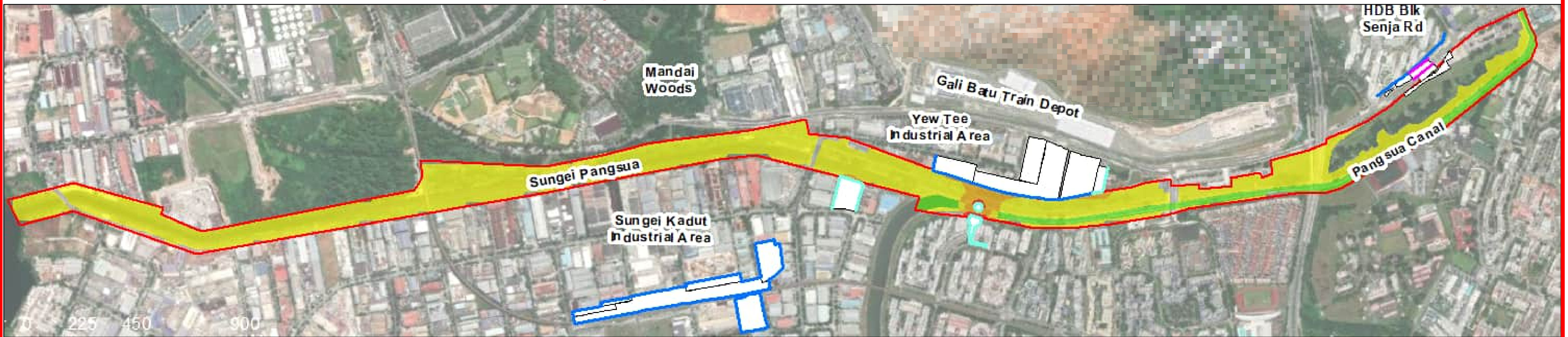
Note: Source of basemap - GoogleEarth Maps



Mitigated Scenario:

- **Erect Noise Barriers of 3m and 12m of STC20. This was proposed based on height of receptors and viability of implementation with consideration of space required**
- **15m high full enclosure with open façade opening at the northern and southern sides for TBM work around the docking shaft location**
- **Localized enclosures/ movable barrier for construction machinery/ equipment within worksites**



Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Impact Significance

- Negligible
- Minor
- Moderate
- Major

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Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm, (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) MITIGATED SCENARIO

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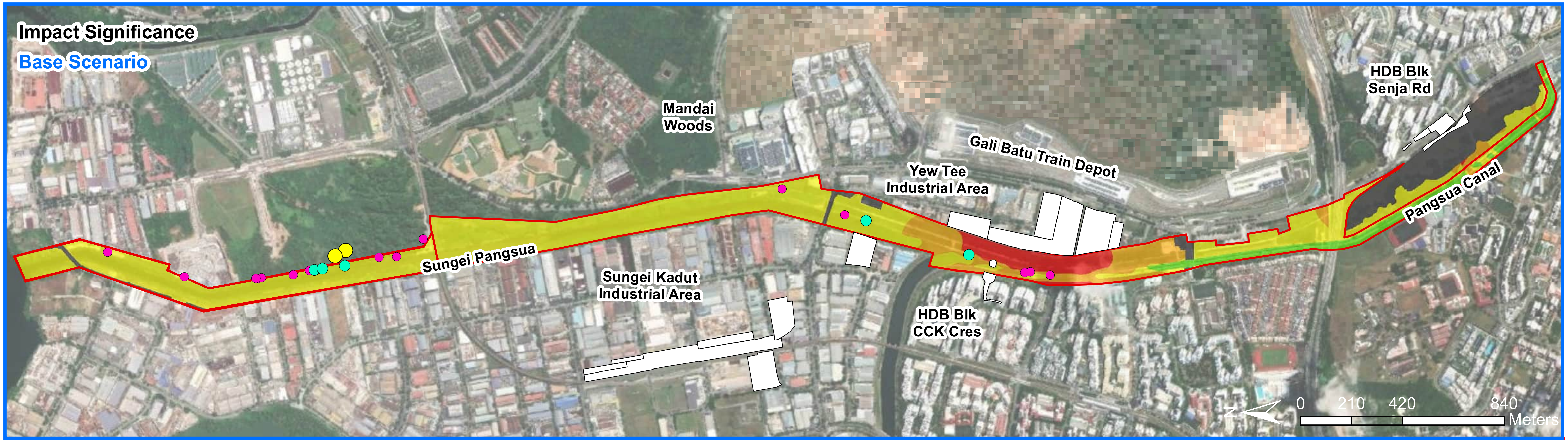
HHL	HHL	JAG	10-37	B	1 of 1
	Drawn SYT	Date MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps



Mitigated Scenario:

- **Erect Noise Barriers of 3m and 12m of STC20. This was proposed based on height of receptors and viability of implementation with consideration of space required**
- **15m high full enclosure with open façade opening at the northern and southern sides for TBM work around the docking shaft location**
- **Localized enclosures/ movable barrier for construction machinery/ equipment within worksites**

Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

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Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7pm - 7am, (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
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	Drawn SYT	Date MAY 2023	CAD File Name :N/A		A3

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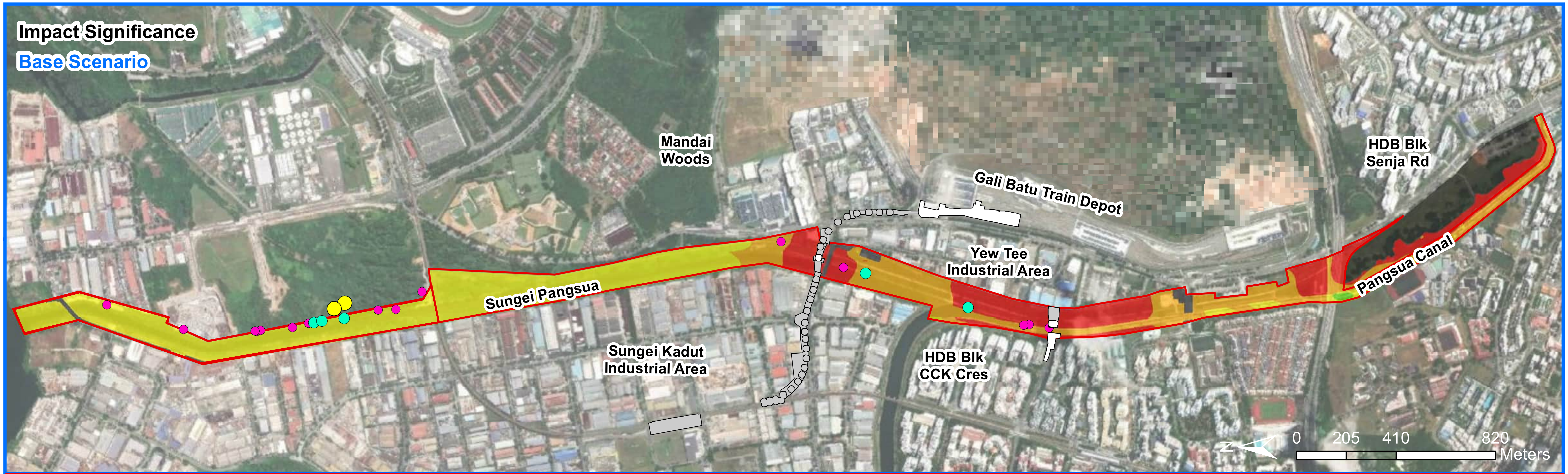

Mitigated Scenario:
- Erect Noise Barriers of 3m and 12m of STC20. This was proposed based on height of receptors and viability of implementation with consideration of space required
- Localized enclosures/ movable barrier for construction machinery/ equipment within worksites

Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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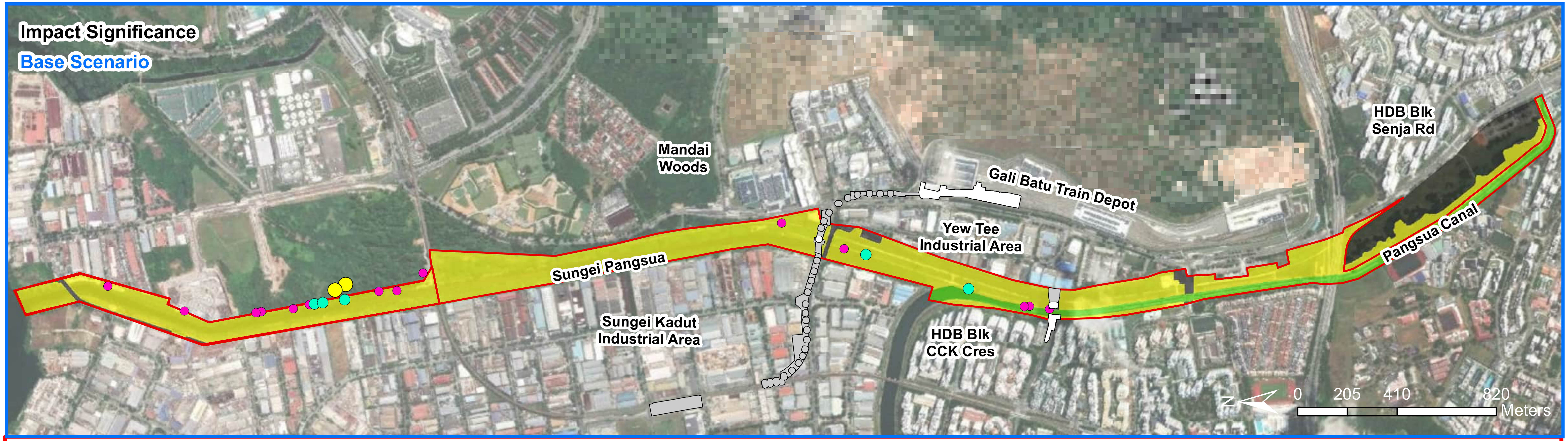
Project Title : CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title : PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7am - 7pm, (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK CUT AND COVER AREAS, AND VEHICULAR BRIDGE CONSTRUCTION) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No.	Rev.	Sheet
HHL	HHL	JAG	10-39	B	1 of 1

Drawn: SYT | Date: MAY 2023 | CAD File Name :N/A | A3

Note: Source of basemap - GoogleEarth Maps



Mitigated Scenario:

- Erect Noise Barriers of 3m and 12m of STC20. This was proposed based on height of receptors and viability of implementation with consideration of space required

- Localized enclosures/ movable barrier for construction machinery/ equipment within worksites

Legend

- Raptor Nest
- Roosting Birds
- Roosting Migratory Bird
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

Rev.	Date	By	Description	Chk'd	App'd
B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

Land Transport Authority — We Keep Your World Moving

Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR ECOLOGICAL RECEPTORS - LAeq(5 mins), 7pm - 7am, (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK CUT AND COVER AREAS, AND VEHICULAR BRIDGE CONSTRUCTION) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
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Drawn	Date	CAD File Name	
SYT	MAY 2023	N/A	A3

Note: Source of basemap - GoogleEarth Maps

10.9.1.1.6 Rock Breaking and Excavation

As discussed in Section 10.7.1.2.6, due to an Impact Significance of **Moderate** for ecological NSRs subjected to airborne noise impacts from rock breaking and excavation, mitigation measures were proposed in Section 11.9 as part of ground-borne noise and vibration management. Upon the application of the mitigation measures, the resulting residual Impact Significance from Sungei Kadut Cut and Cover Station to the ecological NSRs were reduced to **Minor** as given below in Table 10-48.

Table 10-48 Summary of Prediction and Evaluation of Airborne Noise – Rock Breaking and Excavation Impacts at nearest Ecological Receptor from Sungei Kadut Cut and Cover Station, Mitigated Scenario

Location of proposed rock breaking and excavation	Horizontal distance from worksite, m	Ecological Receptor Sensitivity	Discharge Mass (up to), kg	SPL	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Impact Significance
Sungei Kadut Cut and Cover Station	535.0	Priority 1	0.8	114	Negligible	Very Low	Certain	Minor

10.9.1.2 Human Receptors

The residual construction noise impact assessment assumed that the mitigation measures proposed in Section 10.8 were implemented at the proposed construction worksites nearest to the human NSRs predicted by the noise model to experience noise exceedances.

10.9.1.2.1 Scenario 1: Advanced Works

As discussed in Section 10.7.1.2, noise exceedances of up to 6.8 – 7.6 dB(A) with Impact Significance ranging from **Negligible** – **Moderate** were predicted to arise from Scenario 1: Advanced Works for $L_{Aeq(12\ hours)}$, 7am – 7pm (refer to Table 10-35). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 1 to ALARP.

It was observed that mitigation measures of 3 m and 12 m vertical noise barriers and noise reduction netting proposed for Scenario 1 were predicted to be effective in eliminating noise exceedances on the human NSRs. The resulting overall Impact Intensity was reduced from **Imperceptible** – **High** to **Negligible**. When relating to an overall Impact Consequence ranging from **Imperceptible** – **Very Low** and a Likelihood of Occurrence of **Occasional**/ **Likely**, it was determined that the overall Impact Significance for human NSRs subjected to construction noise from Scenario 1 is reduced from **Negligible** – **Moderate** to **Negligible** – **Minor** as elaborated in Table 10-49 below

10.9.1.2.2 Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)

As discussed in Section 10.7.1.2, noise exceedances of up to 5.8 – 10.0 dB(A) with Impact Significance ranging from **Negligible** – **Moderate** were predicted to arise from Scenario 2 for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend, and $L_{Aeq(5\ mins)}$, 7am – 7pm on the Weekend (refer to Table 10-35). Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 2 to ALARP.

It was observed that mitigation measures of 3 m and 12 m vertical noise barriers and noise reduction netting proposed for both Scenario 2a and Scenario 2b were predicted to result in a reduction of noise exceedances by 0.2 – 12.0 dB(A) with the overall Impact Intensity remaining unchanged as **Negligible** – **High**. As elaborated in Table 10-49 below, when relating the Impact Intensity to an overall Impact Consequence of **Imperceptible** – **Medium** to a Likelihood of Occurrence of **Occasional**/ **Likely**, the overall Impact Significance for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend was reduced from **Negligible** – **Moderate** to **Negligible** – **Minor** while that for $L_{Aeq(5\ mins)}$, 7am – 7pm for the Weekend remained unchanged as **Negligible** – **Moderate**.

Upon closer inspection of predicted residual noise results for $L_{Aeq(5\ mins)}$, 7am – 7pm for the Weekend, human NSRs predicted with a residual Impact Significance of **Moderate** are residential receptors near the proposed Pedestrian Linkbridge. Due to the proximity and height of these receptors and the limitation of 3 m vertical noise barriers for proposed worksite areas near residences, predicted residual Impact Significance was not able to be reduced from Moderate to lower. Considering this, communication efforts should be implemented to inform these residences – HDB Block 690D, 691B Choa Chu Kang during the period of works and complaints of noise nuisance that are anticipated should be addressed accordingly.

10.9.1.2.3 Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)

As discussed in Section 10.7.1.2, noise exceedances of up to 6.2 – 22.7 dB(A) with an Impact Significance of **Minor** – **Major** were predicted to arise from construction works proposed for Scenario 2 for $L_{Aeq(12\ hours)}$, 7pm – 7am, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ 7pm – 10pm, 10pm – 7am for both Weekday and Weekend.

It was observed that mitigation measures of 3 m and 12 m vertical noise barriers and noise reduction netting proposed for both Scenario 2a and Scenario 2b were predicted to result in a reduction of noise exceedances by 0.3 – 11.4 dB(A) with the overall Impact Intensity was reduced from a range of **Low** – **High** to **Low** – **Medium**. As presented in Table 10-49, when relating Impact Intensity to an overall Impact

Consequence of **Very Low** – **Medium** to a Likelihood of Occurrence of **Occasional**/ **Likely**, the overall Impact Significance for $L_{Aeq(12\ hours)}$, 7pm – 7am, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ 7pm – 10pm, 10pm – 7am for both Weekday and Weekend was reduced from **Minor** – **Major** to **Minor** – **Moderate**.

Upon closer look at the predicted residual noise results, it was observed that 14 residential receptors (i.e., HDB Block 632A, 632B, 633A, 633B, 633C, 634A, 634C Senja Road, HDB Block 691A, 691B 692A, 692B Choa Chu Kang, 15 Sungei Kadut Street 2 Workers Dormitory), and 2 industrial/ commercial receptors (i.e., JTC Trendspace, Xiong Lue Furniture Pte Ltd), were predicted with a residual Impact Significance of **Moderate** due to the proximity and height of the receptors and limitation of the 3 m and 12 m vertical noise barriers in eliminating the direct line-of-sight of receptors to the proposed worksite areas. Communication efforts should be implemented to inform the human receptors potentially impacted by construction noise impacts, particularly residential receptors that may face sleep disruption due to increased noise levels during the period of construction works. All night works near these residential receptors should be limited to only when safety critical and necessary.

10.9.1.2.4 Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)

As discussed in Section 10.7.1.2, noise exceedances of up to 1.4 – 8.9 dB(A) with Impact Significance of **Negligible** – **Moderate** were predicted to arise from construction works proposed for Scenario 3: potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend, and $L_{Aeq(5\ mins)}$ 7am – 7pm only on the Weekend. Mitigation measures were thereby proposed for the construction phase to mitigate the noise impacts for Scenario 3 to ALARP.

It was observed that mitigation measures of 3 m and 12 m vertical noise barriers proposed for Scenario 3 were predicted to result in a reduction of noise exceedances by 5.9 – 9.4 dB(A) with the overall Impact Intensity reduced from **Negligible** – **High** to **Negligible** – **Medium**. As elaborated in Table 10-49 below, when relating the Impact Intensity to an overall Impact Consequence of **Imperceptible** – **Low** to a Likelihood of Occurrence of **Occasional**/ **Likely**, the overall Impact Significance for $L_{Aeq(12\ hours)}$, 7am – 7pm for both Weekday and Weekend was reduced from **Negligible** – **Moderate** to **Negligible** – **Minor** while that for $L_{Aeq(5\ mins)}$, 7am – 7pm for the Weekend remained unchanged as **Negligible** – **Moderate**.

Upon closer inspection of predicted residual noise results for $L_{Aeq(5\ mins)}$, 7am – 7pm for the Weekend, one human NSR was predicted with a residual Impact Significance of **Moderate** due to the proximity and height of the receptor and the limitation of 3 m vertical noise barriers for proposed worksite areas near residences (proposed elevated vehicular bridge). The predicted residual Impact Significance was not able to be reduced from Moderate to lower. Considering this, communication efforts should be implemented to inform the human receptor – 42 The Quintet during the period of works and complaints of noise nuisance that are anticipated should be addressed accordingly.

10.9.1.2.5 Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction, Night Time

As discussed in Section 10.7.1.2, noise exceedances of up to 4.1 – 8.1 dB(A) with an Impact Significance of **Negligible** – **Minor** were predicted to arise from construction works proposed for Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction for $L_{Aeq(12\ hours)}$, 7pm – 7am, and $L_{Aeq(5\ mins)}$ 7pm – 10pm, 10pm – 7am for both Weekday and Weekend.

It was observed that mitigation measures of 3 m and 12 m vertical noise barriers proposed for Scenario 3 were predicted to result in a reduction of noise exceedances by 5.0 – 15.0 dB(A) with the overall Impact Intensity reduced from **Negligible** – **High** to **Negligible** – **Medium**. Corresponding to an overall Impact Consequence ranging from **Imperceptible** – **Low** and a Likelihood of Occurrence of **Occasional**/ **Likely**, the overall Impact Significance remains unchanged as **Negligible** – **Minor**.

While Impact Significance remains as Negligible – Minor, it should be noted that noise exceedances were not eliminated for commercial receptors – Gali Batu and SBS Depot in close proximity to the proposed worksite areas. Communication efforts should be implemented with the potentially affected stakeholders on noise nuisance during the period of works and complaints anticipated should be addressed accordingly.

Table 10-49 Construction Noise Impacts for Human Receptors, Mitigated Scenario

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						Mitigated Scenario						
Scenario 1: Advanced Works														
LAeq(12 hours), dB (7am – 7pm)	Priority 1	68.6	7.6	High	High	Occasional	Moderate	59.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 9.6 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	68.0	-	Negligible	Imperceptible	Occasional	Negligible	67.0	-	Negligible	Imperceptible	Occasional	Negligible	Maximum predicted noise levels remains unchanged.
	Priority 3	82.8	6.8	High	Low	Occasional	Minor	74.0	-	Negligible	Imperceptible	Occasional	Negligible	Decrease in maximum predicted noise level by 8.8 dB(A). Impact Significance remains unchanged as **Negligible**.
LAeq(5 mins), dB (7am – 7pm)	Priority 1	68.6	-	Negligible	Very Low	Likely	Minor	68.6	-	Negligible	Very Low	Likely	Minor	Maximum predicted noise levels remains unchanged. Impact Significance remains unchanged as **Minor**.
	Priority 2	68.0	-	Negligible	Imperceptible	Likely	Negligible	68.0	-	Negligible	Imperceptible	Likely	Negligible	Maximum predicted noise levels remains unchanged. Impact Significance remains unchanged as **Minor**.
	Priority 3	82.8	-	Negligible	Imperceptible	Likely	Negligible	83.0	-	Negligible	Imperceptible	Likely	Negligible	Maximum predicted noise levels remains unchanged. Impact Significance remains unchanged as **Minor**.
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)														
LAeq(12 hours), dB, Weekday (7am – 7pm)	Priority 1	66.8	5.8	Medium	Medium	Occasional	Moderate	67.0	2.0	Medium	Low`	Occasional	Minor	Decrease in maximum predicted noise level by 0.2 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	84.6	9.6	High	Medium	Occasional	Moderate	80.9	5.9	Medium	Low	Occasional	Minor	Decrease in maximum predicted noise level by 3.7 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 3	85.1	9.1	High	Low	Occasional	Minor	83.9	7.0	High	Low	Occasional	Minor	Decrease in maximum predicted noise level by 1.2 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(5 mins), dB, Weekday	Priority 1	70.0	-	Negligible	Very Low	Likely	Minor	67.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						Mitigated Scenario						
(7am – 7pm)														3.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	85.0	-	Negligible	Imperceptible	Likely	Negligible	81.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 4.0 dB(A). Impact Significance remains unchanged as **Negligible**.
	Priority 3	85.0	-	Negligible	Imperceptible	Likely	Negligible	84.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 1.0 dB(A). Impact Significance remains unchanged as **Negligible**.
LAeq(12 hours), dB, Weekend (7am – 7pm)	Priority 1	66.8	5.8	Medium	Medium	Occasional	Moderate	67.0	2.0	Low	Low	Occasional	Minor	Decrease in maximum predicted noise level by 2.7 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	84.6	9.6	High	Medium	Occasional	Moderate	80.9	5.9	Medium	Low	Occasional	Minor	Decrease in maximum predicted noise level by 3.7 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 3	85.1	10.1	High	Low	Occasional	Minor	83.9	8.9	High	Low	Occasional	Minor	Decrease in maximum predicted noise level by 2.2 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(5 mins), dB, Weekend (7am – 7pm)	Priority 1	70.0	-	Negligible	Very Low	Likely	Minor	67.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 3.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	85.0	10.0	High	Medium	Likely	Moderate	81.0	6.0	Medium	Low	Likely	Moderate	Decrease in maximum predicted noise level by 4.0 dB(A). Impact Significance remains unchanged as **Moderate**.
	Priority 3	85.0	-	Negligible	Imperceptible	Likely	Negligible	84.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 1.0 dB(A). Impact Significance remains unchanged as **Negligible**.
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)														
LAeq(12 hours), dB, Weekday (7pm – 7am)	Priority 1	60.4	6.4	High	High	Occasional	Moderate	54.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 6.4 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						Mitigated Scenario						
	Priority 3	82.4	16.4	High	Low	Occasional	Minor	83.8	17.8	High	Low	Occasional	Minor	Increase in maximum predicted noise level by 1.4 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(1 hour), dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Priority 2	78.7	22.7	High	Medium	Occasional	Moderate	67.3	11.3	High	Medium	Occasional	Moderate	Decrease in maximum predicted noise level by 11.4 dB(A). Impact Significance remains unchanged as **Moderate**.
	Priority 3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LAeq(5 mins), dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	62.2	6.2	High	High	Likely	Major	54.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 6.3 dB(A). Impact Significance reduced from **Major** to **Minor**.
	Priority 2	78.7	22.7	High	Medium	Likely	Moderate	67.3	11.3	High	Medium	Likely	Moderate	Decrease in maximum predicted noise level by 11.4 dB(A). Impact Significance remains unchanged as **Moderate**.
	Priority 3	84.4	14.4	High	Low	Likely	Moderate	83.8	13.8	High	Low	Likely	Moderate	Decrease in maximum predicted noise level by 0.6 dB(A). Impact Significance remains unchanged as **Moderate**.
LAeq(12 hours), dB, Weekend (7pm – 7am)	Priority 1	60.4	8.4	High	High	Occasional	Moderate	54.0	2.0	Low	Low	Occasional	Minor	Decrease in maximum predicted noise level by 6.4 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Priority 3	82.4	16.4	High	Low	Occasional	Minor	83.8	17.8	High	Low	Occasional	Minor	Increase in maximum predicted noise level by 1.4 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(5 mins), dB, Weekend (7pm – 10pm, 10pm – 7am)	Priority 1	66.3	6.3	High	High	Likely	Major	54.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 6.3 dB(A). Impact Significance reduced from **Major** to **Minor**.
	Priority 2	78.7	18.7	High	Medium	Likely	Moderate	67.3	7.3	High	Medium	Likely	Moderate	Decrease in maximum predicted noise level by 11.4 dB(A). Impact Significance remains unchanged as **Moderate**.
	Priority 3	84.4	14.4	High	Low	Likely	Moderate	83.8	13.8	High	Low	Likely	Moderate	Decrease in maximum predicted noise level by

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						Mitigated Scenario						
														0.6 dB(A). Impact Significance remains unchanged as **Moderate**.
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)														
LAeq(12 hours), dB, Weekday (7am – 7pm)	Priority 1	62.4	1.4	Low	Low	Occasional	Minor	53.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 9.4 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	83.9	8.9	High	Medium	Occasional	Moderate	77.6	2.6	Low	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 6.3 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 3	80.1	5.1	Medium	Very Low	Occasional	Minor	74.0	-	Negligible	Imperceptible	Occasional	Negligible	Decrease in maximum predicted noise level by 6.1 dB(A). Impact Significance reduced from **Minor** to **Negligible**.
LAeq(5 mins), dB, Weekday (7am – 7pm)	Priority 1	62.4	-	Very Low	Very Low	Likely	Minor	53.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 9.4 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	83.9	-	Negligible	Imperceptible	Likely	Negligible	78.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 5.9 dB(A). Impact Significance remains unchanged as **Negligible**.
	Priority 3	80.1	-	Negligible	Imperceptible	Likely	Negligible	74.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 6.1 dB(A). Impact Significance remains unchanged as **Negligible**.
LAeq(12 hours), dB, Weekend (7am – 7pm)	Priority 1	62.4	1.4	Low	Low	Occasional	Moderate	53.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 9.4 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 2	83.9	8.9	High	Medium	Occasional	Moderate	77.6	2.6	Low	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 6.3 dB(A). Impact Significance reduced from **Moderate** to **Minor**.
	Priority 3	80.1	5.1	High	Low	Occasional	Minor	74.0	-	Negligible	Imperceptible	Occasional	Negligible	Decrease in maximum predicted noise level by 6.1 dB(A). Impact Significance reduced from **Minor** to **Negligible**.

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						**Mitigated Scenario**						
LAeq(5 mins), dB, Weekend (7am – 7pm)	Priority 1	62.4	-	Negligible	Very Low	Likely	Minor	53.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 9.4 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	83.9	8.9	High	Medium	Likely	Moderate	78.0	3.0	Medium	Low	Likely	Moderate	Decrease in maximum predicted noise level by 5.9 dB(A). Impact Significance remains unchanged as **Moderate**.
	Priority 3	80.1	-	Negligible	Imperceptible	Likely	Negligible	74.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 6.1 dB(A). Impact Significance remains unchanged as **Negligible**.
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)														
LAeq(12 hours), dB, Weekday (7pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Occasional	Minor	36.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 15.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Priority 3	74.1	8.1	High	Low	Occasional	Minor	69.1	3.1	Medium	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 5.0 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(1 hour), dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Priority 2	54.0	-	Negligible	Imperceptible	Occasional	Negligible	43.0	-	Negligible	Imperceptible	Occasional	Negligible	Decrease in maximum predicted noise level by 10.0 dB(A). Impact Significance remains unchanged as **Negligible**.
	Priority 3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
LAeq(5 mins), dB, Weekday (7pm – 10pm, 10pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Likely	Minor	36.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 15.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	54.0	-	Negligible	Imperceptible	Likely	Negligible	43.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 11.0 dB(A). Impact Significance remains unchanged as **Negligible**.
	Priority 3	74.1	4.1	Medium	Very Low	Likely	Minor	67.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 7.1 dB(A). Impact Significance reduced from **Minor – Negligible**.

Assessment Scenario(s)	Human Receptor Sensitivity	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Maximum Predicted Noise Level, dB(A)	Maximum Predicted Noise Exceedances, dB(A)	Impact Intensity	Impact Consequence	Likelihood of Occurrence	Maximum Overall Impact Significance	Remark(s)
		Base Scenario						**Mitigated Scenario**						
LAeq(12 hours), dB, Weekend (7pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Occasional	Minor	36.0	-	Negligible	Very Low	Occasional	Minor	Decrease in maximum predicted noise level by 15.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Priority 3	74.1	8.1	High	Low	Occasional	Minor	69.1	3.1	Medium	Low	Occasional	Minor	Decrease in maximum predicted noise level by 5.0 dB(A). Impact Significance remains unchanged as **Minor**.
LAeq(5 mins), dB, Weekend (7pm – 10pm, 10pm – 7am)	Priority 1	51.0	-	Negligible	Very Low	Likely	Minor	36.0	-	Negligible	Very Low	Likely	Minor	Decrease in maximum predicted noise level by 15.0 dB(A). Impact Significance remains unchanged as **Minor**.
	Priority 2	54.0	-	Negligible	Imperceptible	Likely	Negligible	43.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 11.0 dB(A). Impact Significance remains unchanged as **Negligible**.
	Priority 3	74.1	4.1	Medium	Very Low	Likely	Minor	67.0	-	Negligible	Imperceptible	Likely	Negligible	Decrease in maximum predicted noise level by 7.1 dB(A). Impact Significance reduced from **Minor – Negligible**.

Note: The detailed list of predicted noise levels for each human NSR subjected to airborne noise impacts from the three (3) assessment scenarios are presented in Appendix W.

Table 10-50 Distribution of Impact Significance by number of Human Receptor, Mitigated Scenario

Assessment Scenario(s)	Distribution of Impact Significance by number of Human Receptor										Remark(s)
	Base Scenario					Mitigated Scenario					
	Negligible	Minor	Moderate	Major	Not Applicable	Negligible	Minor	Moderate	Major	Not Applicable	
Scenario 1: Advanced Works											
$L_{Aeq(12\ hours)}$, dB (7am – 7pm)	197	3	4	0	0	198	6	0	0	0	Decrease in number of buildings of **Moderate – Major** Impact Significance by 4 buildings.
$L_{Aeq(5\ mins)}$, dB (7am – 7pm)	198	6	0	0	0	198	6	0	0	0	No change in number of buildings of **Moderate – Major** Impact Significance.
Scenario 2a: Station, Docking Shaft, Pedestrian Linkbridge construction (Day Time)											
$L_{Aeq(12\ hours)}$, dB (7am – 7pm), Weekday and Weekend	134	29	5	0	0	157	11	0	0	0	Decrease in number of buildings of **Moderate – Major** Impact Significance by 5 buildings.
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	151	11	6	0	0	160	8	0	0	0	Decrease in number of buildings of **Moderate – Major** Impact Significance by 6 buildings.
Scenario 2b: Station, Docking Shaft, Pedestrian Linkbridge construction (Night Time)											
$L_{Aeq(12\ hours)}$, dB (7pm – 7am),	101	24	1	0	42	158	10	0	0	0	Decrease in number of buildings of **Moderate –**

Assessment Scenario(s)	Distribution of Impact Significance by number of Human Receptor										Remark(s)
	Base Scenario					Mitigated Scenario					
	Negligible	Minor	Moderate	Major	Not Applicable	Negligible	Minor	Moderate	Major	Not Applicable	
Weekday and Weekend											**Major** Impact Significance by 1 buildings.
$L_{Aeq(1\ hour)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	10	10	22	0	126	32	10	0	0	126	Decrease in number of buildings of **Moderate** – **Major** Impact Significance by 22 buildings.
$L_{Aeq(5\ mins)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	118	20	28	2	0	148	14	6	0	0	Decrease in number of buildings of **Moderate** – **Major** Impact Significance by 24 buildings.
Scenario 3a: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Day Time)											
$L_{Aeq(12\ hours)}$, dB (7am – 7pm), Weekday and Weekend	45	12	2	0	0	53	6	0	0	0	Decrease in number of buildings of **Moderate** – **Major** Impact Significance by 2 buildings.
$L_{Aeq(5\ mins)}$, dB (7am – 7pm), Weekday and Weekend	50	4	5	0	0	53	5	1	0	0	Decrease in number of buildings of **Moderate** – **Major** Impact Significance by 4 buildings.
Scenario 3b: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction (Night Time)											
$L_{Aeq(12\ hours)}$, dB (7pm – 7am),	30	9	0	0	20	31	8	0	0	20	No change in number of buildings

Assessment Scenario(s)	Distribution of Impact Significance by number of Human Receptor										Remark(s)
	Base Scenario					Mitigated Scenario					
	Negligible	Minor	Moderate	Major	Not Applicable	Negligible	Minor	Moderate	Major	Not Applicable	
Weekday and Weekend											of **Moderate** – **Major** Impact Significance.
$L_{Aeq(1 hour)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	20	0	0	0	39	20	0	0	0	39	No change in number of buildings of **Moderate** – **Major** Impact Significance.
$L_{Aeq(5 mins)}$, dB (7pm – 10pm, 10pm – 7am), Weekday and Weekend	51	8	0	0	0	55	4	0	0	0	No change in number of buildings of **Moderate** – **Major** Impact Significance.

The resulting predicted residual airborne noise levels for each human NSRs are detailed in Appendix W and the Impact Significance of each individual building reflected in Figure 10-41 and Figure 10-42, Figure 10-43 to Figure 10-47, and Figure 10-48 to Figure 10-52 respectively for the three (3) assessment scenarios.

Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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B	MAY 2023	SYT	Draft Final Report	HHL	JAG

Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
**CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE**

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7am - 7pm, Weekday and Weekend (SCENARIO 1: ADVANCED WORKS) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-41	B	1 of 1
	Drawn SYT	Date MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 1 Advanced Works (150m Study Area)
- Proposed Worksite Areas (Scenario 1: Advanced Works)
- Selected Demolition Gangs
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7am - 7pm, Weekday and Weekend (SCENARIO 1: ADVANCED WORKS) MITIGATED SCENARIO

Designed	Checked	Approved	Drawn	Date
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Figure No. :	Rev.	Sheet
10-42	B	1 of 1

CAD File Name :N/A A3

Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(12 hours), 7am - 7pm, Weekday and Weekend
(SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)
MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-43	B	1 of 1

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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note: Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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Project Title :
CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7am - 7pm, Weekday and Weekend (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-44	B	1 of 1
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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note:
Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(12 hours), 7pm - 7am, Weekday and Weekend
(SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION)
MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-45	B	1 of 1
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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note:
Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(1 hour), 7pm - 10pm, 10pm - 7am, Weekday Only (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) MITIGATED SCENARIO

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Figure No. : 10-46 | Rev. B | Sheet 1 of 1

CAD File Name :N/A | A3

Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 2: Main Civil Works (150m Study Area)
- Proposed Worksite Areas (Scenario 2: Main Civil Works)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier
- Proposed 15m Noise Enclosure

Note:
Noise Reduction Nets of STC15 shall be installed up to one storey above the height of buildings selected for demolition on the face of all facades. Refer to Appendix X for the full list of construction noise results for individual human receptors.

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :

CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :

PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7pm - 10pm, 10pm - 7am, Weekday and Weekend (SCENARIO 2: STATION, DOCKING SHAFT, PEDESTRIAN LINKBRIDGE CONSTRUCTION) MITIGATED SCENARIO

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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(12 hours), 7am - 7pm,
Weekday and Weekend
(SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION)
MITIGATED SCENARIO

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Figure No. :	Rev.	Sheet
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CAD File Name :N/A A3

Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7am - 7pm, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) MITIGATED SCENARIO

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	Drawn: SYT	Date: MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title : CONTRACT 9175 ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title : PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(12 hours), 7pm - 7am, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-50	B	1 of 1

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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal Sungei
- Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

Consultant : AECOM

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Project Title :
CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS -
LAeq(1 hour), 7pm - 10pm, 10pm - 7am,
Weekday Only
(SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION)
MITIGATED SCENARIO

Designed	Checked	Approved	Figure No. :	Rev.	Sheet
HHL	HHL	JAG	10-51	B	1 of 1
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Note: Source of basemap - GoogleEarth Maps

Legend

- Scenario 3: Potential Future Infrastructure, Reception Track Terminal,Elevated Vehicular Bridge Construction (150m Study Area)
- Proposed Worksite Areas (Scenario 3: Potential Future Infrastructure, Reception Track Terminal, Elevated Vehicular Bridge Construction)
- Scenario 3: Potential Future Infrastructure and Vehicular Bridge Construction (Overall Footprint)
- Biodiversity Study Area
- Pang Sua Canal
- Sungei Pang Sua
- Existing Vegetated Area

Impact Significance

- Negligible
- Minor
- Moderate
- Major
- Not Applicable

Proposed Mitigation Measures

- Proposed 3m Vertical Noise Barrier
- Proposed 12m Vertical Noise Barrier

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Qualified Person Endorsement : N/A

LTA Endorsement : N/A

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CONTRACT 9175
ADVANCE ENGINEERING STUDY FOR THE PROPOSED DOWNTOWN LINE 2 EXTENSION AND A NEW STATION ON EXISTING NORTH-SOUTH LINE

Figure Title :
PREDICTED CONSTRUCTION NOISE IMPACTS FOR HUMAN RECEPTORS - LAeq(5 mins), 7pm - 10pm, 10pm - 7am, Weekday and Weekend (SCENARIO 3: POTENTIAL FUTURE INFRASTRUCTURE, RECEPTION TRACK TERMINAL, ELEVATED VEHICULAR BRIDGE CONSTRUCTION) MITIGATED SCENARIO

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	Drawn: SYT	Date: MAY 2023	CAD File Name :N/A		A3

Note: Source of basemap - GoogleEarth Maps

10.9.2 Operational Phase

10.9.2.1 Ecological Receptors

As the overall Impact Significance for noise emissions associated with the operational phase was assessed as **Negligible**, mitigation measures were not proposed for ecological NSRs subjected to operational noise.

10.9.2.2 Human Receptors

As discussed in Section 10.7.2.2, no exceedances of the $L_{Aeq(1\ hour)}$ noise criteria of 67 dB expected. As such, no mitigation measures have been proposed for the operational phase of the elevated vehicular bridge. No mitigation measures are also required for the operational phase of the potential future infrastructure.

10.10 Cumulative Impacts with Other Concurrent Projects

It is known that several other concurrent project developments, highlighted in Section 3.5.2 and visualized in Figure 3-31, would be on-going during similar construction schedules.

As a means of holistic approach towards the assessment of noise impacts experienced by the ecological and human NSRs in the vicinity of these concurrent developments, potential noise impacts arising from these concurrent developments ought to be assessed along with the noise impacts arising from the construction stages within the Project to deduce the cumulative noise impacts experienced by the NSRs.

In view of this, cumulative impacts from this Project along with that of other concurrent developments identified as the HDB CCK N1 Construction and JTC Woodlands Road Realignment are addressed for construction and operational noise impacts in subsequent sections.

10.10.1 Construction Phase

According to Section 3.5.2, two (2) concurrent developments in the vicinity of the Project site have been identified with their information and locations discussed and presented in Figure 3-32. When considering the other concurrent developments and their construction activities along with those occurring within this Project, the Impact Significance are expected to worsen as assessed below for the respective scenarios and associated NSRs. Due to the lack of information, only cumulative noise impacts arising from HDB CCK N1 proposed worksite areas were addressed in this report.

10.10.1.1 HDB CCK N1 Construction

The timeline overlap is considered minimal as by the time the Project commences work, HDB CCK N1 would already be at tail end of its construction period while the Project's docking shaft would have only started its commencement. Hence, increase in cumulative airborne noise impact in the vicinity of Docking Shaft Worksite is expected to be insignificant.

10.10.2 Operational Phase

For the operational phase, as the other concurrent developments would have been completed along with the developments proposed for the construction phase, it is expected that there will not be any cumulative impacts from other concurrent developments.

10.11 Summary of Key Findings

In this study, noise impact assessment was carried out for both the construction and operational phases of the proposed developments within the Project site to assess for airborne noise impacts on the identified ecological and human NSRs.

10.11.1 Construction Phase

A quantitative means of assessment detailing noise levels predicted with noise models based on inputs of effective SWL of proposed PMEs was conducted for three (3) assessment scenarios defined for assessment in the construction phase – Scenario 1: Advanced Works; Scenario 2: Station, Docking Shaft, Pedestrian Linkbridge construction; and Scenario 3: Potential future infrastructure, reception track cut and cover areas, and vehicular bridge construction.

In predicting for the construction noise impacts associated with the three (3) assessment scenarios, the highest overall SWLs of the construction stages associated with each assessment scenario were selected to assess for the worst-case noisiest scenarios. The rationale behind deducing the worst-case scenarios is under the assumption that if the construction stage with the highest SWL can be mitigated for instance with permanent fixtures such as noise barriers or other means proposed in Section 10.8, noise impacts from other construction stages/ activities with lower SWLs will also be addressed.

Baseline airborne noise monitoring was conducted at eleven (11) locations within the 150 m Airborne Noise Study Area established accordance with noise legislations outlined in EPM, 2008 [R-22]. Secondary baseline airborne noise data from HDB CCK N1 were also referenced and adopted in this study in an agreement of information exchange between LTA and HDB. Construction noise impact assessment findings from the HDB CCK N1 EIS Project were also referenced.

For human receptors, recorded $L_{Aeq(12\ hours)}$, $L_{Aeq(1\ hour)}$, and $L_{Aeq(5\ mins)}$ noise levels were compared against the EPM, 2008 [R-22] guidelines to develop a Project-specific criterion for the construction phase. This criterion was then used as part of construction noise impact assessment for human NSRs (see Section 10.5.3.1.2). While for ecological NSRs, the average baseline noise monitoring results were adopted to assess for impact on fauna species identified within the Biodiversity Study Area, suitable in supporting the presence of fauna as a conservative means of assessment (see Section 10.5.3.1.1).

Noise sensitive ecological and human NSRs were identified within the 150 m Airborne Noise Study Area established in accordance with the noise legislations outlined in EPM, 2008 [R-22]. The identified NSRs were then assessed against the impact evaluation matrices in Section 6.4.2, with the noise contours reflecting the extent of noise propagation from source to receptors and the associated distribution of Impact Significance provided. Mitigation measures were also introduced following predicted noise exceedances for both ecological and human NSRs as detailed below.

10.11.1.1 Ecological Receptors

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of up to 27.0 dB(A) for Scenario 1; 35.0 dB(A) for Scenario 2; and 36.0 dB(A) for Scenario 3. No noise exceedances were predicted for Scenario 3 during the night time for ecological NSRs. The resulting overall Impact Significance was evaluated to range from **Moderate** – **Major** for all three (3) assessment scenarios (see Table 10-32).

Mitigation measures were proposed to mitigate the noise impacts on the ecological NSRs to ALARP as discussed in Section 10.8. Vertical noise barriers of up to 3 m and 12 m in height were proposed, and an addition of 15 m noise enclosure for the docking shaft construction area of Scenario 2.

However, due to the proximity of the noise sources to the Biodiversity Study Area, with noise sources found within the Biodiversity Study Area during stages of construction involving the erection of columns, the proposed mitigation measures were found only to be effective in reducing noise minimally with a residual noise exceedance of up to 19.0 dB(A) for Scenario 1; 30.0 dB(A) for Scenario 2; and 30.0 dB(A) for Scenario 3. The overall residual Impact Significance was reduced from **Moderate** – **Major** to **Negligible** – **Major** (see Table 10-47).

Although the proposed mitigation measures in Section 10.8 were not able to eliminate the noise exceedances, a closer look into the comparison of the distribution of areas of Impact Significance reveals a considerable reduction of areas of Moderate – Major Impact Significance by 13.8 ha for Scenario 1; 30 ha for Scenario 2 day time; 33.1 ha for Scenario 2 night time; and 36 ha for Scenario 3 day time. This suggests that while Impact Significance remains unchanged, ecological NSRs will still benefit from the implementation of proposed mitigation measures with more land area to traverse, forage and seek shelter from a reduction of noise impacted areas. Also, majority of Moderate – Major impact is only expected during short period of time: approximately 2 years for Scenario 1; 6 months for Scenario 2 day time; 18 months for Scenario 2 night time; and 3-12 months for Scenario 3 day time. After this period, the noise impact is expected to reduce significantly until the end of construction period.

10.11.1.1.1 Rock Breaking and Excavation

As part of construction works, rock breaking and excavation can be proposed as an effective and efficient method to break down and remove rocks when common excavation techniques are not able to. At the point of time in writing this report, detailed information was not available. The rock breaking and excavation works could only be carried out by an appointed Contractor at a later stage.

Hence, the assessment approach detailed in BS5228-2:2009+A1:2014 [R-84] was adopted as the assessment criterion. Due to the lack of information for rock breaking and excavation works specific to Singapore, the site constant was assumed based on AS 2187.2-2006 [R-91].

Employing the assumptions on location, depth, and method of rock breaking and excavation, and known information of distance from location of rock breaking and excavation to the nearest NSRs, the assessment provided an estimate on the MIC that should be permitted in order to keep air overpressure within the stated criteria (see Section 10.2.1.1.1).

Based on the approximate distance from Sungei Kadut Cut and Cover Station to the nearest boundary of the ecological NSRs and their respective MIC, airborne noise levels arising from rock breaking and excavation works and experienced by the ecological NSRs was predicted as 122 dB. The resulting overall Impact Significance were evaluated to as **Moderate** (see Table 10-34).

With an Impact Significance of **Moderate**, mitigation measures were proposed to mitigate these impacts to ALARP as part of ground-borne noise and vibration management, detailed in Section 11.9.

Upon the application of the mitigation measures, the resulting residual Impact Significance from Sungei Kadut Cut and Cover Station to the ecological NSRs was reduced to **Minor** (refer to Table 10.9.1.1.6).

10.11.1.2 Human Receptors

Based on the results predicted by the noise models, human NSRs were predicted to experienced noise exceedances of up to 7.6 dB(A) for Scenario 1; 10.0 dB(A) for Scenario 2 day time; 22.7 dB(A) for Scenario 2 night time; 8.9 for Scenario 3 day time; and 8.1 dB(A) for Scenario 3 night time. The resulting overall Impact Significance was evaluated to range from **Negligible** – **Major** (see Table 10-35).

Mitigation measures were proposed to mitigate the noise impacts on the ecological NSRs to ALARP as discussed in Section 10.8. Vertical noise barriers of up to 3 m and 12 m in height were proposed for all three (3) assessment scenarios, and a 15 m noise enclosure for the docking shaft construction area of Scenario 2.

However, due to the proximity and height of the receptors and a limitation in height of noise barriers, the 3 m and 12 m vertical noise barriers were only found to be effective in reducing noise minimally with a residual noise exceedance of up to 8.9 dB(A) for Scenario 2 day time; 17.8 dB(A) for Scenario 2 night time; 3.0 dB(A) for Scenario 3 day time; and 3.1 dB(A) for Scenario 3 night time. No residual noise exceedances were predicted for Scenario 1 with the proposed mitigation measures predicted to effectively eliminate noise exceedances (see Table 10-49). The resulting overall residual Impact Significance was reduced from a range of **Negligible** – **Major** to **Negligible** – **Moderate** (refer to Table 10-50).

Although the proposed mitigation measures in Section 10.8 were not able to eliminate noise exceedances, a comparison of the distribution of Impact Significance by number of human NSRs reflects a reduction in number of buildings of **Moderate** – **Major** Impact Significance for all three (3) assessment scenarios (see Table 10-50). Considering this, communication efforts should be implemented to inform affected human NSRs during the period of works and complaints of noise nuisance that are anticipated should be addressed accordingly.

Cumulative impacts from other major concurrent projects in the vicinity of each construction worksite were presented and detailed in Section 10.10. Due to the presence of these concurrent construction sites, the overall construction footprint was expected to be larger. The HDB CCK N1 construction was found to significantly contribute to elevated noise levels and Impact Significance experienced by human NSRs in the vicinity of the Earth Retaining Stabilising Structure/ Docking Shaft Construction area.

10.11.1.2.1 Rock Breaking and Excavation

As part of construction works, rock breaking and excavation can be proposed as an effective and efficient method to break down and remove rocks when common excavation techniques are not able to. At the point of time in writing this report, detailed information was not available. The rock breaking and excavation works could only be carried out by an appointed Contractor at a later stage.

Hence, the assessment approach detailed in BS5228-2:2009+A1:2014 [R-84] was adopted as the assessment criterion. Due to the lack of information for rock breaking and excavation works specific to Singapore, the site constant was assumed based on AS 2187.2-2006 [R-91].

Employing the assumptions on location, depth, and method of rock breaking and excavation, and known information of distance from location of rock breaking and excavation to the nearest NSRs, the assessment provided an estimate on the MIC that should be permitted in order to keep air overpressure within the stated criteria (see Section 10.2.1.1.1).

Based on the approximate distance from Sungei Kadut Cut and Cover Station to the nearest boundary of the human NSRs and their respective MIC, airborne noise levels arising from rock breaking and excavation works and experienced by the human NSRs were predicted to range from 141 – 150 dB and (see Table 10-37). The resulting overall Impact Significance were evaluated as **Minor** (refer to Table 10-37).

As such, no mitigation measures were proposed for the human NSRs subjected to airborne noise impacts from rock breaking and excavation.

10.11.2 Operational Phase

The assessment for operational noise impacts relating to ACMV systems and land traffic will be addressed in the separate standalone NVS Preliminary Report, Traffic NIA Study Report, and Acoustics Preliminary Report. As discussed in Section 10.3.2, the findings from the separate standalone report have been extracted and presented in this report.

A quantitative means of assessment detailing noise levels predicted with noise models was applied in the determination of impact predicted at the human NSRs due to operational noise emissions from ACMV systems and land traffic development associated with the Project, in accordance with noise legislations outlined in the ACMV Noise Guidelines, 2018 [R-26], and TNIA Guidelines, 2016. For human NSRs, recorded $L_{Aeq(1\ hour)}$ noise levels were compared against the criterion outlined in the TNIA Guidelines, 2016 [R-25], used as part of operational noise impact assessment for human NSRs in the NVS Preliminary Report. While for ecological NSRs, the average baseline noise monitoring results were adopted to assess for impact on fauna species identified within the Biodiversity Study Area, suitable in supporting the presence of fauna as a conservative means of assessment (see Section 10.5.3.2.1).

Baseline airborne noise monitoring was conducted at one (1) location as part of NVS, and two (2) locations for the Traffic NIA Study (see Section 10.2.3.2.2) within the defined Airborne Noise Study Area established in accordance with the noise legislations outlined in TNIA Guidelines, 2016 [R-25].

Information on operational noise impact assessment findings for human NSRs were extracted from the separate standalone reports and presented in this ES. While for ecological NSRs, the operational noise impacts were assessed as part of the ES, taking reference from results presented in these separate standalone reports. The identified ecological NSRs were then assessed against the impact evaluation matrices in Section 6.4.2, with the noise contours reflecting the extent of noise propagation from source to receptors and the associated distribution of Impact Significance provided. Mitigation measures were also introduced following predicted noise exceedances for both ecological and human NSRs where required as detailed below.

10.11.2.1 Ecological Receptors

Based on the results predicted by the noise models, ecological NSRs are predicted to experience noise exceedances of up to 13.0 dB(A) when subjected to operational noise from the operations of trains on the potential future infrastructure (see Table 10-38). The resulting overall Impact Significance was valuated as **Negligible** (see Table 10-39).

No noise exceedances were predicted for ecological NSRs when subjected to operational noise from the operations of the elevated vehicular bridge (refer to Table 10-40), with an overall Impact Significance of **Negligible** (see Table 10-41).

As such, no mitigation measures were proposed for ecological NSRs subjected to noise from the operational phase.

10.11.2.2 Human Receptors

Based on impact assessment of human NSRs extracted from the Traffic NIA Report, two (2) residential human NSRs were predicted to experience noise exceedances of the $L_{Aeq(1\ hour)}$ 67 dB land traffic noise criteria. While four (4) receptor buildings would experience noise levels that exceed the criteria of $L_{Aeq(1\ hour)}$, 71 dB in the NVS Report, as these buildings are not noise-sensitive or residential premises, mitigations measures were not required according to NEA's guidelines.

As such, mitigation measures have been proposed for the operational phase of the elevated vehicular bridge to mitigate the noise impacts to ALARP.

It was observed that source noise control in the form of speed limit proposed by LTA [R-92] was effective in eliminating noise exceedances at the two (2) residential human NSRs.

Table 10-51 Summary of Airborne Noise Impact Assessment

Sensitive Receptors and Phases	Impact Significance (with minimum controls/ best practices)	Residual Impact Significance (with additional mitigation measures)
Construction Phase		
Ecologically Receptors	Negligible – Major	Negligible – Major
Human Receptors	Negligible – Major	Negligible – Moderate
Operational Phase		
Ecologically Receptors	Negligible	N/A
Human Receptors	No receptors were predicted to experience any exceedances for airborne noise in the NVS Preliminary Report and Traffic NIA Report with proposed mitigation measures.	