07

EVALUATION OF IMPACTS

SECTION 7

EVALUATION OF IMPACTS

7.1 INTRODUCTION

This chapter assesses the impacts during the pre-construction, construction and operational stages, as well as project abandonment. The impacts will be assessed in terms of magnitude, prevalence, duration and frequency of occurrence whichever is applicable, and their consequence. The main impacts include:

DOE Functional Areas
1. Soil Erosion and Sedimentation
2. Water Pollution
3. Air Pollution
4. Noise and Vibration
5. Waste

Other Impacts
6. Flooding
7. Impacts on Irrigation Systems
8. Geotechnical and Geological Risks
9. Ecology
10. Socio-economy
11. Traffic
12. Hazards and Public Safety

Findings from the impact evaluation and assessment are summarized in a matrix format as shown in **Figure 7.1-1** (pre-construction stage), **Figure 7.1-2** (construction stage) and **Figure 7.1-3** (operation stage). The matrix relates the type and extent of impact between the various project activities and the physical, biological and human components of the environment.

After the identification of impacts, specific mitigation measures will be proposed in **Section 8**.

7.2 SENSITIVE RECEPTORS

There are numerous sensitive receptors along the alignment in Kelantan and Selangor, as the alignment passes through various types of land uses. The EIA has assessed the impacts to sensitive receptors adjacent to and/or downstream of the alignment. The following description of sensitive receptors is summarized based on the types of impact.

Soil Erosion

The sensitive receptors of soil erosion are the receiving water bodies and the beneficial uses of water therein. In the soil erosion assessment, 21 soil erosion hotspots (areas with high erosion risk) have been identified along the alignment and the sensitive receptors surrounding and/or downstream of these hotspots are mostly suburban and rural residential areas/ villages, with some recreational areas and water treatment plants. Soil erosion sensitive receptors are described in **Section 7.4.1**.

Water Pollution

The sensitive receptors of water pollution are the receiving waterways and the beneficial uses located downstream. In Kelantan, there are a number of riverine fish cage culture especially along Sg. Mentua and Sg. Pengkalan Nangka, as well as numerous irrigation canals. In Selangor, there are four water intakes at Sg. Selangor, one water intake at Sg. Batu, mangroves at Sg. Puloh and a number of aquaculture ponds along Sg. Serendah and the downstream of Sg. Klang. The water pollution impacts of the Project towards these sensitive receptors are described in **Sections 7.4.2 (construction stage) and 7.5.1 (operation stage)**.

Air Pollution

Air pollution sensitive receptors are the communities adjacent to the Project alignment. As the trains will be electric, air pollution during the operation of the railway will be minimal. Air pollution and dust generation during the construction stage, especially during land clearing and earthworks, may affect residential, commercial and institutional sensitive receptors that are close to construction sites and along construction access routes. The air pollution sensitive receptors are described in **Section 7.4.3** (construction stage) and **Section 7.5.2** (operation stage).

Noise and Vibration

Noise and vibration sensitive receptors during the construction and operation stages of the Project are the communities living close to the alignment. The noise and vibration sensitive receptors are described in **Sections 7.4.4 & 7.4.5** (construction stage) and **Sections 7.5.3 & 7.5.4** (operation stage).

Waste

Sensitive receptors from wastes (i.e. construction and demolition wastes, biomass, spoil material and domestic wastes) due to poor handling and improper management include surrounding communities, residential areas and nearby waterways (e.g. drainages, canals, channels and rivers). The excessive waste generation may be potentially impact the existing disposal sites. The sensitive receptors of waste are described in **Section 7.4.6** (construction stage) and **7.5.5** (operation stage).

Flooding

Sensitive receptors of hydrological impacts (drainage and flooding), are the residential, commercial, industrial and institutional land uses along the alignment that may potentially be impacted by changes in the hydrological regime over the short term during the construction stage, and during the long term in the operation stage of the Project. Agricultural areas, especially paddy fields in Kelantan, may also be affected by changes in irrigation and drainage systems. The hydrology/ flooding sensitive receptors are described in **Section 7.4.7** (construction stage) and **Section 7.5.6** (operation stage).

Ecology

Ecological sensitive receptors are the forests and habitats that may be directly affected by the construction. About 19.6 ha of forest reserves will be cleared at Rantau Panjang FR in Hulu Selangor. Sensitive receptors also include wildlife such as tapirs within the forested areas adjacent to the alignment where ecological linkages and wildlife corridors will be split by the alignment, forming barriers to wildlife movement (e.g. Rantau Panjang FR). Communities living near forested areas may experience increased human-wildlife conflicts as forests along the Project alignment are disturbed. The ecological sensitive receptors are described in **Section 7.4.10** and **7.5.9**.

Socio-Economic

Sensitive receptors of socio-economic impacts are the owners and occupants of land and property that will be acquired for the Project during the pre-construction stage. At this stage of the EIA, up to 5,852 lots have been identified for land acquisition.

During the construction stage, the sensitive receptors will be the residential, commercial, industrial and institutional communities along the alignment who will face environmental pollution from construction activities. However, certain parties will also benefit from the business and employment opportunities arising from the Project construction. During operation, the long-term benefits of the Project will be realized by socio-economic receptors, as the ECRL is expected to stimulate economic growth in the East Coast and West Coast and provide an alternative transport mode for passengers and freight. Some sensitive receptors of negative impacts may persist during the operation stage, particularly sensitive receptors of noise and communities that are physically fragmented by the alignment. The socio-economic sensitive receptors are described in **Section 7.3.1**, **7.4.11** and **7.5.10**.

Traffic
Sensitive receptors for traffic related issues during are road users and communities near the alignment, access roads and stations. The traffic sensitive receptors are described in **Section 7.4.12** and **7.5.11**.

Hazards & Public Safety
The public living near the alignment and stations will be sensitive receptors of construction hazards during the construction stage. Road users are also considered sensitive receptors at locations where the Project construction activities intersect with public roads. During the operation stage, transportation of hazardous goods could potentially impact people close to the alignment. The sensitive receptors of hazards are described in **Section 7.4.13** and **7.5.12**.

7.3 IMPACTS DURING PRE-CONSTRUCTION STAGE

7.3.1 Potential Significant Impacts during Pre-Construction

During pre-construction stage, potential social impacts are associated with land acquisition and severances of settlements. From these changes, there arise many secondary impacts that could drastically change lives and disrupt communities and society at large. As a result, most people do not want to live too close to a linear development, be it rail or highway. These impacts affect both individuals and communities. They tend to object if this development is about 500m or less from where they live. The initial fear is land acquisition which would imply a forcible relocation to elsewhere. The second fear is the entire settlement is severed by the infrastructure, making it difficult for them to carry on with their usual daily lives without having to adjust. Thirdly, if they are not affected by land acquisition and relocation, they have to live with severance and close proximity to the railway. Such proximity may cause disturbances to their daily lives. They will face constraints in mobility. Their social, cultural and possible religious interactions and practices are impacted, possibly negatively. Social and cultural ties are altered and even severed. It is these changes that people fear; especially those who have forged long-term relationships and ties in their neighbourhoods and face difficulty to adapt and change with the new infrastructure.

7.3.2 Land Acquisition

In the development of the railway, acquisition of properties and lands is inevitable due to its length and the distances it has to cover. Land acquisition may involve public or private lands. Public lands are government-owned (Federal, State, Local Authorities or government agencies). Here, acquisition seldom poses any issue or if there is, it is usually resolved amicably. Private landowners may be large companies, small enterprises, institutions and individuals. Acquisition of private lands may lead to strong objections. Affected private lands refer to the loss of agricultural land, commercial and industrial land and properties, residential land and homes, cultural buildings, and idle lands, i.e. lands that are presently unutilised or underutilised. Not all private landowners object to acquisition. Some may accept acquisition when they believe compensation is fair or when their properties are in a relatively underdeveloped market of weak demand and acquisition is an acceptable option.

In the case of ECRL Phase 2, the number of lots involved is 5,852 lots of land. They cover an area of 3,281.2 hectares (**Table 7-**1). A more detailed breakdown will be presented in the separate Detailed Social Impact Assessment (SIA) which will be prepared for submission to PLANMalaysia.

Table 7-1 : Potentially Affected Land

No.	Type of Land	No. of Lots/ Locations	Area Affected	
			Acres	Hectares
Kelantan				
1	Private Land	2,852	1,326.3	536.8
2	State Land/ Road/ JPS/ Utility/ Reserve	-	435.4	176.2
	SUBTOTAL		**1,761.7**	**713.0**
Selangor				
1	Private Land	3,000	3,809.1	1,541.5
2	State Land/ Road/ JPS/ Utility/ Reserve	-	537.1	1,026.7
	SUBTOTAL		**6,346.2**	**2,568.2**
Overall Land Acquisition				
1	Private Land	5,852	5,135.4	2,078.3
2	State Land/ Road/ JPS/ Utility/ Reserve	-	2,972.5	1,202.9
	GRAND TOTAL		**8,107.9**	**3,281.2**

Land acquisitions are provided for under the Land Acquisition Act that allow for compensation of land at market values. It does not always have a negative impact. If affected landowners are willing and accept the compensation given, there should not be any issue. In Kelantan, the stakeholder engagements have indicated that people find acquisition generally acceptable. In Kelantan, indication from stakeholders is that under a less developed property market, some landowners view acquisition positively. Some of them have more holdings than they need. Some have holdings that are left idle or are underutilised with low returns. For these people, acquisition has a positive impact. It enables them to earn lump-sum cash from their landed assets. Under such circumstances, it is the compensation value that is significant to them as well as the payment schedule.

The amount of compensation and the timing of compensation pose another issue for people. The stakeholder discussions have found that people, in general, do not know or have sufficient information on the acquisition process and compensation. Often, this is regarded as a personal matter. In group discussions, most participants did not want to discuss acquisition and related issues in depth largely because they were unclear as to who would be affected; only individuals, who believed they were the likely affected persons, were the ones interested to know more. They were the ones more insistent on knowing about affected lots. When these individuals grouped together, then, the deliberations tended to become intense and hostile.

Hostility towards land acquisition is stronger especially among residents more than businesses or institutions. In the case of institutions, the negative feedback varies with the types of institutions. Feedback from stakeholders also tends to be more hostile if they discover religious or cultural sites or buildings within their settlements are potentially vulnerable to acquisition. In some instances, where schools or hospitals are targets for acquisition, it could raise concerns in the affected communities.

Acquisition means relocation and relocation demands seeking new places to settle in. Generally, this does not sit well for many affected groups. For the vulnerable groups, it could hit them hard because they are the usually the ones with the least access to financial resources. At risk are the poor and they could be single-parents, especially females, disabled people, elderly who are alone and in ill-health, lowly – educated, and poor tenants. All are vulnerable because they may not have sufficient resources to work through this process. The land acquisition process does not register the affected groups, especially vulnerable ones. Without counting them, it would be difficult to identify actions targeted at them.

As a result of land acquisition under the ECRL, potential social issues identified are as follows:

7.3.2.1 Worries over Compensation and Payment

The negative social impacts that arise from acquisition are probably due to potential tensions associated with the process itself, the amount of compensation, and the payment schedule. Such worries are highlighted during engagements with stakeholders but not from the survey findings. As people indicated that they find acquisition acceptable; at the same time, they raised questions on compensation i.e. how much, how it would be computed and when it would be given out.

There are clearly gaps in their knowledge on land acquisition. These information gaps cause them to fear the entire process even before acquisition actually occurs. When land acquisition is linked to worries over relocation, their fears intensify. Information on relocation is scanty and people expect the government to do something about it and yet, the usual approach is to allow the private market to operate by itself in these matters. People fear when they do not know what would happen in the acquisition process. Nobody, especially residents, want to be forcibly displaced from their homes and their neighbourhood.

7.3.2.2 Loss of Homes and Shelter

The loss of homes or shelter is very personal in the event acquisition of houses occurs. For many, loss of shelter changes their lives permanently and disrupts their living environment and quality of life. It is especially disruptive to families who have been staying long in a given place. The need to move away affects all family members but can be emotionally distressful for the elderly and schoolchildren. The forced move disrupts their relationships in the neighbourhood and in school. Schoolchildren particularly teenagers have been known to be disoriented when relocation forces them to change school and find new friends.

The loss of shelter can be worst when it affects vulnerable groups such as poor, single mothers and disabled because these groups often find it difficult to find proper shelter at reasonable costs. They are very vulnerable due to their social and economic exclusion in the society. Many of them are unskilled, working in low-paying jobs such as cleaners, petty traders, road sweepers, garbage collectors, general labourers, etc. They usually live in substandard housing conditions and seldom have the means to protest or object when they are evicted for whatever reasons. They and their families are at the bottom of the social hierarchy and their ability to cope, resist and recover from impacts is very low.

Kelantan

In Kelantan, land acquisition is ranked second after relocation as important at pre-construction stage. Across the groups engaged, most appear to accept acquisition as inevitable. Examples are Kg Tunjong, etc.

Although the majority of them indicated acceptance of land acquisition, most raised the issue of compensation i.e. the amount and when payment would be received. The lack of knowledge over the process, especially compensation and payment, underpins these queries on acquisition. It shows that beneath the veneer of acceptability, there are underlying problems to be addressed on land acquisition. The amount of compensation and when it would be paid matter to affected people.

Selangor
The stretch of ECRL in Selangor is long and acquisition of homes is crucial affected areas could include those used for cultivation and businesses.

7.3.2.3 Relocation and Resettlement

The impact of land acquisition is more visible on need to relocate. The loss of homes and shelter including farms and businesses entails finding alternative to relocate. This concern is high among almost all groups engaged and is ranked first among issues during pre-construction. When homes or businesses are acquired, people have to relocate and to do, they have to find appropriate alternative. They are expected to resolve matters of relocation and resettlement on their own based on the assumption they could easily manage with compensations.

Yet, people in Kelantan are indicating that it is not so easy to do this. Even among those who accept acquisition, they highlighted issues with relocation and compensation. It is often assumed that affected families and individuals can relocate if they are compensated but people have highlighted that often the quantum of compensation and payment schedule do not take into consideration the obstacles they encounter in finding new homes. Among these obstacles is the potential inflationary impact on them. They believe land values would rise, making it difficult for them to buy properties nearby to where they currently living. Not only would they lose their homes but they could not find affordable alternatives.

The survey findings also show that most people here have been living in their present location for at least 20 years. Over time, they probably have forged strong social and community ties within their current neighbourhoods. Relocation will be very disruptive for them. The survey findings show relocation is a very common problem across the states.

Kelantan
Stakeholders in Pengkalan Kubur and Wakaf Bahru explained that if compensation is not readily available, they do not have the necessary capital to invest in new homes. An added problem is finding suitable location and land to relocate. They fear land speculation would push up land prices around where they are staying. This means having to relocate and resettle far from where they are currently located. They do not want to move too far away. Some have indicated their willingness to participate in state housing or in any housing scheme when acquisition forces them to relocate and resettle.

Selangor
Relocation is not identified during stakeholder discussions although it is seen as important from the survey findings.

7.3.2.4 Losses of Livelihood and Income

Acquisition and relocation will cause dislocation of families. Dislocation disrupts people lives, especially how they make their living. Affected businesses have to close. Farms have to shut down. People have to move away; some find they would be forced to change jobs because they relocate too far from their current employment places. Such disruptions underpin their objections to land acquisition. The most susceptible would be the vulnerable groups like single mothers, poorly educated, and disabled. When people find their livelihood disruption, they will suffer income losses which bring about more hardships for them and their ability to cope financially, socially and psychologically.

Farmers could also lose their livelihood if their farm lands are acquired. If such lands are idle, then, it would be good for them. However, if not, acquisition could leave them with fragmented farms i.e. parcels that are too small to farm efficiently to yield reasonable returns. Affected farmers would be forced to quit farming and find alternative livelihood. It would not be easy if they are old and have difficulty in acquiring new skills or to take up re-training for new skills.

<u>Kelantan</u>
In Kelantan, it is possible that farmers could be negatively impacted by land acquisition and would be forced to give up farming. Possible disruptions to farming, especially paddy farming, could arise from acquisition of land.

7.3.2.5 Forced Out-Migration and Breakdown of Social Cohesion

Land acquisition indirectly forces people to migrate from the affected neighboured. This forced out-migration is not voluntary and breaks up the neighbourhood. In rural areas where traditions, customs and culture bind people, the forced departure of families and neighbours could mean in a breakdown of social cohesion and in a tightly knit community, it would be disruptive.

7.3.2.6 Loss in Aethetics, Cultural and Traditional Characteristics of Rural Landscape

It is important that the ECRL avoids cultural sites and buildings because of the sensitive nature of these places. People usually have deep religious, social and cultural ties for these places. Religious sites include places of worship and burial grounds. Cultural sites could include places of communal and social gatherings. Some could be heritage sites or buildings with strong historical background. As these places are associated with the religions, traditions and culture of the people living nearby, potential acquisition is likely to meet with strong objections. It is fortunate that the ECRL has avoided encroaching on cultural and religious buildings and sites that would raise strong objections from the public.

The railway will run either at grade or elevated through largely rural areas. Some people may find the rail structures are intrusions into the traditional rural landscape of the East Coast, resulting in the loss of aesthetics and visual appearance of the rural area. Such intrusions in what is regarded by them as having an intrinsic value may mean a long-term loss of their cultural image and visual of the East Coast. These are more important to people in Kelantan.

7.3.3 Severances of Settlements

Beside land acquisition, the ECRL is expected to severe settlements over its long route, fragmenting them and disrupting and distorting affected communities. Severances of villages are anticipated to have permanent adverse social impacts on them. Severances can also occur on farm lands. It was mentioned earlier that farmlands can be subdivide by the alignment and be fragmented into small, uneconomic and unproductive parcels. Severances disrupt the daily lives of people in affected settlements because their mobility is constrained. During pre-construction, potential severances usually identified but may be difficult to resolve. They, in turn, would become permanent features in affected communities.

Affected communities could lose their integral social and cultural values because of severances across their settlements. These are visible even in urban areas in Kuala Lumpur and Selangor when highways cut through traditional villages like Kg Salak South and Kg Sungai Kayu Ara. The villagers are split into two fragmented halves which are not necessarily equal. The smaller parts may decline as people moved away as in Kg Salak South. In Kg Sungai Kayu Ara, severance by the Sprint Highway has distorted social interactions among villagers. It is made worse when religious and cultural activities are indirectly affected. The possibility of a mosque or a community centre or any social amenity where people tend to gather is cut off from one part of the community, it changes how their social, cultural and religious lives. Much of this type of impact is not often visible; they occur as subtle changes over time within the community as people adapt and adjust whichever way they can. If they cannot adapt, the affected parts of the settlements would fall into neglect, as families and business close and migrate out.

7.3.3.1 Disruptions of Social, Cultural and Religious Ties and Relationships

A major issue with severances is, they may cut off social ties within communities. In close-knit communities like those in the rural areas of Kelantan and in the Orang Asli community, it breaks down social interaction and distorts social cohesion. The breakdown and disruptions of social, cultural and religious ties are serious social impacts because of the invisible and subtle negative effects they tend to have on individuals and communities. In communities that have been established over a long period, the breakdown results when they encounter constraints in social interfacing and interactions due to the presence of the railway. This issue is further complicated by acquisition and relocation which tends to cause some psychological problems for affected groups of individuals like the elderly's who have established strong social and cultural ties in a particular community and any relocation is a major upheaval in their lives. It would be the same with those who remain in their villagers and find that severance has cut them off from other members of their community. The inability to move around easily like before, to interact and to share cultural and social events without having to find a way around the railway tracks or stations could distort social relationships in the affected settlements.

Selangor
Severances of villages are possible in Taman Desa Kiambang, Kg Tok Pinang, Kg Damai.

7.3.4 Utilities Relocation

Before the construction proper begins, affected utilities along the Project corridor will be relocated or protected. Some of these relocation works may cause traffic congestion due to temporary diversions, lane reduction or closure of roads, and pose risks to public safety. Potential impacts include damage to buildings, utility lines or pipes due to collisions or impacts during excavation and relocation, leakage from sewers, water pipes or gas pipes, collapse of overhead utilities, vehicular accidents and hazards to the public. Soil erosion and sedimentation is also expected for the construction of access roads to reach these utilities especially for transmission lines at hilly areas.

7.4 IMPACTS DURING CONSTRUCTION STAGE

This section presents the assessment of impacts during the Project construction stage. A summary of the impact assessment is shown in **Table 7-2**.

Table 7-2 : Summary of Impacts during Construction Stage

Potential Impacts During Construction	Activities
Soil erosion and sedimentation	• Site clearing and earthworks • Excavation works and spoil disposal • Tunneling works • Concreting and piling works
Hydrology/ Flooding	• Blockage of drainage channels especially in low-lying areas
Waste generation	• Site office and workers camp • Site clearing (biomass) • Demolition of structures • Spoil/ unsuitable material disposal
Increased noise level for receptors located close to construction zones	• Concreting and piling works • Use of high noise generating machinery such as generator sets, power tools, hydraulic breaker, grinding and cutting equipment
Increased vibration for receptors located close to construction zones	• Movement of construction vehicles • Operation of construction machinery
Air pollution/ dust	• Earthworks • Movement of construction vehicles and machinery
Ecology – Habitat destruction, fragmentation and disturbance to wildlife	• Site clearing and earthworks • Use of high noise generating machinery such as generator sets, power tools, hydraulic breaker and grinding and cutting equipment
Disruption in road traffic flow	• Construction vehicle traffic at alignment, stations, and maintenance bases • Road diversions
Hazards & Public Safety	• Hazards to public due to construction activities

7.4.1 Soil Erosion and Sedimentation

Soil erosion and sedimentation impacts are most critical during site clearing and earthworks. Activities such as removal of existing vegetation as well as cutting and filling of suitable materials to form required platforms all generate loose and expose soil material that is susceptible to erosion, especially during periods of heavy rainfall, flooding and seasonal monsoon.

The direct impacts of soil erosion and sedimentation on receiving waterways include reduced water quality and holding capacity. This in turn elevates flood risks, reduces efficiency of water treatment plants, and affects agriculture and aquaculture productivity. However, the magnitude of impacts for each affected waterway will vary and is dependent on a variety of factors such as existing topography, climate, hydrology, type of construction activity, construction methodology adopted, proximity and susceptibility of sensitive receptors.

7.4.1.1 Overview of Soil Erosion Risk along the Alignment

The soil erosion risk map for Peninsular Malaysia published by the Department of Agriculture (**Figure 7.4.1-1 and 7.4.1-2**) was used to obtain a general overview of soil erosion and sedimentation impacts along the railway alignment as follows:

Segment 1: Kelantan

The alignment from Kota Bharu to Pengkalan Kubor falls under low erosion risk (**Table 7-3).**

Table 7-3 : Soil Erosion Risk along Kelantan Segment

Alignment Segment	Soil erosion risk	Length (km)	Percentage (%)
Kota Bharu – Pengkalan Kubor	Low	23.2	100.00
	Moderate	-	-
	Moderately High	-	-
	High	-	-
	Very High	-	-
	TOTAL	**23.2**	**100.00**

Segment 2: Selangor

Segment 2A: Gombak North to Serendah

The erosion risk where the alignment will traverse from Gombak North to Serendah mostly falls under very high erosion risk (74.1%) where the alignment traverses along Kg. Batu 12 Gombak and through Templer Park and Serendah Forest Reserve. This represents about 18 km of the alignment. The remaining part of the alignment for this section is categorized under high (21.8%) and moderate (4.1%) soil erosion risk (**Table 7-4**).

Majority falls under very high erosion risk (Gombak, Templer Park and Serendah Forest Reserve area), high erosion risk (Sungai Choh area) and moderate erosion risk (Serendah area).

Table 7-4 : Soil Erosion Risk Severity along Gombak North-Serendah Segment

Alignment Segment	Soil erosion risk	Length (km)	Percentage (%)
Gombak North - Serendah	Low	-	-
	Moderate	1.00	4.1
	Moderately High	-	-
	High	5.31	21.8
	Very High	18.09	74.1
	TOTAL	**24.4**	**100.00**

Segment 2B: Serendah to Bandar Puncak Alam

The erosion risk where the alignment will traverse from Serendah to Bandar Puncak Alam mostly falls under high erosion risk (48.9%) which represents 12 km of the alignment for this segment. The remaining part of the alignment for this segment will be categorized under very high (hilly area near Bandar Baru Sg Buaya, 2.3%), moderately high (12.6%), moderate (19.0%), and low (17.2%) soil erosion risk (**Table 7-5**).

Table 7-5 : Soil Erosion Risk Severity along Serendah – Bandar Puncak Alam Segment

Alignment Segment	Soil erosion risk	Length (km)	Percentage (%)
Serendah – Bandar Puncak Alam	Low	4.36	17.2
	Moderate	4.83	19.0
	Moderately High	3.19	12.6
	High	12.41	48.9
	Very High	0.60	2.3
	TOTAL	**25.4**	**100.00**

Segment 2C: Bandar Puncak Alam to Port Klang

The erosion risk where the alignment will traverse from Bandar Puncak Alam to Port Klang mostly falls under low erosion risk (98.5%) which represents 29 km of the alignment for this segment. The remaining part of the alignment for this segment is categorized under moderate risk (1.55%) soil erosion risk (**Table 7-6**).

Table 7-6 : Soil Erosion Risk Severity along Bandar Puncak Alam – Port Klang Segment

Alignment Segment	Soil erosion risk	Length (km)	Percentage (%)
Bandar Puncak Alam – Port Klang	Low	29.26	98.5
	Moderate	0.46	1.55
	Moderately High	-	-
	High	-	-
	Very High	-	-
	TOTAL	**29.75**	**100.00**

7.4.1.2 Overview of Soil Erosion and Sedimentation Impacts Along the Alignment

The impacts of soil erosion and sedimentation varies depending on the construction activities involved. For this project, five different construction circumstances and its impacts have been identified and summarised as follows:

a) Station Construction

The construction of stations takes place at established town and city center. Hence the construction works located at relatively flat areas which has low soil erosion risk. However, due to extensive and longer period of site clearing and earthworks involving substantial amount of area, soil erosion and sedimentation impacts will be significant.

Exposed construction areas with bare soil conditions will be prone to soil erosion and sedimentation. If not managed properly, sediments eroded from the construction area will clog existing drainages in the municipality which will increase flood risk.

b) Viaduct Construction

Viaduct construction occurs at river crossing and relatively flat area (low soil erosion risk). Earthworks is not extensive as it will only be focused on piers location which will minimize the amount of exposed soil. However, the impact may be significant if the piers are in close proximity of rivers.

If not managed properly, the sediment laden runoff will flow directly into the rivers which will affect the water quality, shallowing the depth of river, harming aquatic ecosystems, and in certain instances, disrupting aquaculture activities.

c) Tunnel Construction

The alignment will traverse through hilly regions which consists steep slopes (Class III and Class IV) and identified as potential high soil erosion risk spots. Nevertheless, the proposed alighment passing through these slope sections will be fully tunnelled and will not pose adverse soil erosion risk.

Site clearing and earthworks only concentrate at the tunnel portal area which is relatively smaller as compared to the station construction area. The construction period until the tunnel portal stabilize will also be relatively shorter as compared to station construction. Hence the soil erosion and sedimentation impact will only be significant during the short period of tunnel portal construction.

Nevertheless, if not managed properly, runoff carrying eroded soils from the construction area will flow to nearby waterways reducing its water quality, shallowing, narrowing and clogging of waterways which will increase flood risk in nearby sensitive receptors.

d) At-grade and Cut Section

Most of the alignment will be built as at-grade and cut slopes section. The soil erosion and sedimentation will be significant during this section. At-grade section will ranges from 2m – 15m fill in height whereas the cut section will be constructed at steep slope areas (Class II and III) which has high soil erosion risk.

During site clearing and earthworks, these sections will be exposed and prone to erosion and sedimentation. Loose fill and exposed slope may be eroded during rainfall events and leads to sedimentation which may clog nearby waterways and increase flood risk at nearby sensitive receptors such as residential areas.

e) Access road

Access roads will be constructed to connect the construction site with the existing road network especially at rural areas, plantations and forests where there is limited accessibility. Existing vegetation will be removed to make way for the access road leaving the area exposed and susceptible to erosion and sedimentation.

Soil erosion and sedimentation is of concern when the access road traverse trough hilly slope areas (Class II and III) especially at Segment 2A: Gombak to Serendah. At these areas, the soil erosion risk will be higher due to steep slopes. Surface runoff will increase due to exposed surface and carry along soil sediments to nearby waterways. This will affect the water quality and also clog nearby waterways due to sedimentation.

7.4.1.3 Soil erosion and sedimentation impacts assessment at hotspots

Based on the remote sensing data derived from Interferometric Synthetic Aperture Radar (IfSAR) information available at this stage of the Project, 21 locations have been identified as high soil erosion risk hotspots (**Table 7-7** and **Figure 7.4.1-1** and **Figure 7.4.1-2**). These locations are considered as a general representation of soil erosion impacts for the entire alignment based on comprehensive selection criteria to characterize all forms of expected construction activities for ECRL. The 21 hotspots were identified based on the following criteria (**Table 7-8**):

- Type of construction activities involved.
- Nature and severity of earthwork activities involved.
- Existing soil erosion risk.
- Proximity of rivers and water intake downstream.
- Proximity of nearby sensitive receptors and population density.

Table 7-7 : Soil Erosion Risk Hotspots along the Alignment

Hotspot	Location
Segment 1: Kelantan	
S1	Station : Wakaf Baru
S2	Viaduct : Sg Pengkalan Nangka
S3	Viaduct : Sg Mentua
S4	Station : Pengkalan Kubor
Segment 2: Selangor	
Segment 2A: Gombak North - Serendah	
S5	Viaduct : Kg Batu 12
S6	Tunnel Portal : Kg. Batu 11
S7	Tunnel Portal : Desa Makmur
S8	Tunnel Portal : Kg. Sg Salak
S9	Tunnel Portal : Taman Bukit Permata
S10	Viaduct : Taman Jasa Utama
S11	Tunnel Portal : Templer Park Forest Reserve
S12	Tunnel Portal : Serendah Forest Reserve
Segment 2B: Serendah – Bandar Puncak Alam	
S13	Station : Serendah
S14	Tunnel Portal : Sg. Buaya
S15	Viaduct : Sg. Garing
S16	Viaduct : Sg. Kundang
S17	Cut Section : Rantau Panjang Forest Reserve
Segment 2C: Bandar Puncak Alam – Port Klang	
S18	Viaduct : Sg. Puloh
S19	At-Grade Section : Kg Delek
S20	At-Grade Section : Kg Sireh
S21	Station : Jalan Kastam

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Table 7-8 : Criteria for Soil Erosion Hotspot Identification

No	Location	Nature of earthworks	Erosion Risk Class*	Rivers nearby	Water intake nearby	Sensitive receptors	Population density**
Segment 1: Kelantan							
S1	Station : Wakaf Baru	Involves earthworks over 25 ha	Moderate	Irrigation canal (200m away)	-	Taman Kasturi, Kg Wakaf Delima	Medium
S2	Viaduct : Sg Pengkalan Nangka	Viaduct construction at river crossings	Moderate	Crossing Sg Peng. Nangka. Aquaculture activities 2.8km downstream.	-	Kg. Kubang Panjang	Medium
S3	Viaduct : Sg Mentua	Viaduct construction at river crossings	Moderate	Crossing Sg Mentua. Aquaculture activities 2.6km downstream.	-	-	-
S4	Station : Pengkalan Kubor	Involves earthworks over 9 ha	Moderate	Sg Mentua (560m away)	-	Kg. Mentua	Low
Segment 2: Selangor							
Segment 2A: Gombak North - Serendah							
S5	Viaduct : Kg Batu 12 Gombak	Viaduct construction near sensitive receptors	Very High	Sg Gombak (100m away)	-	Kg Batu 12, Hospital Orang Asli Gombak	High
S6	Tunnel Portal : Kg. Batu 11	Tunnel portal at very high soil erosion risk area	Very High	Sg Gombak (200m away)	-	Kg Batu 11	Low
S7	Tunnel Portal : Desa Makmur	Tunnel portal at very high soil erosion risk area	Very High	Sg Gombak (800m away)	-	Desa Makmur	Low
S8	Tunnel Portal : Kg. Sg Salak	Tunnel portal at very high soil erosion risk area	Very High	Sg Semampos (700m away)	-	Kg Sg Salak	Low

*Erosion Risk Class – Refer to Table 7-11 to 7-14

**Population density – Low Density (< 75 persons per acre), Medium Density (75 – 200 persons per acre), High Density (>200 persons per acre), population considered are within 500 m from hotspot locations

Table 7-8 : Criteria for Soil Erosion Hotspot Identification (Cont'd)

No	Location	Nature of earthworks	Erosion Risk Class*	Rivers nearby	Water intake nearby	Sensitive receptors	Population density**
Segment 2A: Gombak North – Serendah (Cont'd)							
S9	Tunnel Portal : Taman Bukit Permata	Tunnel portal at high soil erosion risk area	Very High	Sg Semampus (100m away)	-	Taman Bukit Permata	Medium
S10	Viaduct : Taman Jasa Utama	Viaduct construction near sensitive receptors	High	Crossing Sg Batu	-	Taman Jasa Utama, Batu Dam	High
S11	Tunnel Portal: Templer Park Forest Reserve	Tunnel portal at very high soil erosion risk area	Very High	-	-	Templer Park Forest Reserve, Taman Jasa Utama, Templer Impian	High
S12	Tunnel Portal: Serendah Forest Reserve	Tunnel portal at very high soil erosion risk area	Very High	-	-	Serendah Forest Reserve, Templer Impian	Low
Segment 2B: Serendah -Bandar Puncak Alam							
S13	Station: Serendah	Involves earthworks over 6 ha	Moderate	Sg Serendah (20m away)	-	Taman Desa Kiambang, Taman Anugerah Suria, Taman Bukit Teratai	Medium
S14	Tunnel Portal: Sg. Buaya	Tunnel portal at very high soil erosion risk area	Very High	-	-	-	-
S15	Viaduct : Sg. Garing	Viaduct construction at river crossing	High	Crossing Sg Garing	Rantau Panjang (11.9km downstream)	Saujana Techno Park	Medium

*Erosion Risk Class – Refer to Table 7-11 to 7-14

**Population density – Low Density (< 75 persons per acre), Medium Density (75 – 200 persons per acre), High Density (>200 persons per acre), population considered are within 500 m from hotspot locations

Table 7-8 : Criteria for Soil Erosion Hotspot Identification (Cont'd)

No	Location	Nature of earthworks	Erosion Risk Class*	Rivers nearby	Water intake nearby	Sensitive receptors	Population density**
Segment 2B: Serendah -Bandar Puncak Alam (Cont'd)							
S16	Viaduct : Sg. Kundang	Viaduct construction at river crossing	High	Crossing Sg Kundang	Rantau Panjang (11.4km downstream)	Sg Kundang, Saujana Rawang	Medium
S17	Cut Section : Rantau Panjang Forest Reserve	Earthworks at high erosion risk area	High	Sg Kundang (720m away)	-	M Residence, Saujana Rawang	Medium
Segment 2C: Bandar Puncak Alam – Port Klang							
S18	Viaduct : Sg. Puloh	Viaduct construction at river crossing	Low	Crossing Sg Puloh	-	Kg Sementa, Kg Rantau Panjang	Low
S19	At-Grade Section : Kg Delek	Earthworks near sensitive receptors	Low	Sg Klang (180m) Sg Teluk Gadong Besar (100m)	-	Kg Delek	Medium
S20	At-Grade Section : Kg Sireh	Earthworks near sensitive receptors	Low	Sg. Klang (450m)	-	Kg Sireh Tambahan	High
S21	Station : Jalan Kastam	Involves earthworks over 5 ha	Low	-	-	Pangsapuri Seri Serantau	High

*Erosion Risk Class – Refer to Table 7-11 to 7-14

**Population density – Low Density (< 75 persons per acre), Medium Density (75 – 200 persons per acre), High Density (>200 persons per acre), population considered are within 500 m from hotspot locations

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a. Assessment Method

Soil erosion and sedimentation assessments have been carried out for each of the hotspots using the RUSLE and MUSLE method. The soil erodibility factor (K factor) for each hotspot was derived from borehole test results (**Refer Table 6-2, Table 6-3 and Appendix B**) using the Tew equation and nomograph (1999) from the Guideline for Erosion and Sediment Control in Malaysia (JPS Malaysia, 2010).

The results are compared with the soil loss tolerance rates soil from the Erosion Risk Map of Malaysia by the Department of Agriculture to determine the magnitude of the soil erosion impact as shown in **Table 7-9** and are further elaborated in **Section 7.4.1.2** to **Section 7.4.1.7**.

Table 7-9 : Soil Loss Tolerance Rates from Erosion Risk Map of Peninsular Malaysia

Soil Erosion Risk Class	Potential Soil Loss (ton/ha/year)
Low	<10
Moderate	11 – 50
Moderately High	51 – 100
High	101 – 150
Very High	>150

Source: Department of Agriculture

7.4.1.4 Segment 1: Kelantan

The ECRL alignment in Kelantan will traverse almost entirely on very flat terrain, with much of it passing through agricultural (paddy) areas. Majority of the alignment are at-grade and elevated sections (viaducts) at river and irrigation canal crossings. The other major construction activity in this segment involves the construction of two stations at Wakaf Bahru and Pengkalan Kubor.

a. Assessment Results

1) S1 Station: Wakaf Baru

This station is located in the western part of Wakaf Baru region, nearby Kg. Wakaf Delima and Taman Kasturi (medium density population within 500 m of construction works). The surrounding area is mostly residential and agricultural field. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-10** and shown in **Figure 7.4.1-3.**

Table 7-10 : Soil Erosion and Sedimentation for S1

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	11.7	93.2	46.6	0.9
Sediment Yield (ton/yr)	14.0	157.5	78.8	2.1
Sediment delivery ratio (%)	5.1	7.3	7.3	9.9
Estimated soil quantity in no of dump trucks*	1	10	5	0.1
Soil erosion risk class	Moderate	Moderately high	Moderate	Low

Note: K Factor = 0.0604 (derived from Tew, 1999 based on soil laboratory results from Borehole BH17)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 12 ton/ha/yr. The soil loss is low during post-construction stage, at 1 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 93 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 158 ton or 10 dump trucks per year (assuming soil bulk density 1600 kg/m^3 and dump truck capacity of 10m^3). However, this could be significantly reduced to about 47 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced by half to about 79 ton or 5 dump trucks per year.

The assessment shows that soil erosion and sedimentation during construction is moderately high if no mitigation measures are implemented. In the worst-case scenario, sediment runoff will clog up the existing drainage (the nearest existing drainage at Kg. Wakaf Delima, Kg. Kubang Batang, Taman Kasturi and Kg. Delima) and eventually the irrigation canals at Kg Kubang Batang Barat (located about 200 m away). This will increase flood risk in the area and negatively impact the irrigation schemes nearby, which could disrupt agricultural activities. The impact on Kg Kubang Batang Barat irrigation canal from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in in **Section 7.4.1.7** and **Section 8.3.1**, respectively.

2) S2 Viaduct: Sg Pengkalan Nangka

This viaduct section at Sg. Pengkalan Nangka is surrounded by Kg. Kubang Panjang settlement (medium density population within 500 m of construction works) and mostly agricultural areas, where it crosses over Sg. Peng. Nangka. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-11** and shown in **Figure 7.4.1-4.**

Table 7-11 : Soil Erosion and Sedimentation for S2

	Pre-Construction	**Construction (Worst Case Scenario)**	**Construction (With Mitigation Measures)**	**Post Construction**
Average soil loss (ton/ha/yr)	10.5	75.1	11.7	0.3
Sediment Yield (ton/yr)	1.4	19.1	3.0	0.03
Sediment delivery ratio (%)	3.6	6.6	6.6	2.4
Estimated soil quantity in no of dump trucks*	0	1	0.2	0
Soil erosion risk class	Moderate	Moderately High	Moderate	Low

Note: K Factor = 0.0274 (derived from Tew, 1999 based on soil laboratory results from Borehole BH18)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 11 ton/ha/yr. The soil loss is low during post-construction stage, at 1 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 75 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 19 ton or 2 dump trucks per year. However, this could be significantly reduced to about 12 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 3 ton or 1 dump truck per year.

In the worst-case scenario, sediment runoff from construction will increase the TSS level in Sg. Pengkalan Nangka. High TSS in the river will harm aquatic animals by clogging its gills or skins, reducing growth rates and lowering resistance to diseases. This could potentially lead to decrease in productivity of several aquaculture projects 2.8km downstream along Sg. Pengkalan Nangka. The impact on Sg Pengkalan Nangka's water quality from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in **Section 7.4.1.7** and **Section 8.3.1**, respectively.

Uncontrolled sediment-laden runoff from construction activities will also clog the existing drainage in Kg. Kubang Panjang. This will reduce the drainage capacity, and may increase flood risk that affects the population in surrounding area, especially during heavy rainfall in the monsoon season.

3) S3 Viaduct: Sg Mentua

This viaduct crosses Sg. Mentua at one point about 2.6km upstream of aquaculture activities at the river. A summary of the soil erosion rates for different stages of construction is tabulated in **Table 7-12** and shown in **Figure 7.4.1-5**.

Table 7-12 : Soil Erosion and Sedimentation for S3

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	1.4	62.5	10.2	0.3
Sediment Yield (ton/yr)	0.2	25.0	4.1	0.03
Sediment delivery ratio (%)	1.9	7.3	7.3	2.1
Estimated soil quantity in no of dump trucks*	0	1.5	0.2	0
Soil erosion risk class	Low	Moderately High	Moderate	Low

Note: K Factor = 0.0388 (derived from Tew, 1999 based on soil laboratory results from Borehole BH19)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is low with average value of about 2 ton/ha/yr. The soil loss is also low during post-construction stage, at 0.30 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 63 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 25 ton or 2 dump trucks per year. However, this could be significantly reduced to about 10 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be greatly reduced to about 4 ton or 0.3 dump trucks per year.

Uncontrolled sediment-laden runoff from construction activities will introduce high TSS concentration into Sg Mentua. This will affect the fisheries at the aquaculture located 2.6km downstream of the river. Similarly to S2 hotspot, high TSS in the river will harm aquatic animals by clogging its gills or skins, reducing growth rates and lowering resistance to diseases hence reducing the productivity of the aquaculture projects downstream. The impact on Sg Mentua's water quality from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in **Section 7.4.1.7** and **Section 8.3.1**, respectively

4) S4 Station: Pengkalan Kubor

This station is located at the northern area of Kg. Mentua (low density population within 500 m of construction works). A summary of soil erosion for the different stages of construction is tabulated in **Table 7-13** and shown in **Figure 7.4.1-6**.

Table 7-13 : Soil Erosion and Sedimentation for S4

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	9.3	50.1	25.1	0.5
Sediment Yield (ton/yr)	4.2	45.4	22.7	0.6
Sediment delivery ratio (%)	3.2	6.6	6.6	8.3
Estimated soil quantity in no of dump trucks*	0.2	3	1.5	0
Soil erosion risk class	Low	Moderately High	Moderate	Low

Note: K Factor = 0.0388 (derived from Tew, 1999 based on soil laboratory results from Borehole BH19)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is low with average value of about 9 ton/ha/yr. The soil loss is also low during post-construction stage, at 0.50 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 50 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 45 ton or 3 dump trucks per year. However, this could be significantly reduced to about 25 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 23 ton or 1.5 dump trucks per year.

If not controlled, sediment-laden runoff from construction works will reduce the holding capacity of Sg. Mentua (560m away from construction works). It is anticipated there may be increase in flood risk in the surrounding area which at Kg Mentua especially during the monsoon season. The impact on Sg Mentua's water quality from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in **Section 7.4.1.7** and **Section 8.3.1**, respectively.

7.4.1.5 Segment 2: Selangor

Segment 2A: Gombak North to Serendah

The ECRL alignment in this segment will traverse the hilly area from Gombak to Serendah especially at Templer Park Forest Reserve and Serendah Forest Reserve. To minimize land clearing and earthworks during construction, majority of the alignment in this segment consists of tunnels. Other construction work will involve viaduct sections which traverse over residential areas.

a. Assessment Results

a) S5 Viaduct: Kg Batu 12

This viaduct section at Kg. Batu 12 is surrounded by residential houses and Hospital Orang Asli Gombak (high density population within 500 m of construction works). A summary of soil erosion rates for the different stages of construction is tabulated in **Table 7-14** and shown in **Figure 7.4.1-7**.

Table 7-14 : Soil Erosion and Sedimentation for S5

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	148.5	4,278.6	231.0	47.8
Sediment Yield (ton/yr)	21.2	493.7	27.6	1.0
Sediment delivery ratio (%)	8.9	7.8	7.8	4.9
Estimated soil quantity in no of dump trucks*	1.3	31	2	0.3
Soil erosion risk class	High	Very High	Very High	Moderate

Note: K Factor = 0.0566 (derived from Tew, 1999 based on soil laboratory results from Borehole BH1)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is high with average value of 149 ton/ha/yr. The soil loss is moderate during post-construction stage, at 48 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 4,279 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 494 ton or 31 dump trucks per year. However, this could be reduced significantly to about 231 ton/ha/yr (which is considered very high) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 28 ton or 2 dump trucks per year.

Although the soil erosion risk is still very high even with the implementation of mitigation measures, the impact is less significant as the earthworks is not extensive as it focused only at piers location which will minimize the amount of exposed soil. Nevertheless, if no mitigation measures are implemented, sediment-laden runoff from earth-disturbing construction activities is expected to clog and reduce existing drainage capacity, thus leading to increase in flood risks, especially at Kg. Batu 12 during the monsoon season. The construction runoff discharge will also affect the water quality of Sg Gombak which located 100 m away. The impact on Sg Gombak's water quality from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in **Section 7.4.1.7** and **Section 8.3.1**, respectively.

b) S6 Tunnel Portal: Kg Batu 11

This tunnel portal, which involves 800m of tunnelling, is located at a hill in Kg. Batu 11 (low density population within 500 m of construction works). A summary of the soil erosion rates for different stages is shown in **Table 7-15** and **Figure 7.4.1-8a** and **7.4.1-8b.**

Table 7-15 : Soil Erosion and Sedimentation for S6

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	23.0	7,661.2	70.2	29.8
Sediment Yield (ton/yr)	2.3	2,289.8	21.0	3.0
Sediment delivery ratio (%)	2.5	7.3	7.3	2.5
Estimated soil quantity in no of dump trucks*	0.2	143	1.5	0.2
Soil erosion risk class	Moderate	Very High	Moderately High	Moderate

Note: K Factor = 0.0566 (derived from Tew, 1999 based on soil laboratory results from Borehole BH1)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 23 ton/ha/yr. The soil loss is remains moderate during post-construction stage, at 30 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 7,661 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 2,290 ton or 143 dump trucks per year. However, this could be significantly reduced to about 70 ton/ha/yr (which is at moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 21 ton or 2 dump trucks per year.

Even though the soil erosion risk is moderately high with the mitigation measures, the magnitude of impact is less significant as the earthworks only concentrates at tunnel portal area about 1.2 ha which is relatively small. Construction period will also be shorter since the area is small hence reduce the soil erosion and sedimentation risk exposure. Regardless, if no mitigation measures are being implemented, the sediment runoff from construction works will cause shallowing, narrowing and clogging of Sg. Gombak (200 m of construction works). This will reduce the holding capacity of both rivers, which may increase flood risk at Kg. Batu 11 and the IIUM apartments, especially during the monsoon season.

c) S7 Tunnel Portal: Desa Makmur

This tunnel portal, which involves about 500 m of tunnelling, is located at a hill in Desa Makmur (low density population within 500 m of construction works). A summary of the soil erosion rates for different stages is shown in **Table 7-16** and **Figure 7.4.1-9a-b.**

Table 7-16 : Soil Erosion and Sedimentation for S7

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	51.8	17,264.7	83.6	60.9
Sediment Yield (ton/yr)	6.4	4,626.6	22.3	5.3
Sediment delivery ratio (%)	3.8	8.1	8.1	2.6
Estimated soil quantity in no of dump trucks*	0.4	289	1.5	0.3
Soil erosion risk class	Moderately High	Very High	Moderately High	Moderately High

Note: K Factor = 0.0566 (derived from Tew, 1999 based on soil laboratory results from Borehole BH1)
*Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderately high with average value of 52 ton/ha/yr. The soil loss is remains moderate during post-construction stage, at 61 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 17,265 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 4,626 ton or 289 dump trucks per year. However, this could be reduced to about 84 ton/ha/yr (which is at moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 22 ton or 2 dump trucks per year.

The soil erosion and sedimentation impact will be less significant despite its risk at moderately high even after taking account into the mitigation measures. This is due to its smaller earthworks area (less than 1 ha) and shorter construction period. The nearest river Sg Gombak is also further away (800 m) which makes the sedimentation into the river will be less likely to occur. However, if no mitigation measures are implemented on-site, the sediment laden runoff from construction works is expected to negatively impact Sg. Gombak in terms of shallowing, narrowing and clogging of the river. This will reduce the holding capacity of the river which may increase flooding risk at the surrounding area (Desa Makmur) especially during the monsoon season.

d) S8 Tunnel Portal: Kg Sg Salak

This tunnel portal, which involves 650m of tunneling is located at a hill near Kg Sg Salak (low density population within 500 m of construction works). A summary of the soil erosion rates for different stages is shown in **Table 7-17** and **Figure 7.4.1-10a-b**.

Table 7-17 : Soil Erosion and Sedimentation for S8

	Pre-Construction	**Construction (Worst Case Scenario)**	**Construction (With Mitigation Measures)**	**Post Construction**
Average soil loss (ton/ha/yr)	73.2	11,294.5	51.6	37.1
Sediment Yield (ton/yr)	7.1	3316.0	15.2	3.6
Sediment delivery ratio (%)	2.3	6.8	6.8	2.3
Estimated soil quantity in no of dump trucks*	0.4	207	1	0.2
Soil erosion risk class	Moderately High	Very High	Moderately High	Moderate

Note: K Factor = 0.0566 (derived from Tew, 1999 based on soil laboratory results from Borehole BH1)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderately high with average value of 73 ton/ha/yr. The soil loss is reduced to moderate risk during post-construction stage, at 37 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 11,295 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 3,316 ton or 207 dump trucks per year. However, this could be reduced to about 52 ton/ha/yr (which is at moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 15 ton or 1 dump trucks per year.

As mentioned previously, the soil erosion impact will be less significant at tunnel portal area due to its small earthworks area. In this hotspot, each of the tunnel portal area involves less than 1 ha of earthworks. Furthermore, the nearest river, Sg Semampos is far away from the tunnel portal area (700 m). Hence the sedimentation will also be less significant. However, effective mitigation measures shall be implemented. If not, in worst-case scenario, sediment runoff from construction will clog the existing drainage in Kg. Sg Salak. This will reduce the holding capacity of the existing drainage, which may increase flood risk in the surrounding area, especially during the monsoon season.

e) S9 Tunnel Portal: Taman Bukit Permata

This tunnel portal, which involves 2.9 km of tunneling, is located at a hill face nearby Taman Bukit Permata (medium density population within 500 m of construction works). The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-18** and shown in **Figure 7.4.1-11a-b**.

Table 7-18 : Soil Erosion and Sedimentation for S9

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	59.0	19,438.9	65.2	60.8
Sediment Yield (ton/yr)	26.0	25,341.6	80.6	44.4
Sediment delivery ratio (%)	2.8	7.7	7.7	4.6
Estimated soil quantity in no of dump trucks*	2	1,584	5	3
Soil erosion risk class	Moderately High	Very High	Moderately High	Moderately High

Note: K Factor = 0.0649 (derived from Tew, 1999 based on soil laboratory results from Borehole BH2)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderately high with average value of 59 ton/ha/yr. The soil loss is still moderately high during post-construction stage, at 61 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 19,438 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 25,342 ton or 1,584 dump trucks per year. However, this could be significantly reduced to about 65 ton/ha/yr (which is at moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 81 ton or 5 dump trucks per year.

Similar as in S8, the soil erosion impact will be less significant at tunnel portal area due to its small earthworks area (about 1 ha). Despite that, effective mitigation measures shall be implemented to avoid potential shallowing, narrowing and clogging of Sg Semampus. As the carrying capacity of both rivers may potentially be reduced due to sedimentation, there is a possible increase flood risk at Gombak Utara and Kg. Sg. Chinchin during occurrences of heavy rainfall, particularly during monsoon seasons.

f) S10 Viaduct: Taman Jasa Utama

This viaduct section at Taman Jasa Utama is surrounded by residential houses and apartments (high density population within 500 m of construction works) namely Taman Jasa Utama and Taman Jasa Perwira. Batu Dam is located 500m away from this section. This section also crosses Sg. Batu. A summary of soil erosion rates for the different stages of construction is tabulated in **Table 7-19** and shown in **Figure 7.4.1-12**.

Table 7-19 : Soil Erosion and Sedimentation for S10

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	46.6	931.4	48.8	9.3
Sediment Yield (ton/yr)	3.8	79.0	3.9	0.2
Sediment delivery ratio (%)	7.0	7.3	7.3	2.0
Estimated soil quantity in no of dump trucks*	0.2	5	0.3	0
Soil erosion risk class	Moderate	Very High	Moderate	Low

Note: K Factor = 0.0649 (derived from Tew, 1999 based on soil laboratory results from Borehole BH2)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 47 ton/ha/yr. The soil loss is reduced to low risk during post-construction stage, at 9 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 931 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 79 ton or 5 dump trucks per year. However, this could be reduced to about 49 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 4 ton or 0.5 dump trucks per year.

There are several residential areas surrounding the construction works namely Taman Jaya Utama and Taman Jasa Perwira. Without the implementation of effective mitigation measures at this area, sediment-laden runoff will ultimately clog existing waterways (eventually to Sg Batu) and drainage systems that cater to these residential areas, potentially increase risk of flood especially during heavy rainfall as the drainage system is no longer able to optimally channel excess runoff away from said area. The impact on Sg Batu's water quality from the construction site's TSS discharge for worst case and mitigation measures are further elaborated in **Section 7.4.1.7** and **Section 8.3.1**, respectively.

g) S11 Tunnel Portal: Templer Park Forest Reserve

This tunnel, which involves 5.2 km of tunneling, is located within Templer Park Forest Reserve (high density population within 500 m of construction works). The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-20** and shown in **Figure 7.4.1-13a-b**.

Table 7-20 : Soil Erosion and Sedimentation for S11

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	138.8	17,632.8	152.4	141.9
Sediment Yield (ton/yr)	111.4	26,828.3	215.1	131.8
Sediment delivery ratio (%)	5.3	9.2	9.2	5.7
Estimated soil quantity in no of dump trucks*	7	1,677	13	8
Soil erosion risk class	High	Very High	Very High	High

Note: K Factor = 0.0642 (derived from Tew, 1999 based on soil laboratory results from Borehole BH3)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is high with average value of 139 ton/ha/yr. The soil loss remains high during post-construction stage, at 142 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 17,632 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 26,828 ton or 1,677 dump trucks per year. However, this could be significantly reduced to about 152 ton/ha/yr (which is considered very high) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 215 ton or 13 dump trucks per year.

As with the other tunnel hotspots, the soil erosion impact will be less significant at tunnel portal area due to its small earthworks area (about 1.5 ha). The soil erosion risk is also already high even during pre-construction stage at this hotspot due to its undulating topography. Nevertheless, effective mitigation measures shall be implemented to avoid sediment-laden runoff from construction works clogging the existing drainage in Taman Jasa Utama and Templer Impian. This will reduce the holding capacity of the existing drainage, which may increase flood risk in the surrounding area especially during the monsoon season.

h) S12 Tunnel Portal: Serendah Forest Reserve

This tunnel portal, which involves 5.8 km of tunneling, is located at a hill face in Serendah Forest Reserve (low density population within 500 m of construction works). The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-21** and shown in **Figure 7.4.1-14a-b**.

Table 7-21 : Soil Erosion and Sedimentation for S12

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	96.3	32,090.9	97.1	96.5
Sediment Yield (ton/yr)	49.8	55,597.5	162.1	87.6
Sediment delivery ratio (%)	2.3	7.8	7.8	4.1
Estimated soil quantity in no of dump trucks*	3	3,475	10	6
Soil erosion risk class	Moderately High	Very High	Moderately High	Moderately High

Note: K Factor = 0.0642 (derived from Tew, 1999 based on soil laboratory results from Borehole BH3)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderately high with average value of 96 ton/ha/yr. The soil loss remains at moderately high risk during post-construction stage, at 97 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 32,091 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 55,597 ton or 3,475 dump trucks per year. However, this could be significantly reduced to about 97 ton/ha/yr (which is considered moderately high) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 162 ton or 10 dump trucks per year.

The area of each tunnel portal at this hotspot is less than 1 ha which will only involve minor earthworks. Hence the soil erosion impact is not significant despite the average soil loss estimated to be moderately high. However, effective mitigation measures shall be implemented to avoid construction sediment runoff clogging the existing drainage in Templer Impian. Which in turn reduce the holding capacity of the existing drainage and increase flood risk in the area.

Segment 2B: Serendah to Bandar Puncak Alam

Alignment at this segment traverse through hilly oil palm plantations, Rantau Panjang Forest Reserve and also traverse near residential areas. Majority of the alignment are at-grade section. Tunneling works will be carried out at the hilly oil palm plantation areas at Batu Arang and Bandar Puncak Alam and viaduct works at river crossings of Sg Garing and Sg Kundang. Major earthworks are expected at the Serendah station and cut section at Rantau Panjang Forest.

a. Assessment Results

a) S13 Station : Serendah

This station is located near the Perodua Global Manufacturing. Further downstream of the station are residential houses (Taman Desa Kiambang, Taman Anugerah Suria and Taman Bukit Teratai with medium density population within 500 m of construction works). Sg Serendah is located about 20m north from the station. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-22** and shown in **Figure 7.4.1-15**.

Table 7-22 : Soil Erosion and Sedimentation for S13

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	33.9	226.4	110.6	2.6
Sediment Yield (ton/yr)	15.8	103.9	50.7	1.1
Sediment delivery ratio (%)	7.7	7.6	7.6	7.7
Estimated soil quantity in no of dump trucks*	1	7	3	0
Soil erosion risk class	Moderate	Very High	High	Low

Note: K Factor = 0.0383 (derived from Tew, 1999 based on soil laboratory results from Borehole BH5)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 34 ton/ha/yr. The soil loss is reduced to low risk during post-construction stage, at 3 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 226 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 104 ton or 7 dump trucks per year. However, this could be reduced to about 111 ton/ha/yr (which is considered high) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 51 ton or 3 dump trucks per year.

In the worst-case scenario, the assessment anticipates sediment runoff from construction works is expected to clog and reduce the carrying capacity of Sg Serendah (20 m away from construction works). This will increase flooding risk downstream at Taman Anugerah Suria and Taman Bukit Teratai and adjacent to construction site (Taman Desa Kiambang) especially during the monsoon season. The impact of TSS discharge from the construction works towards Sg Serendah's water quality is further elaborated in **Section 7.4.1.7**.

b) S14 Tunnel Portal : Sg Buaya

This tunnel portal, which involves 2.2 km of tunneling, is located close to Bandar Baru Sg. Buaya (low density population within 500 m of construction works). The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-23** and shown in **Figure 7.4.1-16a-b**.

Table 7-23 : Soil Erosion and Sedimentation for S14

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	73.6	9,802.5	86.0	70.3
Sediment Yield (ton/yr)	41.4	13,508.9	112.8	59.4
Sediment delivery ratio (%)	4.0	9.7	9.7	6.2
Estimated soil quantity in no of dump trucks*	3	844	7	4
Soil erosion risk class	Moderately High	Very High	Moderately High	Moderately High

Note: K Factor = 0.0527 (derived from Tew, 1999 based on soil laboratory results from Borehole BH6)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderately high with average value of 74 ton/ha/yr. The soil loss remains at moderately high risk during post-construction stage, at about 70 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 9,803 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 13,509 ton or 844 dump trucks per year. However, this could be significantly reduced to about 86 ton/ha/yr (which is considered moderately high) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 113 ton or 7 dump trucks per year.

Although the average soil loss is estimated to be moderately high, the impact from the work area is not critical with no sensitive receptors or waterbody situated nearby. Without proper mitigation plan, the worst possible scenario is sediment runoff from the tunnel construction will clog the nearby drainage especially for the portal near Jln. Sg. Buaya. Consequently, traffic disruption and accidents is to be expected due to increased flood risk during rainy season.

c) S15 Viaduct : Sg Garing

This viaduct section at Sg. Garing is surrounded by Saujana Techno Park Rawang settlement (medium density population within 500 m of construction works) and oil palm plantations. About 11.9 km downstream from the crossing is the Rantau Panjang water intake point. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-24** and shown in **Figure 7.4.1-17.**

Table 7-24 : Soil Erosion and Sedimentation for S15

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	8.3	399.9	21.3	2.0
Sediment Yield (ton/yr)	0.9	77.9	12.8	0.2
Sediment delivery ratio (%)	5.7	9.8	9.8	4.9
Estimated soil quantity in no of dump trucks*	0	5	1	0
Soil erosion risk class	Low	Very High	Moderate	Low

Note: K Factor = 0.0527 (derived from Tew, 1999 based on soil laboratory results from Borehole BH6)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is low with average value of 8 ton/ha/yr. The soil loss remains low during post-construction stage, at 2 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 400 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 78 ton or 5 dump trucks per year. However, this could be significantly reduced to about 21 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 13 ton or 1 dump trucks per year.

High TSS concentration in surface runoff will affect the water quality of Sg Garing which in turn will affect Sg Selangor which is used as raw water source for the Rantau Panjang water intake station (11.9km downstream). Although the intake point is further downstream, the introduction of high TSS in the intake water may wear out the pumps and turbines which will affect the efficiency of the water intake station. The impact towards Sg Garing's water quality resulting from the construction surface runoff is further elaborated in **Section 7.4.1.7**.

Uncontrolled sediment-laden runoff from construction activities will also cause the Sg. Garing to be silted and also clog the existing drainage at Saujana Techno Park Rawang. This will reduce the holding capacity of the waterways, which may increase flood risk of the surrounding area.

d) S16 Viaduct : Sg Kundang

This viaduct section at Sg. Kundang is near the Saujana Rawang settlement (medium density population within 500 m of construction works). About 11.4 km downstream from the crossing is the Rantau Panjang water intake point. A summary of the soil erosion rates for different stages of construction is tabulated in **Table 7-25** and shown in **Figure 7.4.1-18**.

Table 7-25 : Soil Erosion and Sedimentation for S16

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	25.4	511.0	39.7	2.3
Sediment Yield (ton/yr)	2.0	84.5	5.7	0.2
Sediment delivery ratio (%)	4.2	9.1	9.1	3.9
Estimated soil quantity in no of dump trucks*	0.1	5	1	0
Soil erosion risk class	Moderate	Very High	Moderate	Low

Note: K Factor = 0.0527 (derived from Tew, 1999 based on soil laboratory results from Borehole BH6)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 25 ton/ha/yr. The soil loss reduced to low risk during post-construction stage, at 2 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 511 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 85 ton or 5 dump trucks per year. However, this could be significantly reduced to about 40 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 6 ton or 1 dump trucks per year.

Similar to previous hotspot (S15), high TSS concentration in surface runoff will affect the water quality of Sg Kundang and eventually affect Sg Selangor which is used as raw water source for the Rantau Panjang water intake station (11.4km downstream). The impact towards Sg Kundang's water quality resulting from the construction surface runoff is further elaborated in **Section 7.4.1.7**. Uncontrolled sediment-laden runoff from construction activities will also increase flood risk at Saujana Rawang due to shallowing and clogging of the said river.

e) S17 Cut Section : Rantau Panjang Forest Reserve

The cut section is located at high erosion risk area within Rantau Panjang Forest Reserve. The hotspot is located near to resident houses (M Residence and Saujana Rawang with medium density population within 500 m of construction works) and about 720m from Sg Kundang. A summary of the soil erosion rates for different stages is tabulated in **Table 7-26** and shown in **Figure 7.4.1-19**.

Table 7-26 : Soil Erosion and Sedimentation for S17

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	13.0	4,331.6	42.9	19.5
Sediment Yield (ton/yr)	4.6	4,412.2	43.2	9.0
Sediment delivery ratio (%)	3.0	8.5	8.5	3.9
Estimated soil quantity in no of dump trucks*	0.3	276	3	1
Soil erosion risk class	Moderate	Very High	Moderate	Moderate

Note: K Factor = 0.0506 (derived from Tew, 1999 based on soil laboratory results from Borehole BH7)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 13 ton/ha/yr. The soil loss remains moderate during post-construction stage, at 20 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 4,332 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 4,412 ton or 276 dump trucks per year. However, this could be significantly reduced to about 43 ton/ha/yr (which is considered moderate risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 43 ton or 3 dump trucks per year.

The assessment shows that soil erosion and sedimentation during construction is very high although it can be greatly reduced with the implementation of effective mitigation measures. However, without proper mitigation plan, the sediment runoff from construction works will cause shallowing, narrowing and clogging of existing drainage of M Residence and of Sg. Kundang (720m of construction works). This will reduce the holding capacity of the said waterways, which may increase flood risk at M Residence and downstream of Sg Kundang (Saujana Rawang).

Segment 2C: Bandar Puncak Alam to Port Klang

Alignment at this segment traverses through flat oil palm plantations at Kapar, mangrove forest at Sg Puloh and also residential and industrial areas at Port Klang area. Majority of the alignment are at-grade section and the remaining are viaduct sections at Taman Klang Utama industrial area and Sg Puloh mangrove area. Major earthworks are expected at Jalan Kastam station, viaduct section at Sg Puloh and at-grade sections at Kg Delek and Kg Sireh.

a. Assessment Results

a) S18 Viaduct : Sg Puloh

The viaduct crosses Sg Puloh which is also a fishing area for the fishermen of Kg Sementa and Kg Rantau Panjang (low density population within 500 m of construction works). A summary of the soil erosion rates for different stages is tabulated in **Table 7-27** and shown in **Figure 7.4.1-20**.

Table 7-27 : Soil Erosion and Sedimentation for S18

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	0.4	62.9	20.2	0.3
Sediment Yield (ton/yr)	0.1	28.7	9.2	0.1
Sediment delivery ratio (%)	3.0	6.1	6.1	3.5
Estimated soil quantity in no of dump trucks*	0	2	0.5	0
Soil erosion risk class	Low	Moderately High	Moderate	Low

Note: K Factor = 0.0392 (derived from Tew, 1999 based on soil laboratory results from Borehole BH14)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is low with average value of 0.4 ton/ha/yr. The soil loss is remains low during post-construction stage, at 0.3 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 63 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 29 ton or 2 dump trucks per year. However, this could be reduced to about 20 ton/ha/yr (which is considered moderate risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 9 ton or 0.5 dump trucks per year.

In the worst-case scenario, sediment runoff from construction will increase the TSS level in Sg Puloh. High TSS in the river will harm fish by clogging gills, reducing growth rates and lowering resistance to disease. This could potentially reduce the productivity of fishermen in Kg Sementa and Kg Rantau Panjang. The impact of high TSS discharge from the construction works towards Sg Puloh's water quality is further elaborated in **Section 7.4.1.7.**

b) S19 At-Grade Section : Kg Delek

The at-grade section is located at Kg. Delek. The sensitive receptors nearby are Kg. Delek, Sg. Teluk Gadong Besar and Sg. Klang, which are at close proximity of about 10m (medium density population within 500m of construction works). The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-28** and shown in **Figure 7.4.1-21**.

Table 7-28 : Soil Erosion and Sedimentation for S19

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	38.4	153.4	84.4	0.7
Sediment Yield (ton/yr)	16.1	52.5	28.9	0.1
Sediment delivery ratio (%)	7.8	6.4	6.4	3.0
Estimated soil quantity in no of dump trucks*	1	3	2	0
Soil erosion risk class	Moderate	Very High	Moderately High	Low

Note: K Factor = 0.0536 (derived from Tew, 1999 based on soil laboratory results from Borehole BH15)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 38 ton/ha/yr. The soil loss reduced to low risk during post-construction stage, at 1 ton/ha/yr.

During construction stage, the soil loss will be very high (average value of about 153 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 53 ton or 3 dump trucks per year. However, this could be reduced to about 84 ton/ha/yr (which is considered moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 29 ton or 2 dump trucks per year.

Due to the presence of both sensitive receptors and waterbody nearby, the mitigation measures at this hotspot ought to be effectual as the impact can be calamitous considering that soil loss with mitigation is already moderately high. In the worst-case scenario, sediment runoff will clog up the existing drainage in Kg. Delek. This will reduce the drainage capacity, and may increase flood risk that affects the residents badly. In addition, the quality of the nearby rivers of Sg. Teluk Gadong Besar which eventually flows to Klang will be further deteriorated by siltation. The impact of high TSS discharge from the construction works towards Sg Klang's water quality is further elaborated in **Section 7.4.1.7.**

c) S20 At-Grade Section : Kg Sireh

The at-grade section is located at Kg. Sireh. The sensitive receptors nearby are Kg. Sireh, Kg. Sg. Sireh Tambahan, Taman Sg. Sireh (high density population within 500 m of construction works) and Sg. Klang, which are at relatively close proximity of about 450m. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-29** and shown in **Figure 7.4.1-22**.

Table 7-29 : Soil Erosion and Sedimentation for S20

	Pre-Construction	Construction (Worst Case Scenario)	Construction (With Mitigation Measures)	Post Construction
Average soil loss (ton/ha/yr)	14.2	94.9	50.1	0.4
Sediment Yield (ton/yr)	7.5	26.6	13.9	0.1
Sediment delivery ratio (%)	10.8	5.8	5.8	3.4
Estimated soil quantity in no of dump trucks*	0.5	2	1	0
Soil erosion risk class	Moderate	Moderately High	Moderately High	Low

Note: K Factor = 0.0294 (derived from Tew, 1999 based on soil laboratory results from Borehole BH16)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is moderate with average value of 14 ton/ha/yr. The soil loss reduced to low risk during post-construction stage, at 0.4 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 95 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 27 ton or 2 dump trucks per year. However, this could be reduced to about 50 ton/ha/yr (which is considered moderately high risk) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 14 ton or 1 dump trucks per year.

Similar to the previous hotspot (S19), sediment-laden runoff from earth-disturbing construction activities is expected to clog and reduce existing drainage capacity, thus leading to increase in flood risks, especially at Kg. Sireh during the monsoon season. In addition, the quality of the nearby river, Sg Klang will be further deteriorated by siltation. The impact of high TSS discharge from the construction works towards Sg Klang's water quality is further elaborated in **Section 7.4.1.7.**

d) S21 Station : Jalan Kastam

This station is surrounded by residential buildings (Pangsapuri Seri Perantau, Kg Kastam, Taman Raja Uda and Kg Sireh Tambahan with high density population within 500 m of construction works). Sg Klang is located about 250m northwest from the station. The summary of the soil erosion rates for the different construction stages is tabulated in **Table 7-30** and shown in **Figure 7.4.1-23**.

Table 7-30 : Soil Erosion and Sedimentation for S21

	Pre-Construction	**Construction (Worst Case Scenario)**	**Construction (With Mitigation Measures)**	**Post Construction**
Average soil loss (ton/ha/yr)	9.9	66.1	32.2	0.7
Sediment Yield (ton/yr)	3.6	19.0	9.1	0.2
Sediment delivery ratio (%)	8.5	6.7	6.7	8.5
Estimated soil quantity in no of dump trucks*	0.2	1	0.5	0
Soil erosion risk class	Low	Moderately High	Moderate	Low

Note: K Factor = 0.0294 (derived from Tew, 1999 based on soil laboratory results from Borehole BH16)
Assuming soil bulk density = 1600 kg/m^3, dump truck capacity = 10m^3

The results show that during pre-construction, the soil loss is low with average value of 10 ton/ha/yr. The soil loss remains low during post-construction stage, at 1 ton/ha/yr.

During construction stage, the soil loss will be moderately high (average value of about 66 ton/ha/yr) if mitigation measures are not implemented. The sediment yield will be about 19 ton or 1 dump trucks per year. However, this could be reduced to about 32 ton/ha/yr (which is considered moderate) with the implementation of effective soil erosion and sediment control measures. The sediment yield will be reduced to about 9 ton or 0.5 dump trucks per year.

The assessment shows that soil erosion and sedimentation during construction is moderately high if no mitigation measures are implemented. In the worst-case scenario, sediment runoff will clog up the existing drainage in the surrounding area (the nearest existing drainage at Pangsapuri Seri Perantau, Kg Kastam and Taman Raja Uda and Kg Sireh Tambahan) and also Sg Klang (250m northwest). This will reduce the drainage and river capacity, and may increase flood risk in the said area, especially during heavy rainfall in the monsoon season. The impact of Sg Klang's water quality resulting from the construction works' TSS discharge is further elaborated in **Section 7.4.1.7.**

7.4.1.6 Summary of soil erosion risk assessment at hotspots location

Segment 1 : Kelantan

For Kelantan, the soil erosion risk for all the hotspots during construction with the implementation of mitigation measures are at moderate risk. This is due to relatively flat topography along the Kelantan alignment. However, emphasis should be given to station construction area (S1 and S4) as it involves substantial earthworks area (25 ha and 9 ha respectively) which are prone to soil erosion and sedimentation in longer period. **Table 7-31** shows the summary of soil erosion risk class at Segment 1 hotspots.

Table 7-31 : Summary of Soil Erosion Risk Class at Segment 1 Hotspots

Hotspot		Soil Erosion Risk Class			
		Pre-Construction	Construction (worst case)	Construction (with mitigation)	Post Construction
S1	Station : Wakaf Baru	Moderate	Moderately High	Moderate	Low
S2	Viaduct : Sg Pengkalan Nangka	Moderate	Moderately High	Moderate	Low
S3	Viaduct : Sg Mentua	Low	Moderately High	Moderate	Low
S4	Station : Pengkalan Kubor	Low	Moderately High	Moderate	Low

Segment 2A : Gombak North - Serendah

Except for S10, the soil erosion risks are moderately high to very high risk except for S10. This is due to the steep and undulating topography along Segment 2A alignment. S5 has very high soil erosion risk during construction despite the implementation of mitigation measures. However, the impact less significant as the earthworks is not extensive as it focused only at piers location which will minimize the amount of exposed soil. All the tunnel portal areas (S6, S7, S8, S9, S11 and S12) have moderately high risk. Regardless, the impact will be less significant as the earthworks only concentrates at tunnel portal area (about 1ha) is small. Construction period will also be shorter since the area is small hence reduce the soil erosion and sedimentation risk exposure. **Table 7-32** shows the summary of soil erosion risk class at Segment 2A hotspots.

Table 7-32 : Summary of Soil Erosion Risk Class at Segment 2A Hotspots

Hotspot		Pre-Construction	Construction (worst case)	Construction (with mitigation)	Post Construction
S5	Viaduct : Kg Batu 12	High	Very High	Very High	Moderate
S6	Tunnel Portal : Kg. Batu 11	Moderate	Very High	Moderately High	Moderate
S7	Tunnel Portal : Desa Makmur	Moderately High	Very High	Moderately High	Moderately High
S8	Tunnel Portal : Kg. Sg Salak	Moderately High	Very High	Moderately High	Moderate
S9	Tunnel Portal : Taman Bukit Permata	Moderately High	Very High	Moderately High	Moderately High
S10	Viaduct : Taman Jasa Utama	Moderate	Very High	Moderate	Low
S11	Tunnel Portal : Templer Park Forest Reserve	High	Very High	Very High	High
S12	Tunnel Portal : Serendah Forest Reserve	Moderately High	Very High	Moderately High	Moderately High

Segment 2B : Serendah – Bandar Puncak Alam

For Segment 2B, the soil erosion risks are moderate except for S13 (station) and S14 (tunnel portal). The soil erosion risk at S13 is high as it involves substantial earthworks area (6 ha) which is prone to soil erosion and sedimentation in longer period. For S14, the soil erosion risk is moderately high due to steep slopes at the area. Regardless, the impact will be less significant as the earthworks only concentrates at tunnel portal area (about 1.5ha) is small. Construction period will also be shorter since the area is small hence reduce the soil erosion and sedimentation risk exposure. **Table 7-33** shows the summary of soil erosion risk class at Segment 2B hotspots.

Table 7-33 : Summary of Soil Erosion Risk Class at Segment 2B Hotspots

Hotspot		Pre-Construction	Construction (worst case)	Construction (with mitigation)	Post Construction
S13	Station : Serendah	Moderate	Very High	High	Low
S14	Tunnel Portal : Sg. Buaya	Moderately High	Very High	Moderately High	Moderately High
S15	Viaduct : Sg. Garing	Low	Very High	Moderate	Low
S16	Viaduct : Sg. Kundang	Moderate	Very High	Moderate	Low
S17	Cut Section : Rantau Panjang Forest Reserve	Moderate	Very High	Moderate	Moderate

Segment 2C : Bandar Puncak Alam – Port Klang

For Segment 2C, the soil erosion risks are moderate except for S19 and S20 which are at-grade sections. The soil erosion risk for both are moderately high as they involve substantial earthworks which requires about 6-8 m fill height. During site clearing and earthworks, these sections will be exposed and prone to erosion and sedimentation. **Table 7-34** shows the summary of soil erosion risk class at Segment 2C hotspots.

Table 7-34 : Summary of Soil Erosion Risk Class at Segment 2C Hotspots

Hotspot		Pre-Construction	Construction (worst case)	Construction (with mitigation)	Post Construction
S18	Viaduct : Sg. Puloh	Low	Moderately High	Moderate	Low
S19	At-Grade Section : Kg Delek	Moderate	Very High	Moderately High	Low
S20	At-Grade Section : Kg Sireh	Moderate	Moderately High	Moderately High	Low
S21	Station : Jalan Kastam	Low	Moderately High	Moderate	Low

7.4.1.7 Prediction of TSS Concentration in the Rivers

Assessment Method

To assess the impact of suspended solids on receiving waterways at the potential hotspots, a simple mixing and decay model is applied to Segments 1, 2A and 2C (an example is illustrated in **Chart 7-1**) while at Segment 2B, the assessment was carried out using the QUAL2K water quality model (**Chart 7-2**). All scenarios assessed are with the condition that mitigation measures are implemented.

The following scenarios were simulated:

Scenario 1 (with Mitigation Measures):
The maximum sediment contribution from the Project is 50 mg/L with implementation of mitigation measures.

Scenario 2 (Worst Case with Mitigation Measures):
The sediment contribution from the Project is 1,000 mg/L with implementation of mitigation measures at peak discharge of 2-year-return-period.

Scenario 3 (Waste Load Allocation):
The maximum allowable sediment contribution from the Project to preserve the baseline water quality status within its NWQS Class (if the need arises).

For all scenarios, the following assumptions and criteria were made:

- Runoff from the Project site and receiving water body is assumed to be completely mixed at the confluence points.
- Other point/diffuse sources along and leading into the receiving water bodies are not considered.

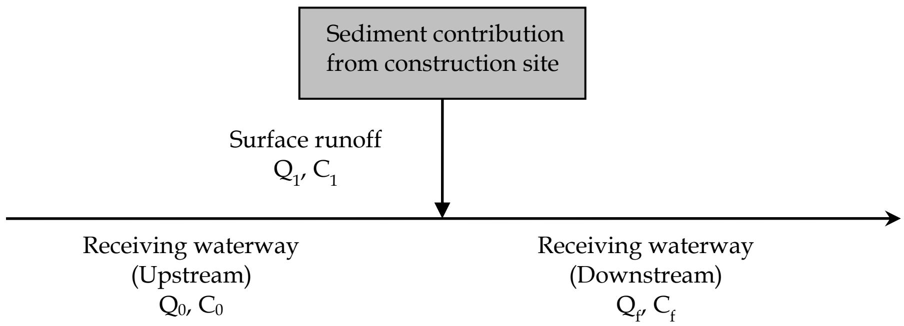


Chart 7-1 : Sediment Contribution into receiving waterway

The expected suspended solids concentration (C_f) after the sediment discharged from the Project site mixes with the receiving waters is calculated as:

$$C_0Q_0 + C_1Q_1 = C_fQ_f$$

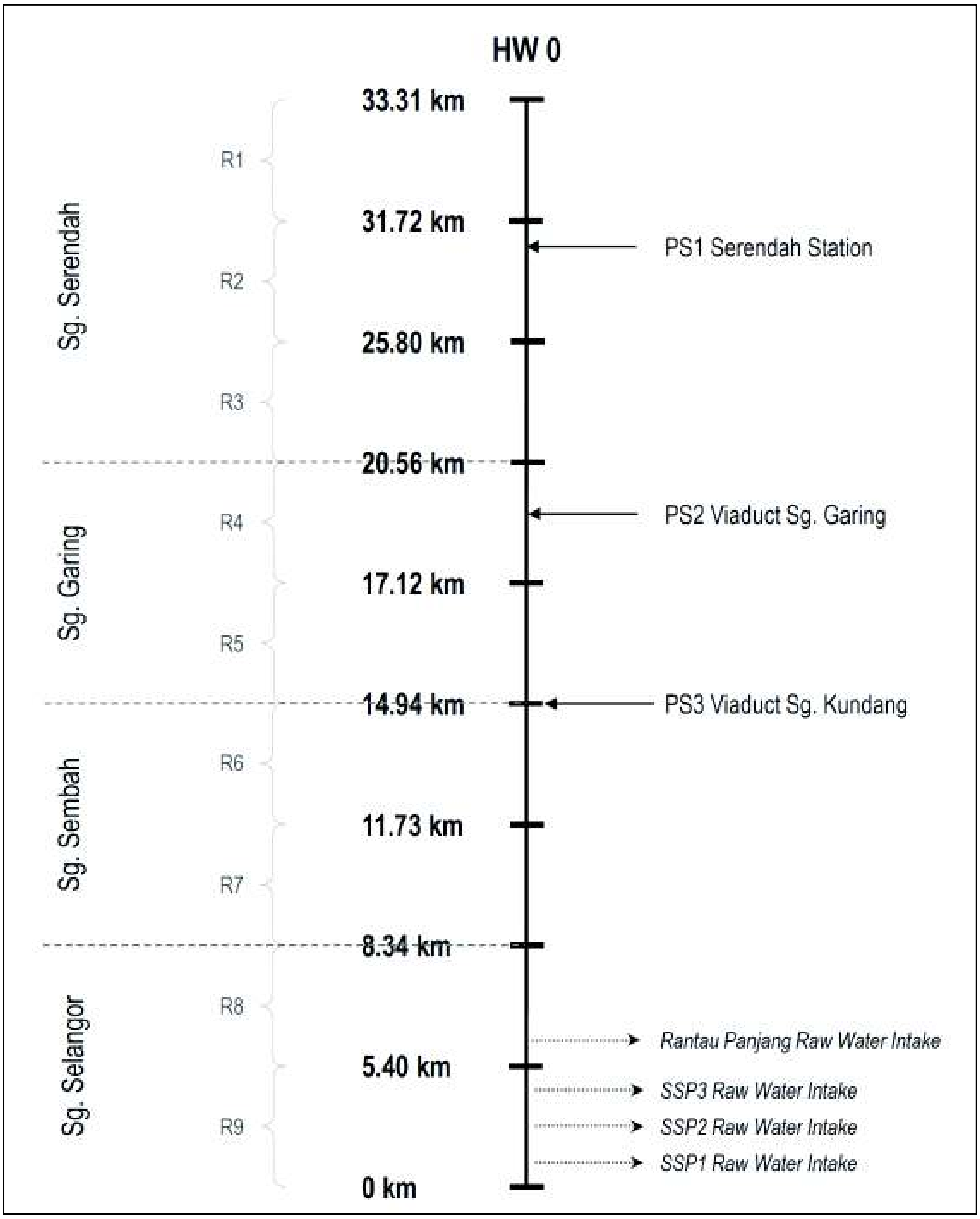
$$C_f = \frac{C_0Q_0 + C_1Q_1}{Q_f}$$

Where;

C_0 = concentration upstream (mg/l)
C_1 = concentration of sediment from Project, (mg/l)
C_f = concentration after mixing (mg/l)

Q_0 = flow rate upstream (m^3/s)
Q_1 = flow rate of discharge from Project (m^3/s)
Q_f = flow rate after mixing (m^3/s)

Chart 7-2 : QUAL2K River Schematic (Construction Phase)



a) Segment 1 : Kelantan

The sensitive downstream receptors along the Kota Bharu – Pengkalan Kubor stretch are mainly the caged brackish water fish breeding near the river mouth of Sg. Mentua and Sg. Pengkalan Nangka. Other potential receptors comprise mainly of irrigation infrastructure (canals, pipelines, pumphouses, tidal gates) that provide water to the paddy fields in the coastal granary area of Tumpat, which are served by the irrigation schemes of the Kemubu Agricultural Development Authority (KADA) and the Department of Irrigation and Drainage.

The potential water pollution hotspots during the construction stage are listed in **Table 7-35** and **Figure 7.4.2-1**. During the construction stage, the major water pollutant will be sediment runoff thus the assessment will focus on the concentration of suspended solids.

Table 7-35 : Potential Hotspots, Receptors and Rivers in Kelantan

	River/ Crossing/ Flow Path (assumed)	Receptors	Distance Downstream
Pengkalan Kubur Station	Irrigation canal → Sg. Mentua	Caged freshwater fish breeders	1.05 km
Viaduct at Sg. Mentua	Irrigation canal → Sg. Mentua	Caged freshwater fish breeders	3.29 km
Viaduct Sg. Pengkalan Nangka	Sg. Pengkalan Nangka	Caged freshwater fish breeders	2.95 km
Wakaf Bahru Station	Existing drainage → Irrigation canal at Kg. Kubang Batang Barat	Irrigation canal / drainage	0.77 km

<u>*Assessment Results*</u>

Scenario 1: The maximum sediment contribution from the Project is 50 mg/L with implementation of mitigation measures.

The predicted concentration of suspended solids and its respective change from the baseline water quality in Scenario 1 are presented in **Table 7-36** below. In this scenario, the levels of suspended solids in the receiving irrigation canals near the construction sites of both Pengkalan Kubur Station and Wakaf Bharu Station are predicted to deteriorate. The baseline levels of TSS at both sites are within Class I levels but will degrade to Class IIB at both sites. In the case of Sg. Mentua and Sg. Pengkalan Nangka, the impacts to the receiving rivers are lesser, with only a slight increase to the current baseline concentrations. This is due to the larger flow and volume of both rivers thus the rivers are able to receive the sediment load without being severely polluted.

Table 7-36 : Predicted Changes of Suspended Solids for Scenario 1

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline	Predicted	Change	
Pengkalan Kubur Station	16	44.16	+28.16	Baseline water quality for TSS degrades from Class I to Class IIB with discharge from Project site.
Viaduct at Sg. Mentua	6	7.05	+1.05	Baseline water quality for TSS remains within Class I even with discharge from Project site.
Viaduct Sg. Pengkalan Nangka	32	32.67	+0.67	Baseline water quality for TSS remains within Class IIA/B even with discharge from Project site.
Wakaf Bharu Station	20	38.80	+18.80	Baseline water quality for TSS degrades from Class I to Class IIB with discharge from Project site.

Scenario 2: The sediment contribution from the Project is 1,000 mg/L with implementation of mitigation measures at peak discharge of 2-year-return-period.

In the event of rain (with an assumption of 2-year-return-period peak discharge), the flow and sediment concentration in the waterways are expected to increase due to runoff from within the catchment. The estimated sediment concentration in the waterways are calculated using the Event Mean Concentration (EMC) which is a flow weighted average of a constituent concentration and is calculated based on an area's land use. Based on this, the sediment concentration during rain events is anticipated to be high (Class V levels) due to the major agriculture land use. In a worst-case scenario, the sediment basins from the Project are assumed to be discharging 1,000 mg/L of sediments into the receiving waterways. In these conditions, the predicted changes from the baseline water quality are as per **Table 7-37.** Although the baseline levels are already high, the discharge of 1,000 mg/L TSS will drastically worsen the conditions of the receiving waterways. This will increase the turbidity in the drainage drastically as well as increase the risk of sediment deposition in the drainage later when the flow subsides.

Table 7-37 : Predicted Changes of Suspended Solids for Scenario 2

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline*	Predicted	Change	
Pengkalan Kubur Station	150.00	623.01	+473.01	Estimated baseline water quality for TSS degrades from Class III to Class V with discharge from Project site.
Viaduct at Sg. Mentua	985.74	985.75	+0.01	Estimated baseline water quality for TSS exceeds Class V limits. Discharge from Project site causes slight increase.
Viaduct Sg. Pengkalan Nangka	698.87	703.00	+4.14	
Wakaf Bharu Station	520.02	900.92	+380.90	Estimated baseline water quality for TSS exceeds Class V limits. Discharge from site will worsen TSS concentration in receiving waters by 73%.

*Note: Baseline suspended solids concentration is estimated using Event Mean Concentration (EMC) calculations

Scenario 3: The maximum allowable sediment contribution from the Project to preserve the baseline water quality status within its NWQS Class

From both scenarios above, the high-risk location for TSS pollution are at the sites of both stations. Under normal conditions (Scenario 1), the recommended TSS pollution loads are 25.9 kg/day (Pengkalan Kubur Station) and 82.1 kg/day (Wakaf Bharu Station) to preserve the current baseline water quality for suspended solids within its NWQS Class. At design Q2 discharge from the sediment basins, the sediment concentration should not exceed the values tabulated in **Table 7-38** below.

Table 7-38 : Concentration of Suspended Solids required preserve baseline water quality status

Potential Hotspot / Construction Area	Concentration (mg/l)		
	Recommended Discharge	Scenario 1 Discharge	Reduction
Pengkalan Kubur Station	**27**	50	23
Wakaf Bharu Station	**28**	50	22

In the worst-case scenario (Scenario 2), it is recommended that during storm events the TSS concentration from the sediment basin discharge do not exceed 150 mg/L, which is the maximum limit for Class III of the NWQS. This is to ensure no further deterioration of the receiving waterways by the Project.

Summary

The impact from TSS contribution is not expected to cause deterioration to Sg. Mentua and Sg. Pengkalan Nangka at the points where the Project alignment crosses the rivers (viaducts) due to the larger flow and capacity of the receiving rivers. However, the construction sites of both Pengkalan Kubor and Wakaf Bharu stations are predicted to cause severe pollution to the nearby receiving waterways, even with mitigation measures in place.

Approximately 40% load reduction is recommended at Pengkalan Kubor and Wakaf Bharu to preserve the baseline water quality at normal conditions. During storm events, a maximum of 150 mg/L TSS discharge is allowable to ensure no further deterioration of the receiving waterways by the Project. In addition, it is important to note that baseline conditions may vary throughout the construction period and should be constantly monitored.

b) Selangor

The impact assessment for the alignment in Selangor is divided into three segments and two different methods were applied. For Segments 2A and 2C, a simple mixing and decay model was used while for Segment 2B, the water quality model QUAL2K was applied. This is due to the major beneficial use found in Segment 2B (Sg. Selangor water supply intakes) compared to the beneficial uses of rivers found in the other two segments. The QUAL2K application worksheet is attached in **Appendix J**.

Segment 2A: Gombak North to Serendah

Based on the current alignment, the two potential hotspots are where the viaduct passes close to or crosses the rivers as listed in **Table 7-39 (Figure 7.4.2-2)**. For Viaduct Kg Batu 12 Gombak, it will be located about 100m west of Sg. Gombak near the Hospital Orang Asli Gombak. The main sensitive receptor for Sg. Gombak is the Wangsa Maju WTP Intake which is located 4.2 km downstream. At Sg. Batu, the alignment is approximately 450m downstream of the Sg. Batu WTP Intake therefore will not directly impact the water quality at the intake point. During the construction stage, the major water pollutant will be sediments (as suspended solids).

Table 7-39 : Potential Hotspots, Receptors and Rivers in Segment 2A

Potential Hotspot / Construction Area	River/ Crossing/ Flow Path (assumed)	Distance from Construction Area	Receptors
Viaduct Kg Batu 12 Gombak	Sg. Gombak	100 m	Wangsa Maju WTP Intake (4.2 km downstream)
Viaduct Taman Jasa Utama	Sg. Batu	Crossing	Sg. Batu WTP Intake (0.45 km upstream)

Assessment Results

Scenario 1: The maximum sediment contribution from the Project is 50 mg/L with implementation of mitigation measures.

The predicted concentration of suspended solids and its respective change from the baseline water quality in Scenario 1 are presented in **Table 7-40** below. In this scenario, the levels of suspended solids in both the receiving rivers are predicted to increase but will remain within Class I as the baseline which is acceptable for the major beneficial use (water supply intake).

Table 7-40 : Predicted Changes of Suspended Solids for Scenario 1 at Segment 2A

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline	Predicted	Change	
Viaduct Kg Batu 12 Gombak	6	8.60	+2.60	TSS concentration will increase slightly but baseline water quality for TSS remains within Class I even with discharge from Project site.
Viaduct Taman Jasa Utama	7	20.10	+13.10	

Scenario 2: The sediment contribution from the Project is 1,000 mg/L with implementation of mitigation measures at peak discharge of 2-year-return-period.

In the event of a 2-year-return-period storm and sediment basins are assumed to be discharging 1,000 mg/L of sediments into the receiving waterways, the predicted changes from the baseline water quality are as per **Table 7-41.** The levels of suspended solids in both Sg. Gombak and Sg. Batu will increase slightly but water quality will still be suitable for water supply intakes as the TSS levels are within Class IIA of the NWQS. This is due to the larger volume of flow in the rivers compared to the flow from the sediment basin discharge.

Table 7-41 : Predicted Changes of Suspended Solids for Scenario 2 at Segment 2A

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline*	Predicted	Change	
Viaduct Kg Batu 12 Gombak	25	27.37	+2.37	TSS concentration will increase slightly but baseline water quality for TSS remains within Class IIA, suitable for water supply use.
Viaduct Taman Jasa Utama	25	30.68	+5.68	

*Note: Baseline suspended solids concentration is assumed as the maximum limit of Class I of the NWQS for TSS as the Event Mean Concentration (EMC) estimation was lower than measured baseline concentrations.

Summary

The impact from TSS contribution at 50 mg/L discharge (Scenario 1) is not expected to cause severe water quality deterioration to Sg. Gombak and Sg. Batu at the points where the Project alignment are located close to or crosses the rivers. In Scenario 2, although the predicted impact is minimal, it is not recommended to discharge at 1,000 mg/L for water quality and safety reasons. Ideally, TSS concentration should be capped at 150 mg/L (Class III) during storm events. It is also important to note that baseline conditions may vary during the construction period thus changes to water quality should be constantly monitored.

Segment 2B: Serendah to Bandar Puncak Alam

In Segment 2B, the major sensitive receptors are the water supply intakes in Sg. Selangor. There are four water supply intakes along the river – Rantau Panjang and Sg. Selangor Phases 1 to 3. In addition to that, there are several aquaculture ponds operating along the tributaries as well. Currently the baseline water quality at these stretches is Class III, however, ideally for water supply uses it should be Class IIA.

The potential water pollution hotspots during the construction stage are listed in **Table 7-42 (Figure 7.4.2-2)**. During the construction stage, the major water pollutant will be sediment runoff thus the assessment will focus on the concentration of suspended solids.

Table 7-42 : Potential Hotspots, Receptors and Rivers in Segment 2B

Potential Hotspot / Construction Area	River/ Crossing/ Flow Path (assumed)	Receptors	Distance Downstream
Serendah Station	Sg. Serendah	River	0.15 km
Viaduct: Sg. Garing	Sg. Garing → Sg. Sembah → Sg. Selangor	Aquaculture operators	0.63 – 9.88 km
		Water supply intake	12.82 – 17.78 km
Viaduct: Sg. Kundang	Sg. Kundang → Sg. Sembah → Sg. Selangor	Aquaculture operators	0.73 – 9.54 km
		Water supply intake	12.48 – 17.44 km

Assessment Results

The simulation results for sediment concentration in both Scenarios 1 and 2 are presented in **Chart 7-3** below.

Scenario 1: The maximum sediment contribution from the Project is 50 mg/L with implementation of mitigation measures.

The model begins at Sg. Serendah and the first point source from the Project is Serendah Station construction site. At this point, the TSS concentration will increase slightly (approx. 4.37 mg/L, 27.3%) compared to the baseline TSS levels. However, the water quality class remains at Class I. As the river flows into Sg. Garing, the water quality in general falls to Class IIA levels, and degrades further as it flows into Sg. Sembah. This is due to the existing high levels of TSS in the rivers. When the river flows into Sg. Selangor, the concentration of suspended solids will be diluted approximating the baseline values, thus not causing further pollution issues to the water intakes.

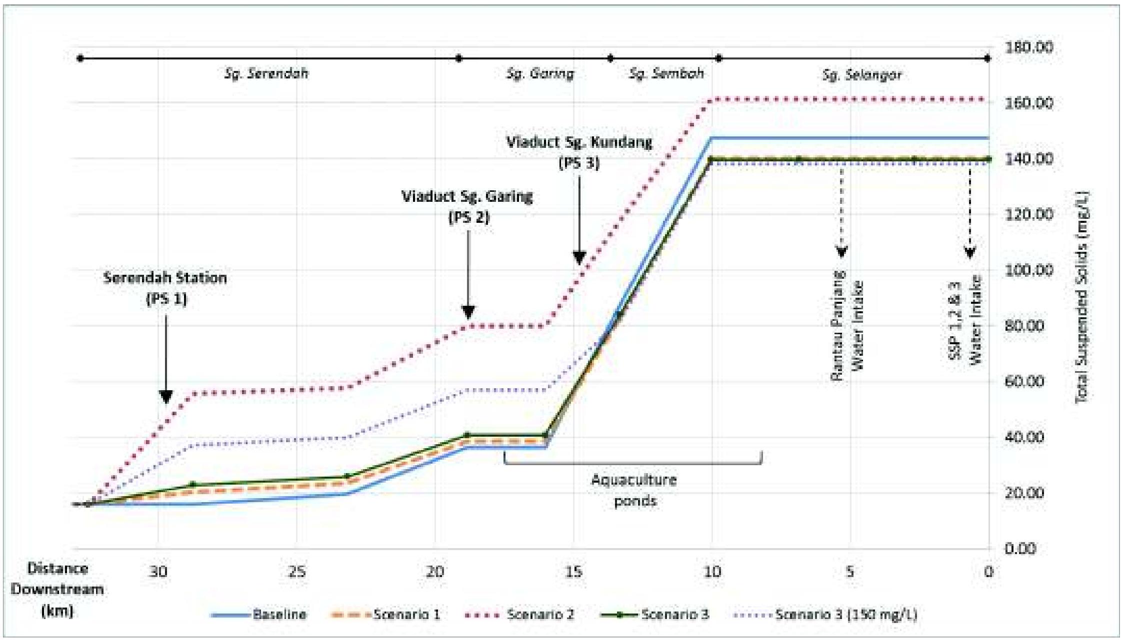


Chart 7-3 : Simulated Suspended Solids Concentration in Segment 2B

Scenario 2: The sediment contribution from the Project is 1,000 mg/L with implementation of mitigation measures at peak discharge of 2-year-return-period.

In Scenario 2 (worst-case), the increased flow and TSS concentration in the rivers as well as the discharge of 1,000 mg/L from the Project sites will cause an overall increase in the TSS simulation. Water quality in the rivers may deteriorate to Class III at Sg. Serendah and Class IV at Sg. Selangor. The discharge of 1,000 mg/L from the Project sites during storm events is not recommended.

Scenario 3: The maximum allowable sediment contribution from the Project to preserve the baseline water quality status within its NWQS Class

Based on the outcome in Scenario 2, two options of pollution loads are proposed in Scenario 3 to reduce the impact of TSS pollution from the Project sites during storm events.

Option 1 – During storm events, the maximum allowable TSS concentration from Serendah Station and Viaduct Sg. Garing are **60 mg/L** each and maximum allowable TSS concentration from Viaduct Sg. Kundang is **240 mg/L**. These concentrations will preserve the river water quality similar to the outcome in Scenario 1, maintaining the water quality classes and not cause pollution issues to the water intakes.

Option 2 – The maximum allowable TSS concentration from all sediment basin discharge is 150 mg/L (Class III) during storm events. This will cause the water quality in Sg. Serendah degrade from Class I to Class IIA, and at Sg. Garing to degrade to Class III. However, as the river flows into Sg. Sembah and Sg. Selangor, the concentration of suspended solids will approximate the baseline levels.

Summary

Generally, the construction works of the Project at Segment 2B will not affect the river water quality at the water intakes during normal flow conditions at discharges of 50 mg/L of suspended solids. During storm events, it is recommended that the concentration of TSS discharged does not exceed 150 mg/L to maintain the water quality in Sg. Sembah and Sg. Selangor which are used for fisheries activites and water supply intakes respectively.

Segment 2C: Bandar Puncak Alam to Port Klang

The sensitive downstream receptors for Segment 2C are mainly the mangroves at Sg. Puloh and aquaculture ponds near the mouth of Sg. Klang. During the construction phase, the main concern for the mangroves is suffocation and stress to the trees due to sedimentation. For Sg. Klang, most of the aquaculture operations are located at the river banks and obtain water from the river. However, the existing water quality at Sg. Klang is generally polluted, at Class IV levels. At the same time, there is a water gate operated by the Department of Irrigation and Drainage at Jalan Sungai Sirih, Kg. Delek. High sedimentation from the Project may cause blockage at the water gate as well.

The potential water pollution hotspots during the construction stage are listed in **Table 7-43** below **(Figure 7.4.2-2)**. During the construction stage, the major water pollutant will be sediment runoff thus the assessment will focus on the concentration of suspended solids.

Table 7-43 : Potential Hotspots, Receptors and Rivers in Segment 2C

Potential Hotspot / Construction Area	Receptors	River/ Crossing/ Flow Path (assumed)	Distance Downstream
Viaduct Sg Puloh	Mangroves	Sg. Puloh	Alignment crossing
At-Grade Section: Kg. Delek	River	Sg. Klang	Alignment crossing
At-Grade Section: Kg. Sireh	Water gate No. 44, Jalan Sungai Sirih, Kg. Delek	Sg. Klang	0.25 km
Jalan Kastam Station	Aquaculture ponds	Sg. Klang	6.20 km

Assessment Results

Scenario 1: The maximum sediment contribution from the Project is 50 mg/L with implementation of mitigation measures.

The predicted concentration of suspended solids and its respective change from the baseline water quality in Scenario 1 are presented in **Table 7-44** below. In this scenario, the TSS levels at Sg. Puloh are expected to increase slightly. In contrast, at the hotspots in Sg. Klang's vicinity, the predicted TSS concentrations are expected to decrease due to the large volume and flow of the river as well as the already polluted baseline conditions.

Table 7-44 : Predicted Changes of Suspended Solids for Scenario 1 at Segment 2C

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline	Predicted	Change	
Viaduct Sg Puloh	32	32.05	+0.05	TSS concentration will increase slightly but baseline water quality for TSS remains within Class IIA/B.
At-Grade Section: Kg. Delek	230	229.70	-0.30	TSS concentration remains within Class IV levels.
At-Grade Section: Kg. Sireh	352	347.62	-4.38	TSS concentration remains within Class V levels.
Jalan Kastam Station	215	214.82	-0.18	TSS concentration remains within Class IV levels.

Scenario 2: The sediment contribution from the Project is 1,000 mg/L with implementation of mitigation measures at peak discharge of 2-year-return-period.

In Scenario 2, the water quality trend is similar to that of Scenario 1. TSS levels at Sg. Puloh will increase by 58.2% and borderlines between Class III and Class IV. Meanwhile, effects of suspended solids in Sg. Klang are not prevalent due to the large volume and existing TSS concentration in the river.

Table 7-45 : Predicted Changes of Suspended Solids for Scenario 2 at Segment 2C

Potential Hotspot / Construction Area	Concentration (mg/l)			Remarks
	Baseline	Predicted	Change	
Viaduct Sg Puloh	32	50.63	+18.63	TSS concentration will increase by 58.2% and baseline water quality will borderline Class III and Class IV.
At-Grade Section: Kg. Delek	230	231.57	+1.57	TSS concentration remains within Class IV levels.
At-Grade Section: Kg. Sireh	352	352.83	+0.83	TSS concentration remains within Class V levels.
Jalan Kastam Station	215	216.95	+1.95	TSS concentration remains within Class IV levels.

Summary

The impact from TSS contribution in Segment 2C is not prevalent to the existing baseline conditions in both Scenarios. However, it is not recommendable to discharge at 1,000 mg/L for water quality and safety reasons regardless of the baseline conditions. Ideally, TSS concentration should be capped at 150 mg/L (Class III) during storm events. It is also important to note that baseline conditions may vary during the construction period thus changes to water quality should be constantly monitored.

In addition to the hotspots assessed, the impact from suspended solids will occur along the whole alignment during construction, especially during periods of rain. The severity will be lesser than that at the hotspots as these areas are farther from water bodies. However, sufficient control and mitigation should be put in place for these areas as per **Section 8.3.1**.

7.4.2 Water Pollution

The baseline monitoring results show that river water quality along the Project alignment falls mostly within Class III categories with some areas upstream at Class II and downstream areas at Class IV. Water pollution caused by the Project could affect the existing water quality of receiving waterbodies including rivers, irrigation canals and surrounding drainage especially where the alignment crosses. This can subsequently affect the beneficial uses located downstream of the Project alignment.

Construction site runoff from stations and alignment

During the construction phase, land clearing and earthwork activities are the main sources of water pollution. Sedimentation can occur in the receiving watercourses, and concentration of suspended solids in the waterways is likely to increase, especially during heavy rainfall events.

In general, surface runoff is the proportion of water that flows on the soil surface (as opposed to the proportion of water that infiltrates the soil) once the surface's maximum saturation or permeability levels have been reached. In construction sites, land that has been cleared and left exposed is more susceptible to surface runoff as there is no vegetation to intercept and shield the ground from direct rainfall. This results in higher raindrop impact and increased surface runoff flow, which carries sediments into receiving waterways and water bodies.

Sewage and sullage from workers' camp/ toilet facilities

The other potential water pollution issues that may arise during the construction phase is the sewage and sullage that will be generated from toilets established on-site and at workers' camps. Direct discharge of untreated sewage and sullage into the surrounding waters will lead to increased levels of nutrients and organic matter in receiving waterways. This will lead to decreased levels of dissolved oxygen (DO), and increase in biochemical oxygen demand (BOD), chemical oxygen demand (COD) and ammoniacal nitrogen (NH_3-N), which will result in water quality deterioration. In severe cases, eutrophication or anoxia is also a possibility.

Wastewater from tunneling works or batching plants

Wastewater generated will include slurry from tunneling works and cement slurry from the operation of batching plants, concrete washings and other grouting materials.

Improper discharge or spillage

Spillage and/or leakage of fuel, oils, lubricants, or scheduled wastes either through improper storage or improper maintenance of machinery/ equipment can cause oil & grease and chemical contamination of receiving waterways.

Soil contamination

When not properly handled and/or disposed, oil and hazardous waste could leach into the ground, causing soil contamination and risking the water table. Some of the potential sources of soil contamination include:

- Improper storage of oil and petroleum products/ scheduled waste.
- Leakage or accidental spillage of contaminated waste oil/ oil and petroleum products.
- Leachate originating from the waste dumped on site.

Construction work along the alignment, including at the stations, and maintenance base are prone to soil contamination. The major potential impacts would be contamination of groundwater that is used for water supply, especially in Kelantan (described in **Section 7.4.2.1**). Other impacts include surface water contamination in the event of heavy rainfall, whereby contaminated soil is carried and deposited in surrounding waterways.

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Table 7-46 : Potential Sources of Water Pollution, Receptors and Impacts

Source of Pollution	Potential Receptors	Potential Impacts
Construction site runoff Wastewater from tunnelling work/ batching plant	Irrigation canals and paddy fields (Kelantan)	Sediment runoff from earthworks and construction sites can cause siltation and clogging of irrigation canals, and reduction of the irrigation conveyance capacity of the irrigation canals of paddy fields. Sedimentation of the irrigation system will also lead to increased flooding due to the reduced capacity of canals and waterways. Sediment runoff from the work area will cause sediment transport in the water column as they move downstream. This will subsequently cause sediment deposition at the major rivers located downstream of the ECRL alignment.
	Aquaculture	High erosion and sedimentation rates due to surface runoff can eventually smother river beds and harm fish by clogging gills, reducing growth rates and lowering resistance to disease. Based on the literature, moderate to good aquaculture fisheries is possible in water containing 25 to 80 mg/L of total suspended solids (TSS), while TSS values of 80-100 mg/L and above do not support good fisheries.
	Water intake points for treated water supply	High sedimentation rate due to increased surface runoff can reduce the efficiency of water treatment operations that abstract raw water from the affected rivers. Although water with high TSS concentration can be treated by conventional water treatment system, this will incur higher cost and resources.
	Mangroves (Sg. Puloh)	Excess sediments in mangrove areas can cause suffocation and stress to the mangrove trees leading to mangrove degradation and loss of habitat.
	Recreational areas (Templer Park and Kanching Recreational Forest)	Sediments tend to remain suspended longer in moving waters as the settling rate is lower. These suspended particles result in increased turbidity in waterways for a long time after a rainfall event. Turbidity reduces the aesthetics and function of affected recreational waters.
Sewage and sullage discharge	Aquaculture	The evident impact will be on the aquaculture farming as sewage discharge can directly cause negative effects on farmed organisms. This includes clogging of gills of fish, excess mucus formation and the ammonia in sewage can be toxic to fish. Excess nutrients may lead to eutrophication or anoxia which causes stress and death to aquatic species.

Source of Pollution	Potential Receptors	Potential Impacts
	Recreational areas (Templer Park and Kanching Recreational Forest)	Water bodies with high levels of coliforms ammonia, contaminated with pathogenic microorganisms and bad odor will decrease the recreational value. The water quality required for recreational uses with body contact is Class IIB of the National Water Quality Standards (NWQS).
Improper discharge or spillage	Water intake point for Water Treatment Plant	Accidental spills/ leakages will introduce hazardous materials (such as oil & grease, hydrocarbons, solvents) into the nearest water bodies. Water supply intake points that are affected need to be temporarily shut down to prevent the intrusion of these hazards into the water treatment system. This will lead to water cuts and shortage of potable water supply to its intended supply areas.
	Aquaculture	Spillage, especially oil & grease and petroleum products, can cause damage to aquaculture resources by toxic effects. Catches and cultivated fish stock may become contaminated or tainted which affects their taste and safety for consumption. Oil spills can also foul up floating cages, kill fish stock, and cause socio-economic losses to the affected parties.
	Mangroves (Sg. Puloh)	Mangroves provide key habitat to various fauna including both terrestrial and aquatic species. It also serves as nursery areas for fish, shrimps, snails, and other invertebrates. Spillages of hazardous materials may cause both short- and long-term impacts such as death by toxicity, accumulation of toxins, and habitat degradation.
	Recreational areas (Templer Park and Kanching Recreational Forest)	Polluted river with high level of oil and grease as well as other spillage materials will decrease the aesthetic values and functionality of a recreational spot.
	Irrigation Canal and paddy field	Contaminated water supplied to paddy fields will affect the growth and yield of paddy.

7.4.3 Air Pollution

There are several sources of air emissions that could potentially affect the ambient air quality surrounding the Project site during the construction phase. These include:

- Fugitive dust including particulate matters less than 10 microns and 2.5 microns (PM_{10} and $PM_{2.5}$) generated from site clearing, earthworks, movement of vehicles over unpaved surfaces, tunneling activities, concrete batching, stockpiling and transport of friable materials, and laying of ballast; and
- Combustion of fuel by construction vehicles, equipment and generators. These combustion emissions consist of dust and gaseous emissions of PM_{10}, $PM_{2.5}$, carbon oxides (CO_x), nitrogen oxides (NO_x) and sulphur oxides (SO_X).

The main air quality impacts that may arise during construction are dust deposition resulting in soiling of surfaces, elevated particulate concentrations as a result of dust-generating activities and an increase in concentration of airborne particles and nitrogen dioxide to the surrounding environment.

An air quality assessment has been carried out to address the potential impacts in terms of air quality during construction stage. The assessment has focused on the potential dispersion of fugitive dust towards the air sensitive receptors (ASRs) during earthworks activities for the platform preparation of the stations as these are likely the main sources of emission during construction stage.

a. Assessment Method

The assessment is based on the methodology outlined in the *Guidance on the Assessment of Dust from Demolition and Construction Version 1.1* published by the Institute of Air Quality Management (IAQM) on year 2014. The steps involved in the assessment were as follows:

- **Step 1** – Screen for the need of a detailed assessment
- **Step 2** – Assess the risk of dust impacts

<u>**Step 1**</u>

According to the guidance document, the ASRs or 'human receptors' within 350 m of the boundary of the Project site are to be identified. Following the step, the screening exercise was carried out and it was found that all 4 areas which involve platform preparation for stations have been identified to have ASRs within 350 m distance. The 4 areas are 2 locations in Kelantan (Wakaf Bharu Station and Pengkalan

Kubor Station), and 2 locations in Selangor (Serendah Station and Jalan Kastam Station).

Table 7-47 and **Table 7-48** shows the summary of the screening part in Step 1. Details of the ASRs within 350 m distance from the Project site can be referred in **Table 7-49**. The risk of dust impact to the ASRs within these 4 areas was further assessed in Step 2. **Figure 7.4.3-1** to **Figure 7.4.3-4** shows the location of potential dust emission hotspots in Kelantan and Selangor.

Table 7-47 : Summary of the Air Sensitive Receptors (ASRs) Screening for Stations

No.	Name	Air Sensitive Receptors within 350 m	Proceed for Detailed Assessment
Kelantan			
1.	Wakaf Bharu Station	Yes	Yes
2.	Pengkalan Kubor Station	Yes	Yes
Selangor			
3.	Serendah Station	Yes	Yes
4.	Jalan Kastam Station	Yes	Yes
Total Number of Areas with ASRs within 350 m			**4**

Table 7-48: Summary of the Air Sensitive Receptors (ASRs) Screening for Railway Construction

No.	Name	Chainage	Air Sensitive Receptors within 350 m	Proceed for Detailed Assessment
Kelantan				
1.	EW-1	7500 - 8300	Yes	Yes
2.	EW-2	10300 - 10500	Yes	Yes
Selangor				
3.	EW-3	0-500	Yes	Yes
4.	EW-4	1400 - 1700	Yes	Yes
5.	EW-5	21400- 21700	Yes	Yes
6.	EW-6	23400 - 23700	Yes	Yes
7.	EW-7	24000 - 24200	Yes	Yes
8.	EW-8	36600 - 36900	Yes	Yes
9.	EW-9	63500 - 63900	Yes	Yes
10.	EW-10	69100 - 69200	Yes	Yes
11.	EW-11	76200-76700	Yes	Yes
12.	EW-12	77100 - 77500	Yes	Yes
Total Number of Areas with ASRs within 350 m				**12**

Table 7-49 : Air Sensitive Receptors (ASRs) within 350 m from the Project Site

Section	Areas	Air Sensitive Receptors (ASRs) within 350 m from boundary	
Kelantan	Wakaf Bharu Station	1. Kg. Lati 3. Kg. Kubang Batang 5. SMU(A) Mardziah Kubang Batang	2. Kg. Delima 4. Kg. Chondong Bata
	Pengkalan Kubor Station	6. Kg. Mentua	7. Kg. Serkong
	EW-1	8. Kg. Cherang 10. Kg. Kubang Panjang	9. Kg. Telok
	EW-2	11. Kg. Bendang	12. Kg. Talak
Selangor	Serendah Station	13. Taman Desa Kiambang 15. Laman Serendah	14. Taman Melati
	Jalan Kastam Station	16. Pangsapuri Seri Perantau 18. Kg. Sg. Sireh Tambahan 20. SRK Methodist Port Klang	17. Kg. Sg. Sireh 19. Kg. Kastam 21. Taman Raja Uda
	EW-3	22. Kg. Batu 12 Gombak 24. Hospital Orang Asli Gombak	23. Kg. Sungai Rumput
	EW-4	25. Kg. Batu 11 Gombak	
	EW-5	26. Bandar Baru Serendah	
	EW-6	27. Taman Melati	28. Laman Serendah
	EW-7	29. Taman Desa Kiambang	
	EW-8	30. M Residence	
	EW-9	31. Taman Jaya	32. Taman Kapar Setia
	EW-10	33. Kg. Sementa	
	EW-11	34. Kg. Delek	35. Kg. Sireh
	EW-12	36. Kg. Sg. Sireh Tambahan	37. Taman Sg. Sireh

Step 2

Step 2 involves the assessment of risk of dust impact to ASRs where there are 3 important sub-steps involved in this step as follows:

- **Step 2A** – Define of the potential of dust emission magnitude
- **Step 2B** – Define of the sensitivity of the area
- **Step 2C** – Define of the risks of impacts

a) Step 2A

In this step, the dust emission magnitude of the earthworks activities is classified at three scales i.e. small, medium or large. According to the guidance document, dust emission magnitude for earthworks can be defined as follows:

- **Large**: Total site area >10,000 m^2, potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes;

- **Medium**: Total site are 2,500 – 10,000 m², moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 – 8 m in height, total material moved 20,000 – 100,000 tonnes; and

- **Small**: Total site area <2,500 m², soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <20,000 tonnes, earthworks during wetter month.

It has been identified that the total area involved for the earthworks activities at all 4 stations (Wakaf Bharu Station, Pengkalan Kubor Station, Serendah Station and Jalan Kastam Station) is more than 10,000 m². Conservative soil type was assumed, i.e. dusty soil type. From the exercise, potential dust emission magnitude was identified to be large for all 4 stations.

Quantity of soil mass movement was used to classify the potential dust emission magnitude for earthworks activities for railway construction (EW-1 to EW-12). The emission magnitude varies from small (EW-7), medium (EW-2, EW-3, EW-4, EW-6, EW-9, EW-10 and EW-12) and large (EW-1, EW-5, EW-8 and EW-11).

The analysis of the potential dust emission magnitude for all 16 areas involving station platform preparation and railway construction is shown in **Table 7-50**.

Table 7-50 : Summary of the Potential Dust Emission Magnitude (Step 2A)

No	Name	Estimated Earthworks Area (m²)	Total Site Area (m²)	Estimated Soil Mass Movement (tonne)	Total Material Moved (tonne)	Potential Dust Emission Magnitude
Kelantan						
1.	Wakaf Bharu Station	236,118	>10,000	2,029,198	>100,000	Large
2.	Pengkalan Kubor Station	182,481	>10,000	1,533,692	>100,000	Large
3.	EW-1	37,265	>10,000	253,078	>100,000	Large
4.	EW-2	12,065	>10,000	93,948	20,000-100,000	Medium

Table 7-50 : Summary of the Potential Dust Emission Magnitude (Step 2A) (cont'd)

No	Name	Estimated Earthworks Area (m²)	Total Site Area (m²)	Estimated Soil Mass Movement (tonne)	Total Material Moved (tonne)	Potential Dust Emission Magnitude
Selangor						
5.	Serendah Station	206,506	>10,000	398,836	>100,000	Large
6.	Jalan Kastam Station	167,216	>10,000	368,098	>100,000	Large
7.	EW-3	20,468	>10,000	98,992	20,000-100,000	Medium
8.	EW-4	11,631	>10,000	57,529	20,000-100,000	Medium
9.	EW-5	24,949	>10,000	337,872	>100,000	Large
10.	EW-6	13,419	>10,000	79,325	20,000-100,000	Medium
11.	EW-7	3,109	2500-10,000	5,495	<20,000	Small
12.	EW-8	14,465	>10,000	106,423	>100,000	Large
13.	EW-9	16,784	>10,000	93,773	20,000-100,000	Medium
14.	EW-10	8,067	2500-10,000	60,050	20,000-100,000	Medium
15.	EW-11	26,739	>10,000	200,214	>100,000	Large
16.	EW-12	16,752	>10,000	95,029	20,000-100,000	Medium

b) Step 2B

In this step, the sensitivity of the ASRs to the health effects of PM_{10} is to be identified. Information of the existing land use described in **Section 6.5** has been used to classify the sensitivity of the ASRs within 350 m of the Project site whereby most of the ASRs are individuals from residential and school which are classified as high sensitivity receptor by the IAQM. The approximate number of receptors (>100, 10-100 and 1-10) was estimated using satellite imagery with judgement of 'a residential unit is one receptor' as recommended by the IAQM.

The sensitivity of the ASRs at each location within 20 m, 50 m, 100 m, 200 m and 350 m from the Project site was assessed by referring to a general matrix (**Table 7-51**).

Table 7-51 : General Matric to Evaluate the Sensitivity of Certain Area to Human Health Impacts

Receptor Sensitivity	PM_{10} Concentration (µg/m^3)*	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	Tier 1	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	Tier 2	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	Tier 3	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	Tier 4	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low

Note: * Concentration values for the respective area can be referred in Table 7-51

Instead of using the annual PM_{10} concentration range (identified as Tier 1 to Tier 4 in the **Table 7-51**) in the United Kingdom, the values have been localized and reclassified based on the 24-hour PM_{10} concentration range as tabulated in **Table 7-52**. The PM_{10} concentrations range (**Table 7-53)** was derived from the minimum and maximum 24-Hour PM_{10} concentration values for 7-years period (2009–2015) extracted from the Compendium of Environment Statistics Reports by the Department of Statistics (DOS) as shown in **Table 7-53**.

Table 7-52 : Reclassified 24-Hour PM_{10} Concentrations Range (µg/m^3) for Kelantan and Selangor

Tier	Kelantan	Selangor
1	>81	>132
2	52-81	80-132
3	23-52	28-80
4	<23	<28

Table 7-53 : Summary of the 24-Hour PM_{10} Concentrations (µg/m^3) from 2009 to 2015 for Kelantan and Selangor

Station	2009		2010		2011		2012		2013		2014		2015		7- Year	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Kota Bharu	36	55	37	46	36	56	28	60	33	54	23	55	44	81	23	81
Kelantan															**23**	**81**
Batu Muda	33	70	32	50	31	66	31	66	28	83	36	82	30	132	28	132
Klang	46	97	52	69	43	82	48	98	45	122	47	138	49	162	43	162
Selangor															**43**	**162**

Source: Compendium of Environment Statistics Reports by the DOS

With reference to the **Table 7-51**, **Table 7-52** and baseline ambient air quality monitoring result (**Section 6**), the sensitivity of the human health towards the fugitive dust generated from the earthworks activities was evaluated (**Table 7-54**). From the evaluation, it was observed that ASRs located within less than 20 m from Jalan Kastam Station, EW-11 and EW-12 is classified as a high sensitive area. This location is dense with residential apartments and villages namely Pangsapuri Seri Perantau located north to the Jalan Kastam Station.

c) Step 2C

The risks of fugitive dust impacts (PM_{10}) with no mitigation applied during earthworks to the health of the ASRs is determined in this step by combining the dust emission magnitude with the sensitivity of the areas as determined in Step 2A and Step 2B respectively. From the assessment (**Table 7-55**), it can be deduced that the risk of fugitive dust impacts during earthworks would be much more critical at the distance of less than 20 m.

Impact for the earthworks activities in Selangor for Jalan Kastam Station, EW-11 and EW-12 is classified as high risk or area with high chance for the fugitive dust to affect the health of the people living within less than 20 m from the Project site. Risk of impacts at areas farther away from the Project site (100 - 350 m) would be low or defined as minor impact.

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Table 7-54 : Summary of the Sensitivity of the Areas to Human Health Impacts (Step 2B)

No.	Name	Receptor Sensitivity	24-Hr Average PM_{10} Concentration (µg/m³)#	Tier	Number of Receptors	Distance from the Source (m)				
						<20	<50	<100	<200	<350
Kelantan										
1.	Wakaf Bharu Station	High	36	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	Low	Low	-
					1-10	Medium	Low	-	-	-
2.	Pengkalan Kubor Station	High	43	Tier 3	>100	-	-	-	-	-
					10-100	-	-	-	-	Low
					1-10	Medium	Low	Low	Low	-
3.	EW-1	High	42	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	Low	Low	-
					1-10	-	Low	-	-	-
4.	EW-2	High	42	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	Low	Low	-
					1-10	-	Low	-	-	-
Selangor										
5.	Serendah Station	High	62	Tier 3	>100	-	-	-	-	-
					10-100	-	-	Low	Low	Low
					1-10	Medium	Low	-	-	-
6.	Jalan Kastam Station	High	36	Tier 3	>100	-	Medium	Low	Low	Low
					10-100	High	-	-	-	-
					1-10	-	-	-	-	-
7.	EW-3	High	36	Tier 3	>100	-	-	-	Low	Low
					10-100	-	-	Low	-	-
					1-10	-	-	-	-	-
8.	EW-4	High	36	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	Low	Low	-
					1-10	-	-	-	-	-
9.	EW-5	High	62	Tier 3	>100	-	-	-	-	-
					10-100	-	-	-	Low	Low
					1-10	-	-	Low	-	-

No.	Name	Receptor Sensitivity	24-Hr Average PM_{10} Concentration ($\mu g/m^3$)#	Tier	Number of Receptors	Distance from the Source (m)				
						<20	<50	<100	<200	<350
10.	EW-6	High	62	Tier 3	>100	-	-	-	Low	Low
					10-100	-	-	Low	-	-
					1-10	-	Low	-	-	-
11.	EW-7	High	62	Tier 3	>100	-	-	-	-	Low
					10-100	-	Medium	Low	Low	-
					1-10	Medium	-	-	-	-
12.	EW-8	High	46	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	-	Low	-
					1-10	-	-	Low	-	-
13.	EW-9	High	53	Tier 3	>100	-	-	-	Low	Low
					10-100	-	-	-	-	-
					1-10	-	-	-	-	-
14.	EW-10	High	38	Tier 3	>100	-	-	-	-	Low
					10-100	-	-	-	Low	-
					1-10	-	-	Low	-	-
15.	EW-11	High	36	Tier 3	>100	-	-	Low	Low	Low
					10-100	High	Medium	-	-	-
					1-10	-	-	-	-	-
16.	EW-12	High	36	Tier 3	>100	-	-	Low	Low	Low
					10-100	High	Medium	-	-	-
					1-10	-	-	-	-	-

Notes:

 # PM_{10} values were referred from the baseline ambient air quality monitoring in Section 6

means the result of sensitivity of the area

- means not applicable as there are no air sensitive receptors found within the respective distance

Table 7-55 : Risk of Fugitive Dust Impacts during Earthworks (Step 2C)

No.	Name	Step 2A	Step 2B					Step 2C				
		Potential Dust Emission Magnitude	Sensitivity of the Areas					Risks of Impacts				
			<20 m	<50 m	<100 m	<200 m	<350 m	<20 m	<50 m	<100 m	<200 m	<350 m
Kelantan												
1.	Wakaf Bharu Station	Large	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low
2.	Pengkalan Kubor Station	Large	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low
3.	EW-1	Large	-	Low	Low	Low	Low	-	Low	Low	Low	Low
4.	EW-2	Medium	-	Low	Low	Low	Low	-	Low	Low	Low	Low
Selangor												
5.	Serendah Station	Large	Medium	Low	Low	Low	Low	Medium	Low	Low	Low	Low
6.	Jalan Kastam Station	Large	High	Medium	Low	Low	Low	High	Medium	Low	Low	Low
7.	EW-3	Medium	-	-	Low	Low	Low	-	-	Low	Low	Low
8.	EW-4	Medium	-	-	Low	Low	Low	-	-	Low	Low	Low
9.	EW-5	Large	-	-	Low	Low	Low	-	-	Low	Low	Low
10.	EW-6	Medium	-	Low	Low	Low	Low	-	Low	Low	Low	Low
11.	EW-7	Small	Medium	Medium	Low	Low	Low	Low	Low	Negligible	Negligible	Negligible
12.	EW-8	Large	-	-	Low	Low	Low	-	-	Low	Low	Low
13.	EW-9	Medium	-	-	-	Low	Low	-	-	-	Low	Low
14.	EW-10	Medium	-	-	Low	Low	Low	-	-	Low	Low	Low
15.	EW-11	Large	High	Medium	Low	Low	Low	High	Medium	Low	Low	Low
16.	EW-12	Medium	High	Medium	Low	Low	Low	Medium	Medium	Low	Low	Low

Note:

- means not applicable as there are no air sensitive receptors found within the respective distance

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7.4.3.1 Segment 1: Kelantan

a. Assessment Results

Based on the air quality assessment carried out (**Table 7-55**), the earthwork activities at Wakaf Bharu Station and Pengkalan Kubor Station poses medium risk potential to cause fugitive dust impact towards the ASRs <20 m. The ASRs within 20 - 350 m of Wakaf Bharu Station and Pengkalan Kubor Station are assessed to have low potential risk to cause dust impact during earthwork.

The remaining portion of Kelantan alignment involved in earthwork activities has been assessed to have low risks potential to cause fugitive dust impact towards ASR within 20 - 350 m.

7.4.3.2 Segment 2: Selangor

a. Assessment Results

The earthwork activities at Jalan Kastam Station and EW-11 was assessed to have high risk potential of dust impact to the ASRs <20 m. For ASRs located within 20 – 350 m of Jalan Kastam Station, the earthwork activities pose medium to low risk potential of dust impact. The high population density results in greater susceptibility of dust impact to residents living in this area.

The earthwork activities at Serendah Station and EW-12 poses medium risk potential to cause fugitive dust impact towards the ASRs <20 m. For ASRs located within 20 – 350 m of Serendah Station and EW-12, the earthwork activities pose low risk potential of dust impact. For EW-3 to EW-10, all ASRs located within 350 m of these areas are anticipated to experience low risk or negligible potential of fugitive dust impact.

7.4.3.3 Summary

Air quality assessment has been carried out to identify the risk of dust impact for the earthworks activities during construction stage. From the assessment, it was assessed and identified that the earthworks activities at Jalan Kastam Station and EW-11 (Chainage 76200-76700, near to Kg. Delek and Kg. Sireh) located in Selangor has higher risk which has the potential to cause fugitive dust impact to the ASRs. The fugitive dust impact during construction will not cause residual impact as it will be occurred temporary during construction period.

Nevertheless, the risk to cause the dust impact can be further reduced and managed through effective and proper air quality control. The proposed mitigation controls can be referred to **Section 8.3.3**.

7.4.4 Noise

a. Assessment Method

Noise impacts from the construction works are anticipated at the following locations:

- Stations
- Railway tracks along alignment
- Tunnel works

Noise generation during construction stage is anticipated from earth moving equipment (dozers, tractors), heavy vehicles (lorries), diesel generator sets and piling works. At the tunnel sections, there is also anticipated to be blasting works.

Equipment and vehicles noise sources are mobile, and the noise generated is usually transient in nature. The only exception to this are diesel generator sets which may be in continuous operations. The noise sources are however localized to specific locations where they are used.

Noise generated from construction activities is usually perceived by most residents as intrusive in nature (as compared to an adjacent industrial facility or even existing road traffic) due to the situation where the construction noise is a new noise source (disturbance) introduced into an existing community.

Construction of piers supporting the elevated section of the Project is anticipated to require piling. Piling vibrations and noise represent potential areas of concern as confirmed from past experiences of construction works within residential communities.

Construction works are progressive in linear segments along the entire alignment. It is therefore inevitable that there are issues of concern for noise and vibration affecting residential receivers near the alignment.

Noise from construction activities shall comply with recommended noise limits as stipulated in DOE's Guidelines for Environmental Noise Limits and Control (2007), Annex A, Schedule 6 (**Table 7-56**). Due to the fluctuating nature of construction noise, limits are prescribed for a continuous equivalent noise level and a maximum threshold (defined by the instantaneous maximum L_{max}). The L_{max} limit typically applies to piling and other transient peaks.

Table 7-56 : Maximum Permissible Sound Level of Construction, Maintenance and Demolition Works By Receiving Land Use

Receiving Land Use	Noise Parameter	Day Time 7.00 am - 7.00 pm	Evening 7.00 pm - 10.00 pm	Night Time 10.00 pm - 7.00 am
Residential	L_{max}	90 dBA	85 dBA	
*(Note 2 **)*	L_{10}	75 dBA	70 dBA	*(Note 1*)*
	L_{90}	60 dBA	55 dBA	*(Note 1*)*
Commercial	L_{10}	75 dBA	70 dBA	NA
*(Note 2 **)*	L_{90}	65 dBA	60 dBA	NA
Industrial	L_{10}	80 dBA	NA	NA
	L_{90}	70 dBA	NA	NA

*Note *1: At these times the maximum permissible levels as stipulated in the Schedule 1 for the respective residential density type shall apply. This may mean that no noisy construction work can take place during these hours.*

***Note 2: A reduction of these levels near certain institutions such as schools, hospitals mosque and noise sensitive premises (apartments, residential dwellings, hotel) may be exercised by the Local Authority or Department of Environment.*

Source: DOE Planning Guidelines for Environmental Noise Limits and Control 2007

Table 7-57 tabulates typical sound power levels for construction equipment. The equipment typically has sound power levels above 100 dBA. Depending on proximity of the construction sites and activities noise emitted to the adjacent receiver could range from L_{10} of 65 dBA to 80 dBA. The L_{90} levels are usually dependent on other noise sources prevalent at the receiver. Piling noise from impact drop hammers could result in noise levels approaching or even exceeding the above recommended L_{max} levels.

Table 7-57 : Typical Sound Power Levels for Typical Construction Equipment

Equipment	Typical Sound Power Level (dBA)
Hydraulic Breaker	122
Bulldozer	115
Typical Lorry	110
Concrete Mixing Truck	109
Bore Piling Activities	100
Generator with Minimal Enclosure	100
Cutting and Grinding Equipment	98

Source: BS 5228-1:2009+A1:2014 Code of practice for noise and vibration control on construction and open sites. Part 1: Noise

Diesel generator sets are often the highest continuous noise source in construction sets (and with diesel exhaust pollution affecting air quality on site).

Piling where undertaken in residential areas represent a major noise source. Piling instantaneous noise from could potentially exceed 95 dBA for impact drop piles. The use of low noise piling methods is required to ensure minimal impact to the neighbors in noise sensitive land use. Compliance to the maximum permissible noise limits for construction at residential land use, and the L_{max} levels shall require the use of bored piles or injection piles. It is also necessary to restrict piling activities to day time only (and to include restrictions during weekends and public holidays).

Other potential noise sources are from heavy vehicles and earth moving equipment. Noise disturbance from these vehicles and equipment are anticipated and should be mitigated from administrative control to minimize the impact. Vehicles transporting construction materials should be arranged for arrival at site during off peak hours' day time hours, and to avoid night time hours.

Noise propagation and potential disturbance from construction from piling are anticipated to occur at Stations where located near residential areas. Noise modelling were undertaken to demonstrate the extent of noise propagation (without and with mitigation) at certain stretch of the alignment or at the station where the sensitive receptors are located.

Noise propagation was conducted for the three scenarios for each segment; work site without mitigation (no hoarding) with mitigation (4m temporary hoarding) and with improved mitigation (8m temporary hoarding).

7.4.4.1 Segment 1 : Kelantan

a. Assessment Results

Noise modelling was undertaken for the Wakaf Bharu Station in Kelantan, amidst a relatively less urban environment. **Chart 7-4** shows 3-D noise model of the work site without mitigation (no hoarding), and the resulting noise propagation map shown in **Chart 7-5.**

Chart 7-4 : Noise Model of Work Site at Wakaf Bharu Station without mitigation

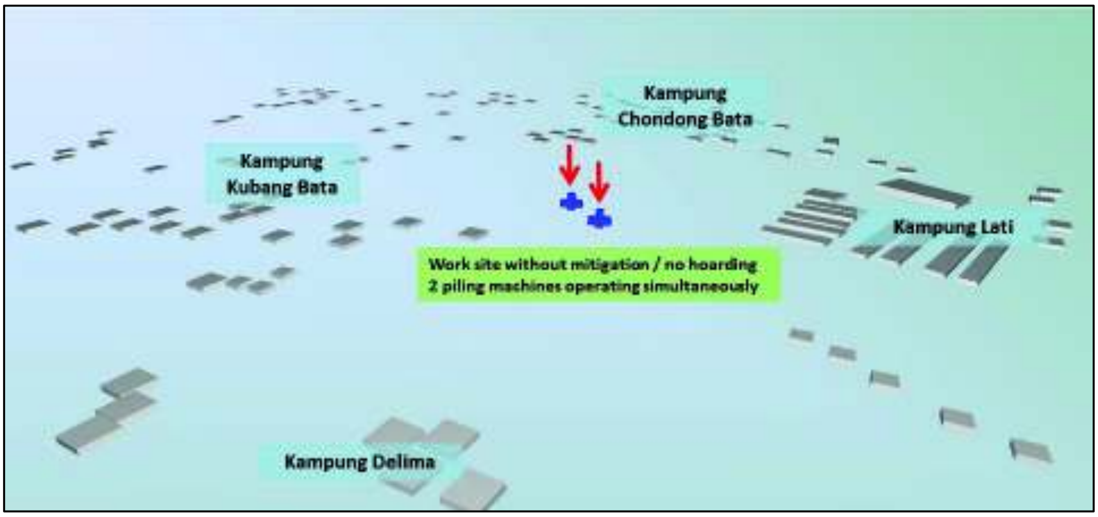


Chart 7-5 : Noise Propagation from Piling at Wakaf Bharu Station without Mitigation

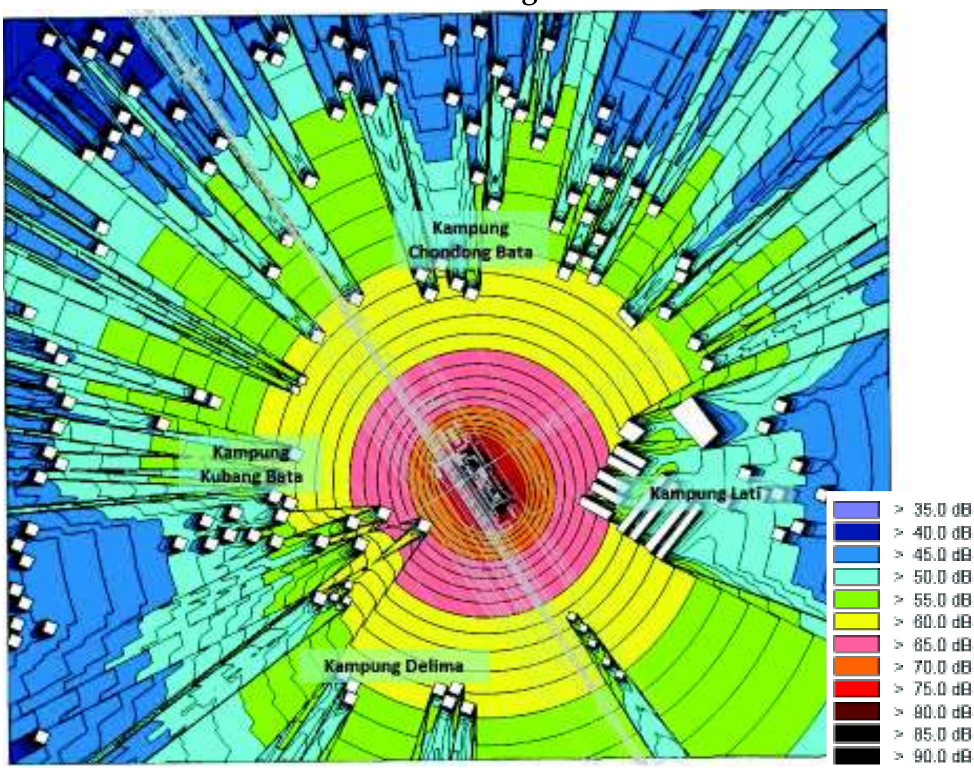


Chart 7-6 : Noise Model of Work Site at Wakaf Bharu Station with 4m hoarding

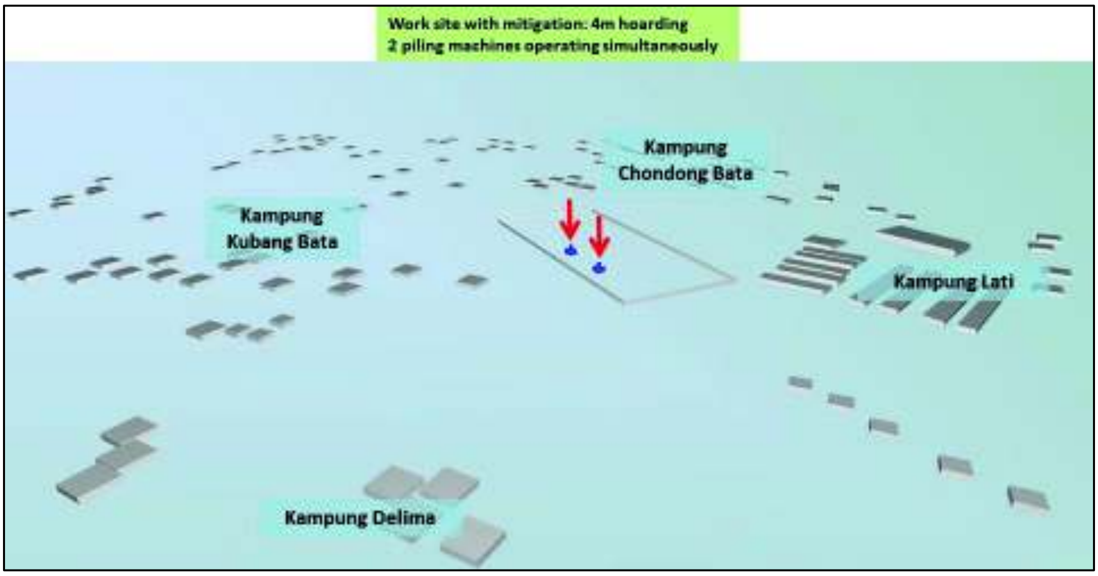


Chart 7-7 : Noise Propagation from Piling at Wakaf Bharu Station with 4m hoarding

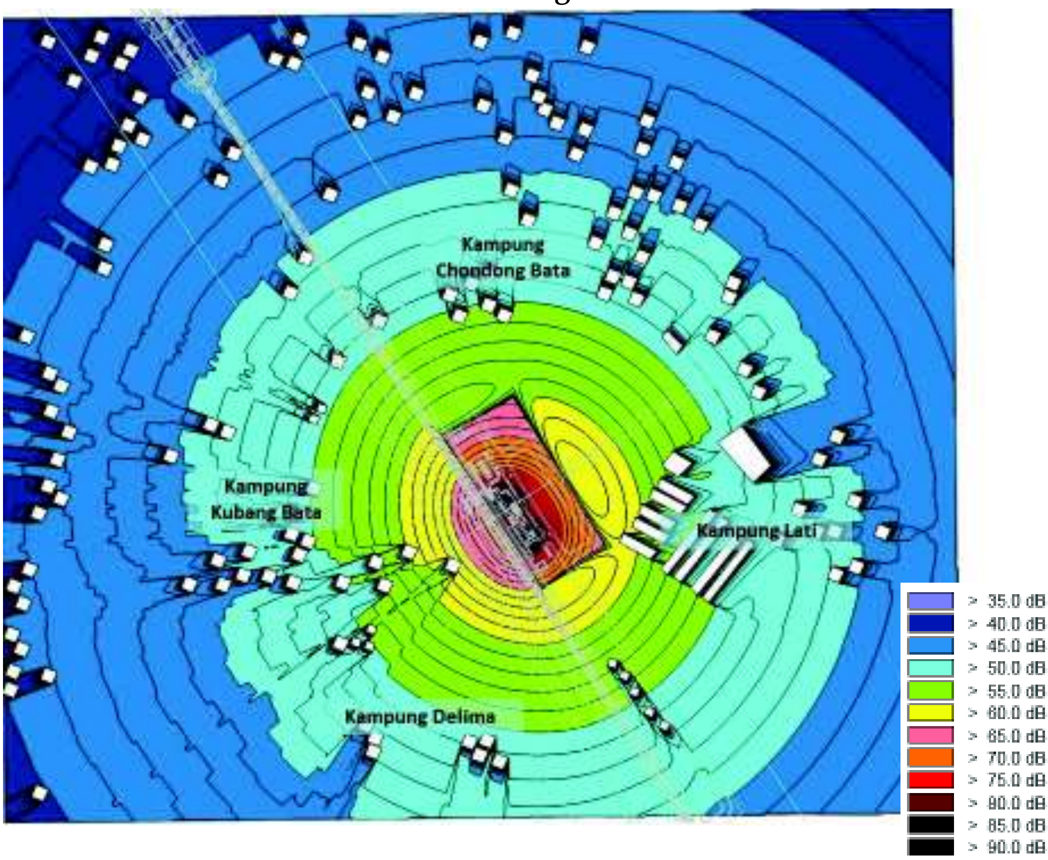


Chart 7-8 : Noise Model of Work Site at Wakaf Bharu Station with 8m hoarding

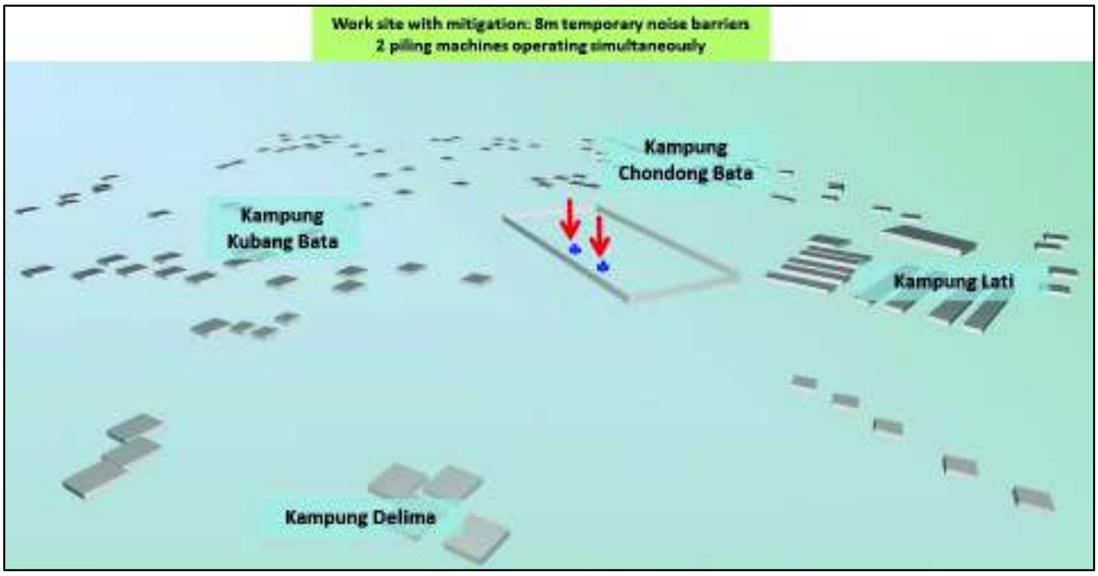
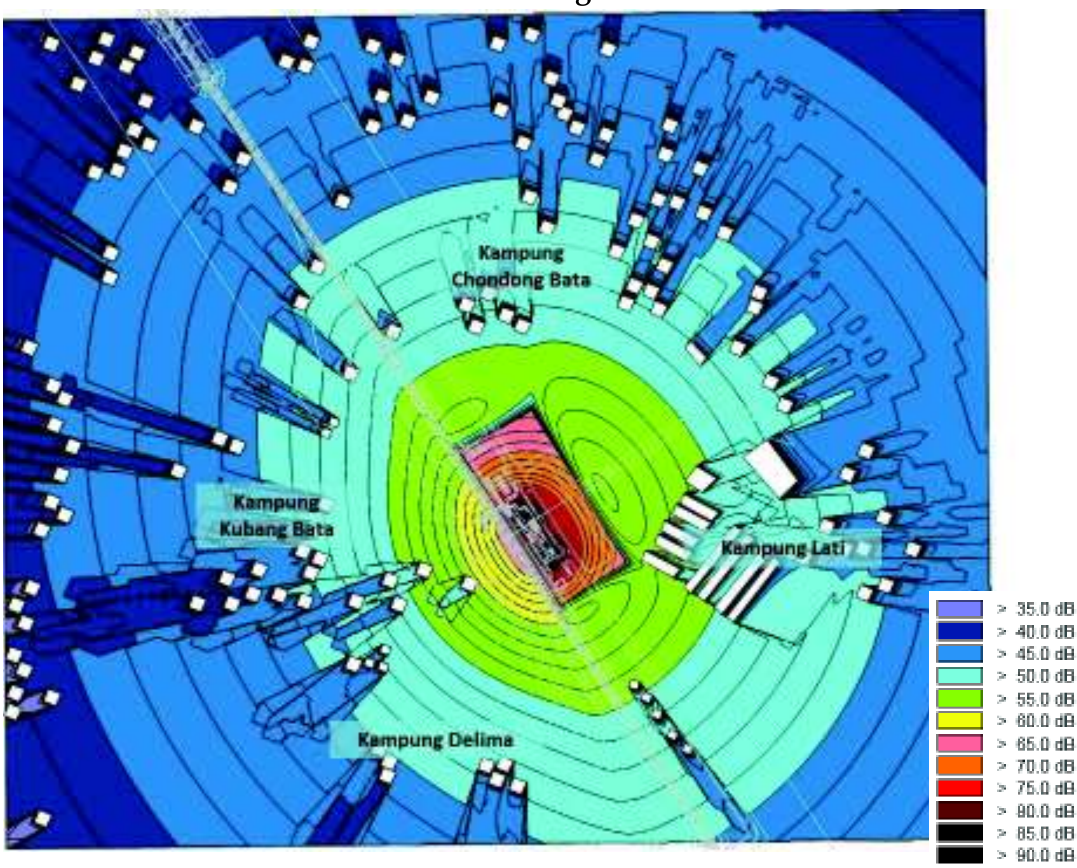


Chart 7-9 : Noise Propagation from Piling at Wakaf Bharu Station with 8m hoarding



7.4.4.2 Segment 2 : Selangor

a. Assessment Results

Chart 7-10 shows 3-D noise model of the column work site without mitigation (no hoarding) located amongst the residential areas Taman Jasa Utama, Taman Jasa Perwira, Mawar and Teratai Apartment, and Lakeview Apartment. Noise propagation to the nearby receptors in the above residential areas are shown in **Chart 7-11. Chart 7-12** shows noise model with mitigation (4m piling shroud) with the resulting noise propagation shown in **Chart 7-13**. An additional noise model with improved mitigation (8m temporary noise barrier) and the corresponding noise propagation shown in **Chart 7-14** and **Chart 7-15**.

Chart 7-10 : Noise Model of Work Site at Taman Jasa Utama without mitigation

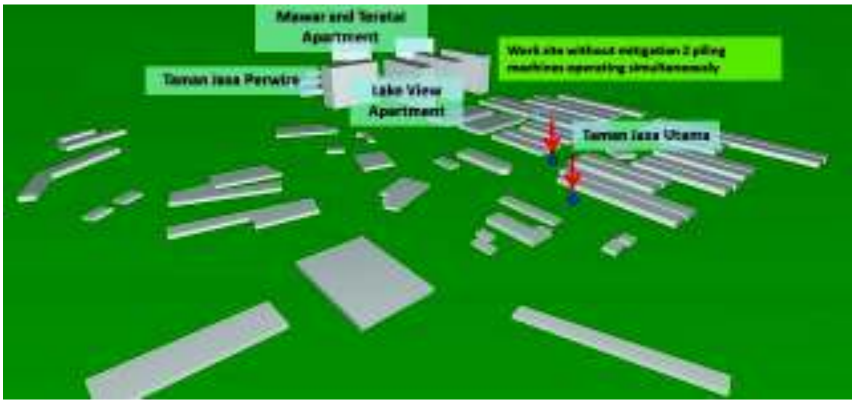


Chart 7-11 : Noise Propagation from Piling at Taman Jasa Utama without Mitigation

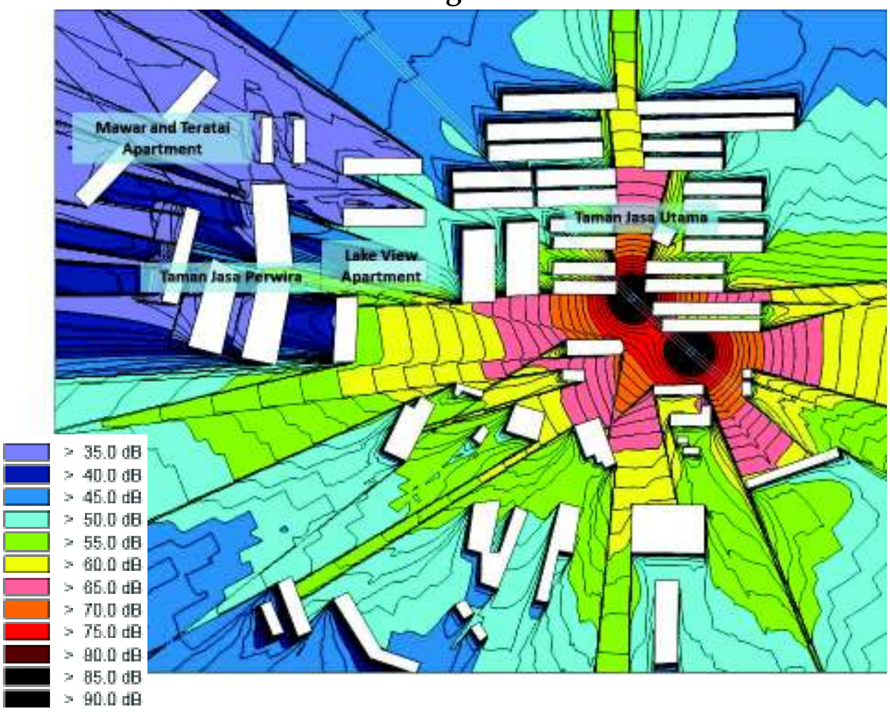


Chart 7-12 : Noise Model of Work Site at Taman Jasa Utama with 4m piling shroud

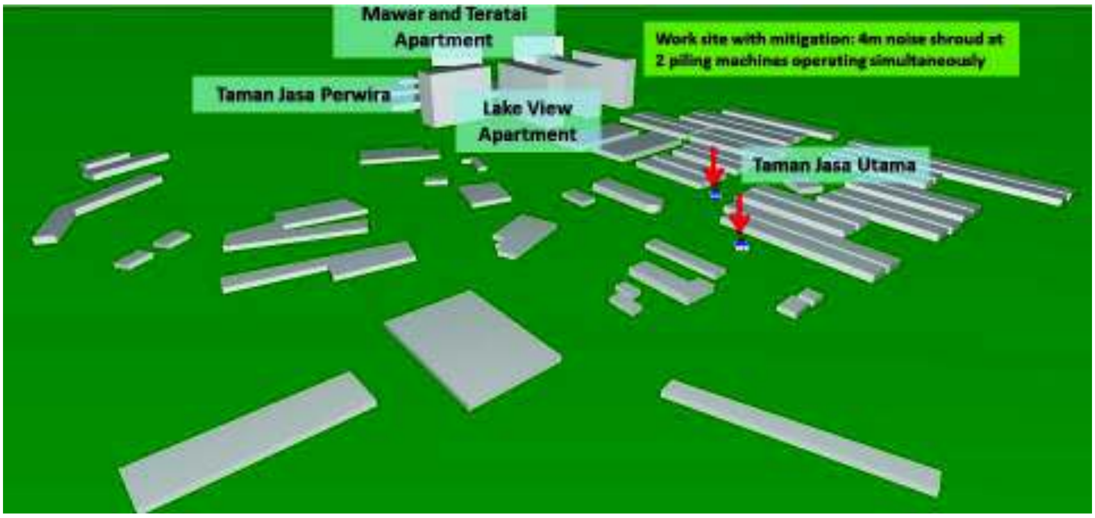


Chart 7-13 : Noise Propagation from Piling at Taman Jasa Utama with 4m piling shroud

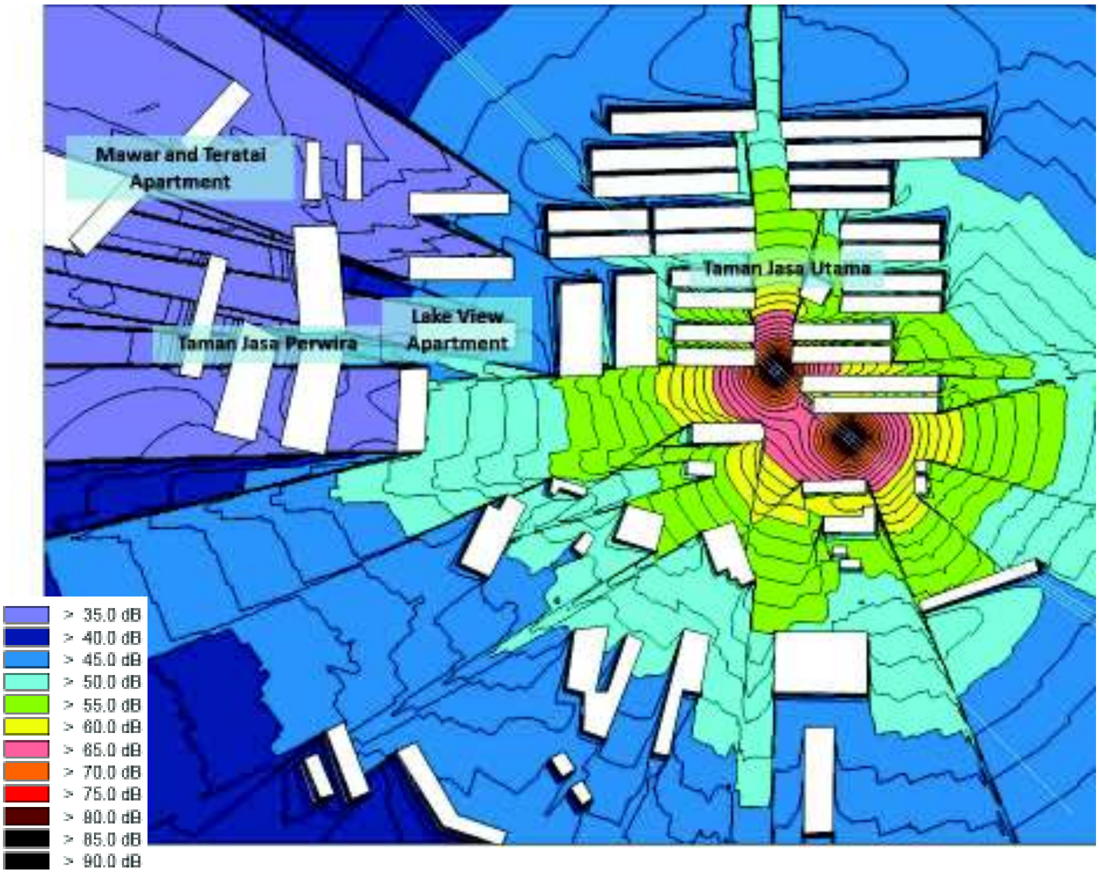


Chart 7-14 : Noise Model of Work Site at Taman Jasa Utama with 8m piling shroud

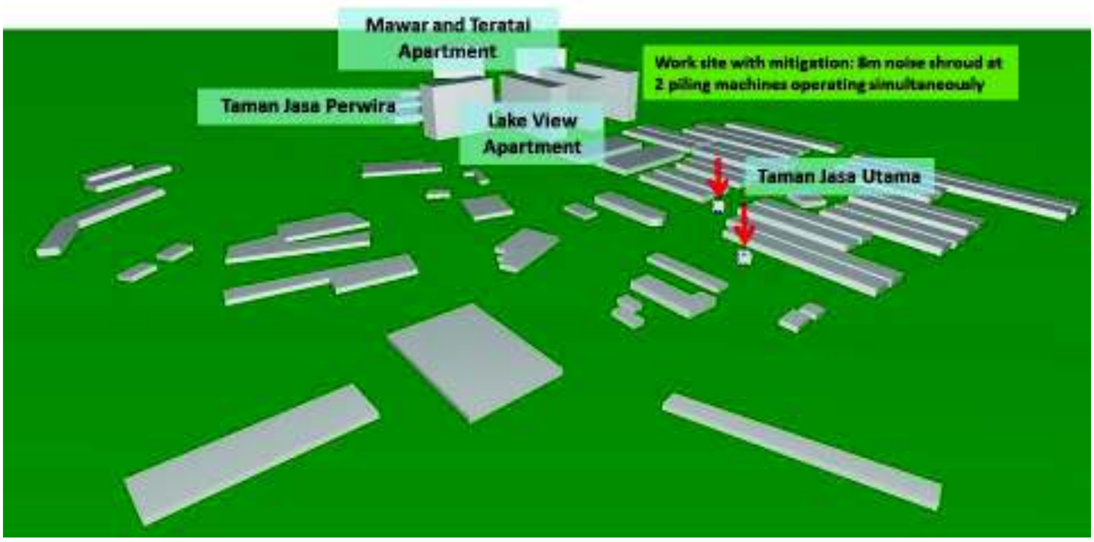
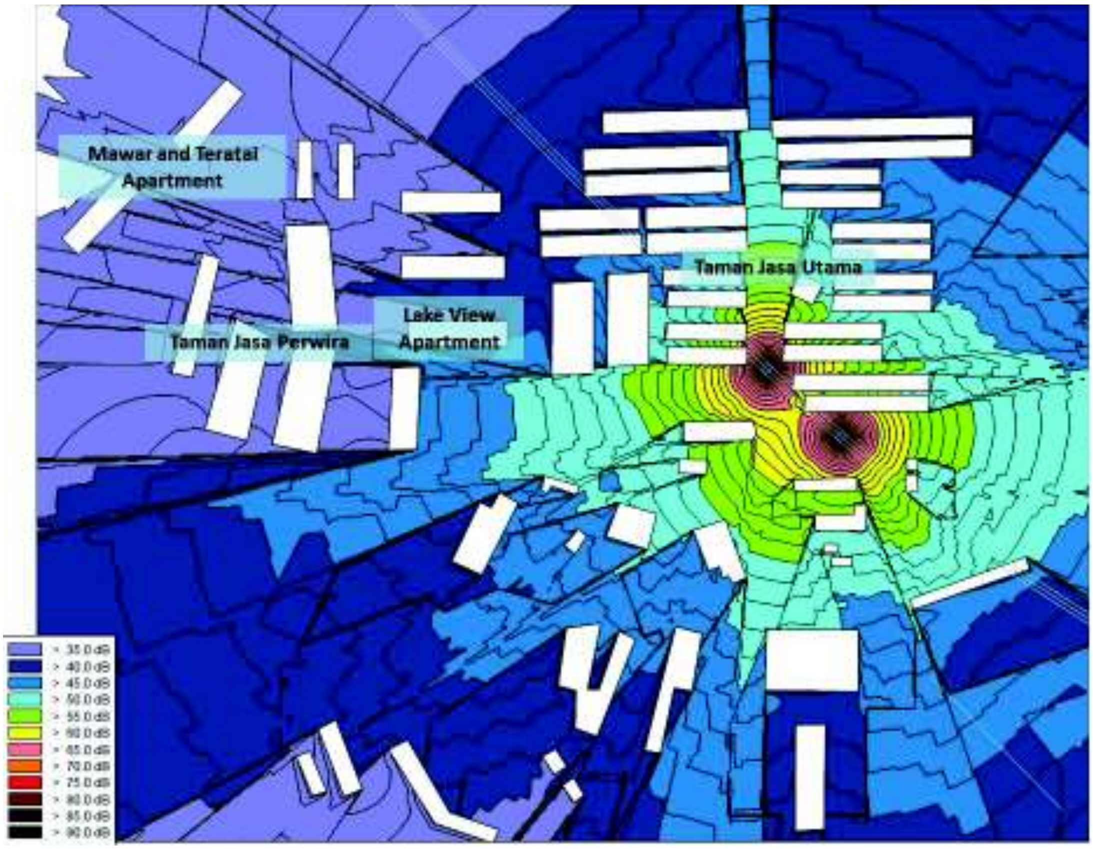


Chart 7-15 : Noise Propagation from Piling at Taman Jasa Utama with 8m piling shroud



Segment 2B: Serendah to Bandar Puncak Alam

Chart 7-16 shows 3-D noise model of the work site without mitigation (no hoarding) at Serendah located amongst the residential areas Taman Desa Kiambang and Taman Melati. Noise propagation to the nearby receptors in the above residential areas are shown in **Chart 7-17. Chart 7-28** shows noise model with mitigation (4m piling shroud) with the resulting noise propagation shown in **Chart 7-29**. An additional noise model with improved mitigation (8m temporary noise barrier) and the corresponding noise propagation shown in **Chart 7-20** and **Chart 7-21**.

Chart 7-16 : Noise Model of Work Site at Serendah Station without mitigation

Chart 7-17 : Noise Propagation from Piling at Serendah Station without Mitigation

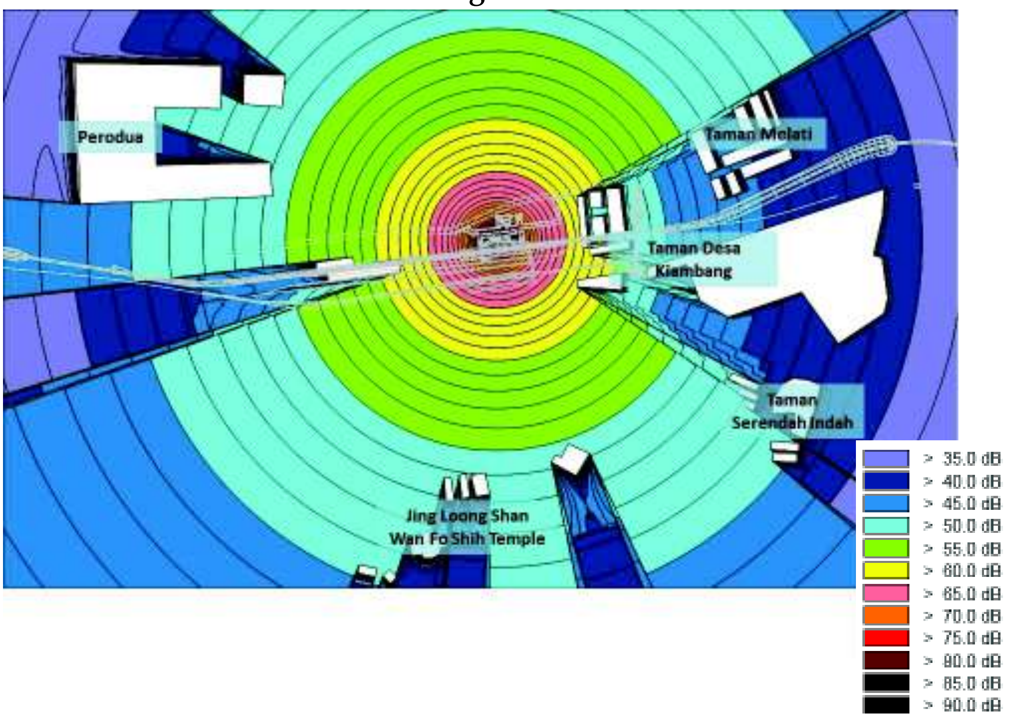


Chart 7-18 : Noise Model of Work Site at Serendah Station with 4m hoarding

Chart 7-19 : Noise Propagation from Piling at Serendah Station with 4m hoarding

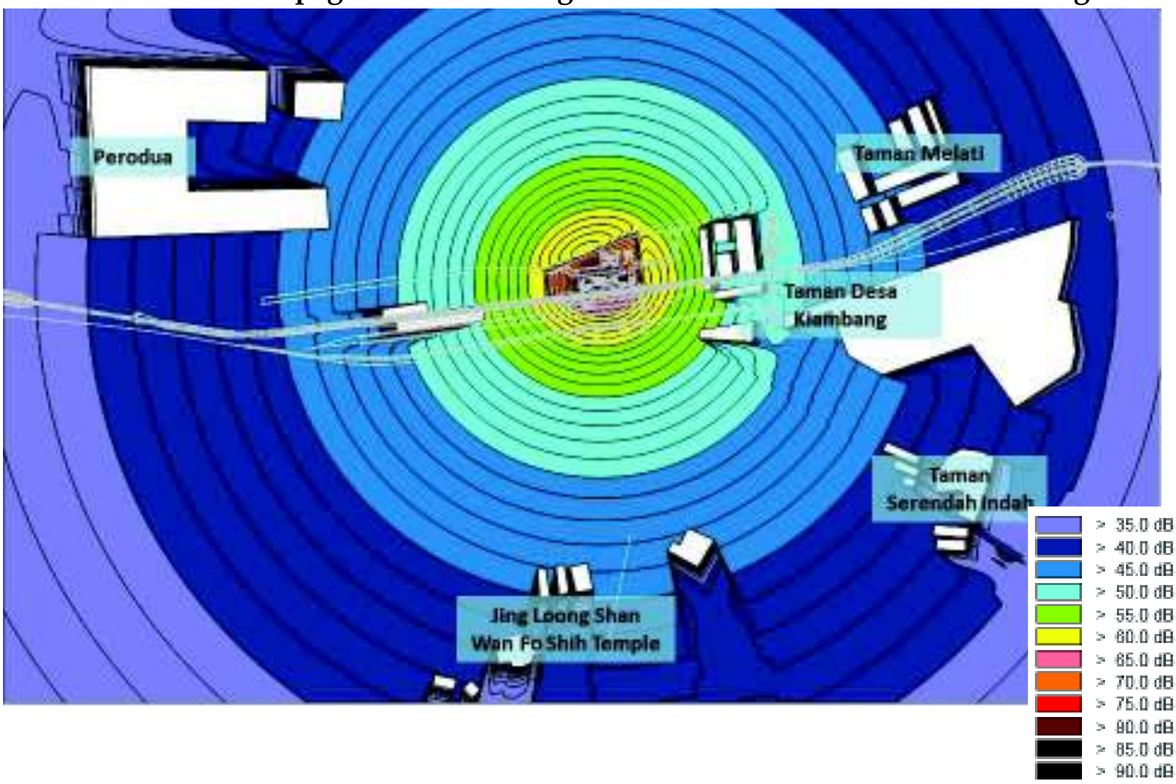


Chart 7-20 : Noise Model of Work Site at Serendah Station with 8m hoarding

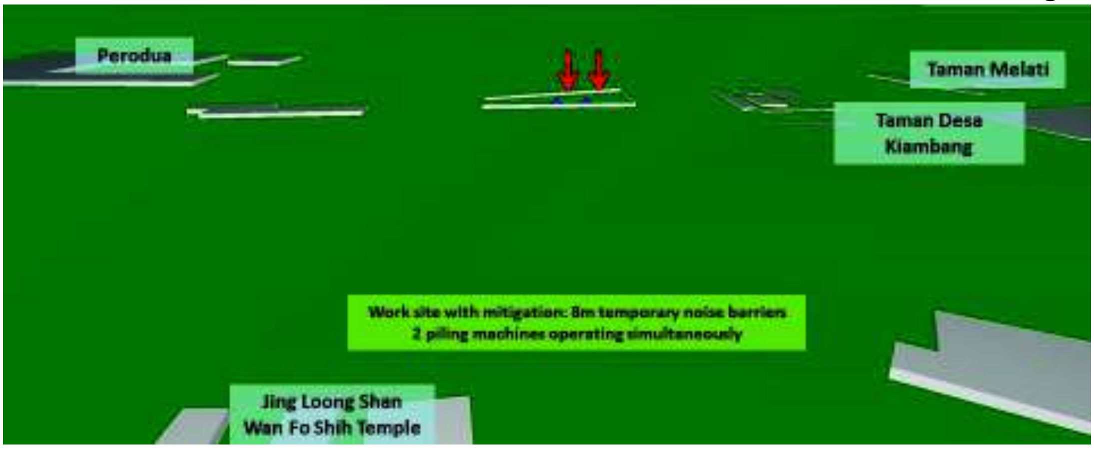
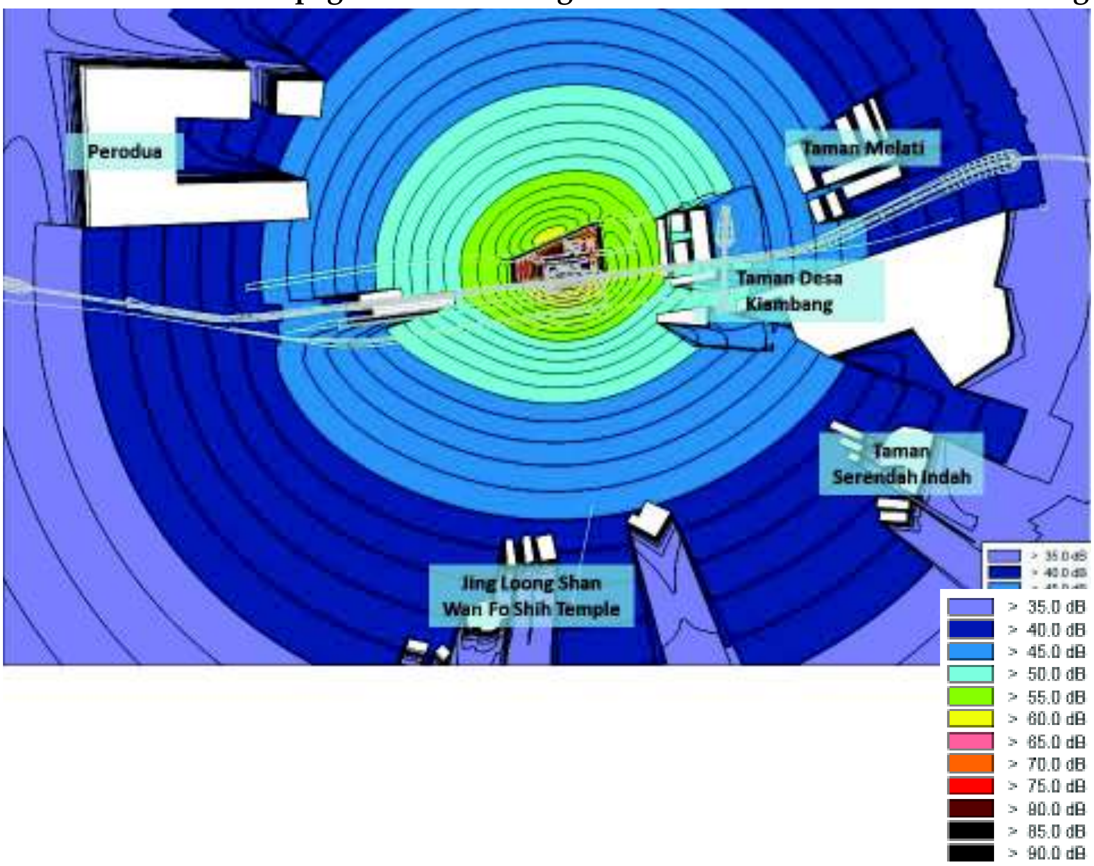


Chart 7-21 : Noise Propagation from Piling at Serendah Station with 8m hoarding



Segment 2C: Bandar Puncak Alam to Port Klang

Chart 7-22 shows 3-D noise model of the work site without mitigation (no hoarding) at Port Klang located amongst the residential areas Kampung Keretapi, Kampung Kastam, Seri Perantau Apartment, Taman Raja Uda and Kampung Raja Uda. Noise propagation to the nearby receptors in the above residential areas are shown in **Chart 7-23**. **Chart 7-24** shows noise model with mitigation (4m piling shroud) with the resulting noise propagation shown in **Chart 7-25**. An additional noise model with improved mitigation (8m temporary noise barrier) and the corresponding noise propagation shown in **Chart 7-26** and **Chart 7-27**.

Chart 7-22 : Noise Model of Work Site at Port Klang Station without mitigation

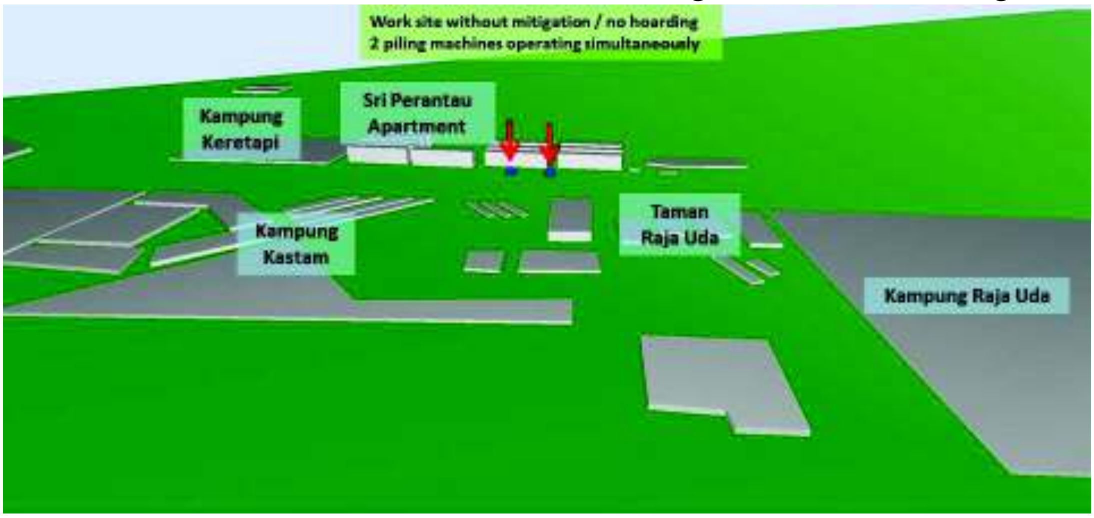


Chart 7-23 : Noise Propagation from Piling at Port Klang Station without Mitigation

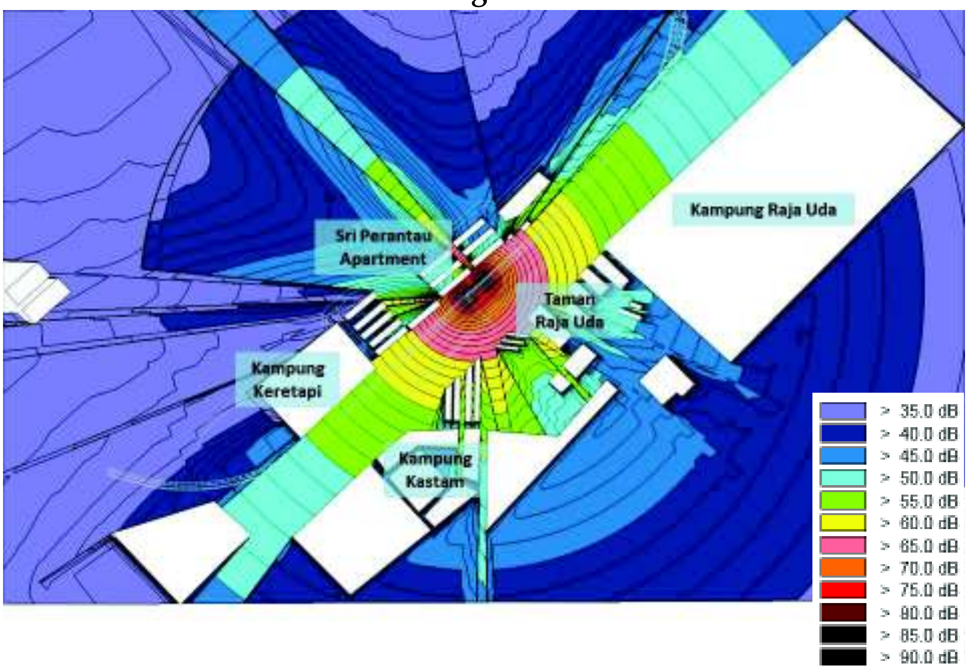


Chart 7-24 : Noise Model of Work Site at Port Klang Station with 4m hoarding

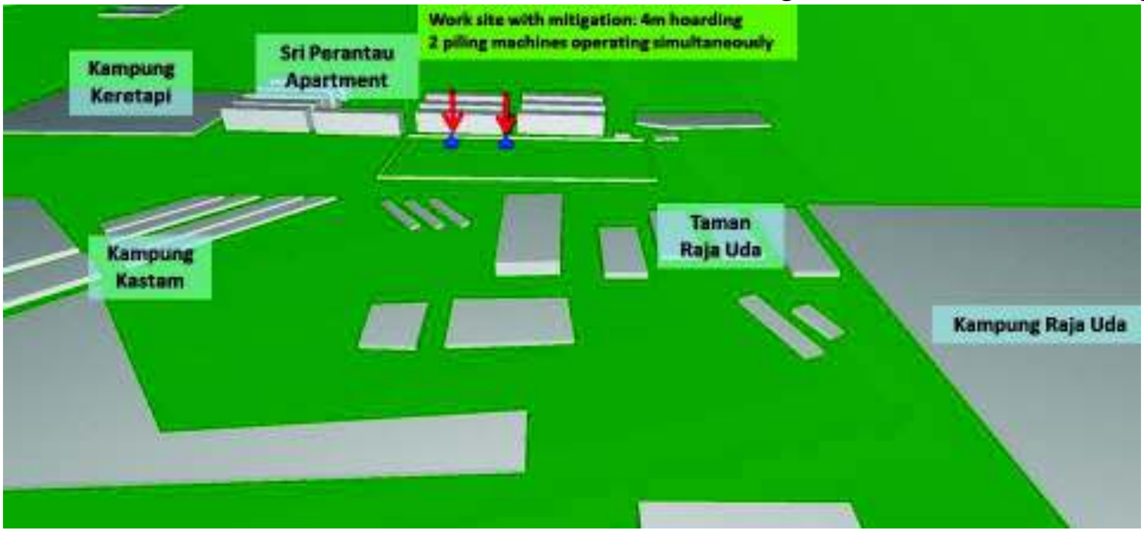


Chart 7-25 : Noise Propagation from Piling at Port Klang Station with 4m hoarding

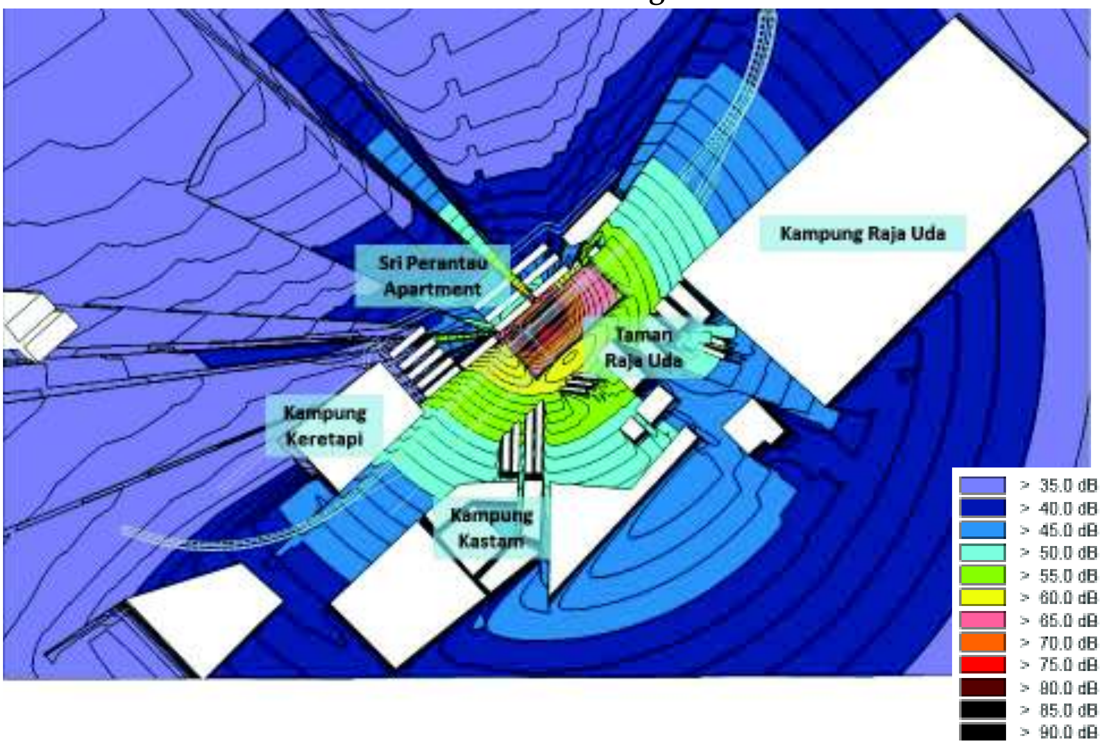


Chart 7-26 : Noise Model of Work Site at Port Klang Station with 8m hoarding

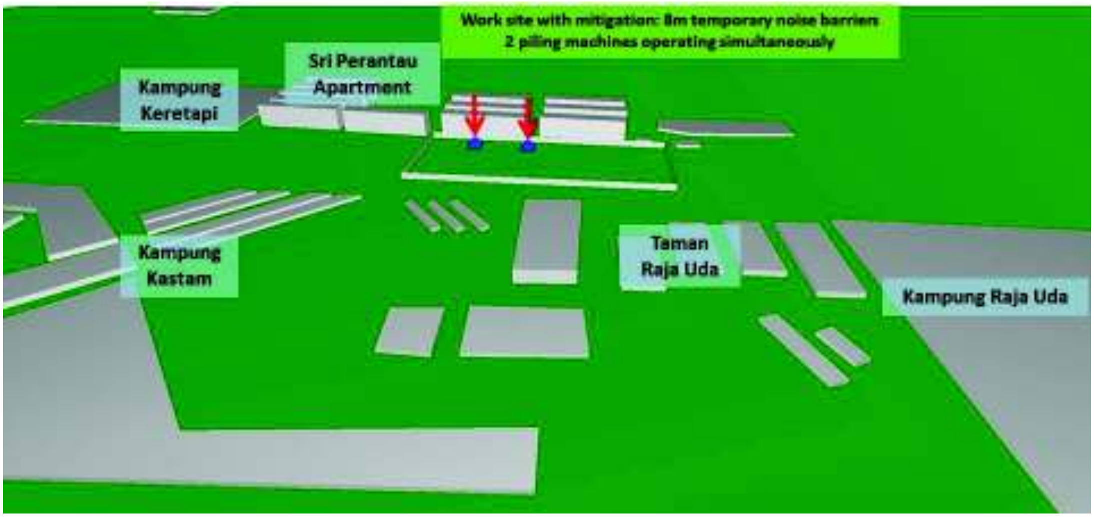
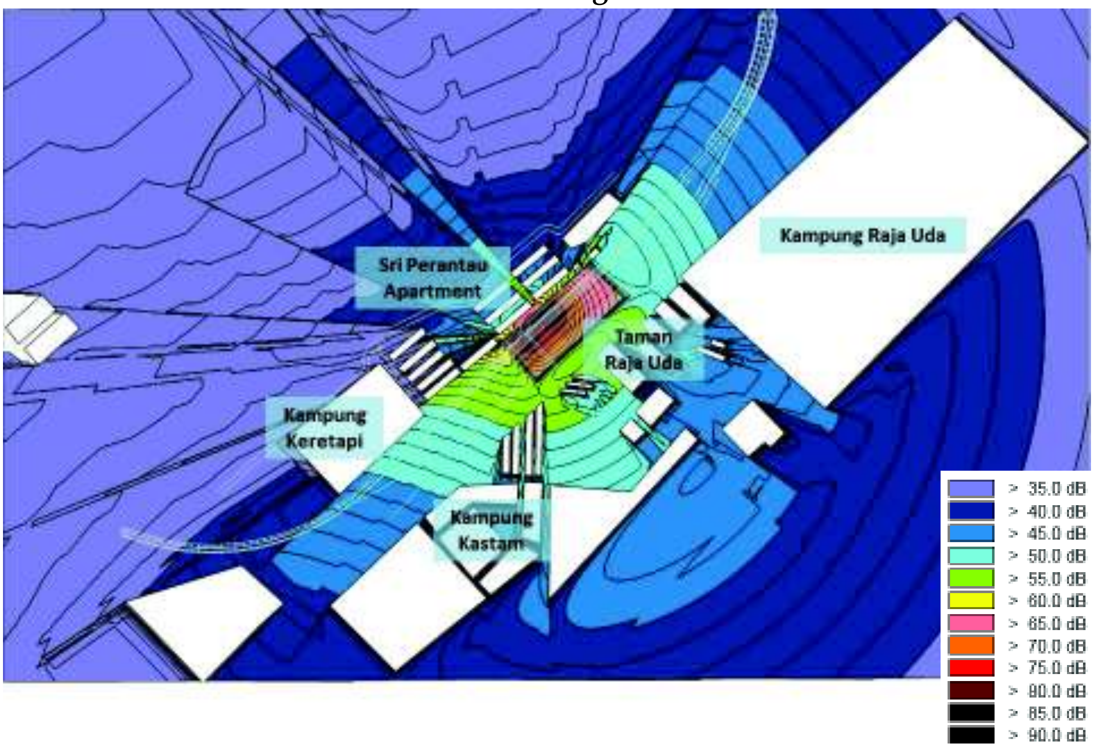


Chart 7-27 : Noise Propagation from Piling at Port Klang Station with 8m hoarding



Noise impact for the construction of the railway tracks are anticipated to be of concern in urban built up areas as well as low density residential areas with prevailing low ambient noise. Noise disturbance are anticipated from piling works and earth clearing works that include heavy vehicles for removal and supply of materials.

Noise from the tunneling works are also a lesser issue of concern as the tunnel works sites are typically located in relatively less populated areas of the alignment.

In addition to noise disturbance at the construction work sites, additional impacts from road traffic congestion with increased noise impact are however likely. The increase in absolute noise levels may not necessarily be very significant, although the subjective perception may suggest otherwise due to increased frustration of associated with the traffic disturbance in the neighborhood.

Notwithstanding whether the noise levels are significantly increased due to road traffic congestions, it is nevertheless necessary to minimize local road traffic disturbances due to construction of the railway tracks and Stations. Road traffic diversions and traffic management shall be required to minimize adverse impact relating to the environment and inconvenience to the affected community and public.

7.4.5 Vibration

a. Assessment Method

Vibration during the construction phase is a concern, particularly from piling activities. Excessive vibrations near vibration sensitive structures may indeed result in concerns of potential structural damage. Recommended environmental vibration limits are given in the DOE the Guidelines for Environmental Vibration Limits and Control (2007). Vibrations limits for human response in buildings for short term exposure to vibration are given in the Guidelines Annex A, Schedule 6 as follows:

For Residential Land Use ***Day time: Curve 8 to Curve 16***
Night Time: Curve 4

("Curve 1" is based on the vibration perception threshold for human response).

Annex A, Schedule 2 of the Vibration Guidelines recommends vibration limits for damage risk in buildings for short term vibration exposure (**Table 7-58**).

Table 7-58 : Limit for Damage Risk in Buildings from Short Term Vibration

Type of Structure	**Vibration Velocity v_i (mm/s) at foundation** *(as defined by the respective rating curves of Figure 5-1)*	**Vibration Velocity v_i (mm/s) at plane of floor of uppermost full storey** *(all frequencies)*
Industrial buildings and buildings of similar design	**Curve C**	**40**
Commercial building, dwelling and buildings of similar design and/or use	**Curve B**	**15**
Structures that, because of their particular sensitivity to vibration, do not correspond to those listed above, or of great intrinsic value (e.g. residential houses, or heritage buildings)	**Curve A**	**8**

Source: DOE Planning Guidelines for Vibration Limits and Control in Environment, 2007

Typical vibrations from bored piles as measured at approximately 10m from the piling site are shown in the **Chart 7-28**. The figure gives a vibration versus time plot demonstrating transient vibration excursions during casing driving, with short term vibrations of up to 4.5 mm/s (Curve 4.5).

Chart 7-28 : Typical vibration from bored piling in Malaysian construction works (Penang Bridge widening works)

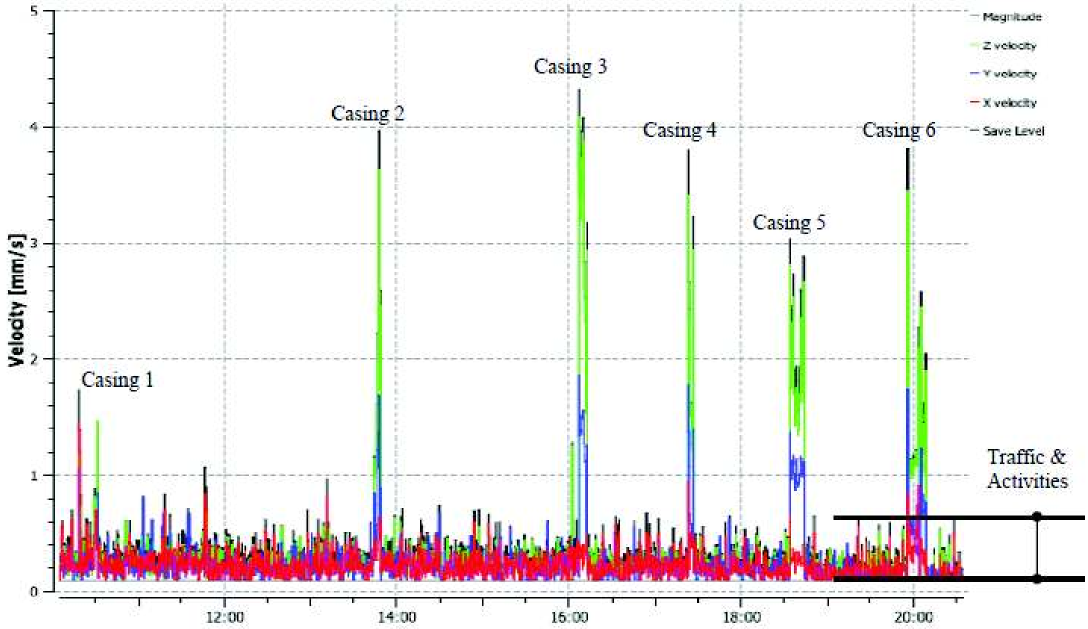
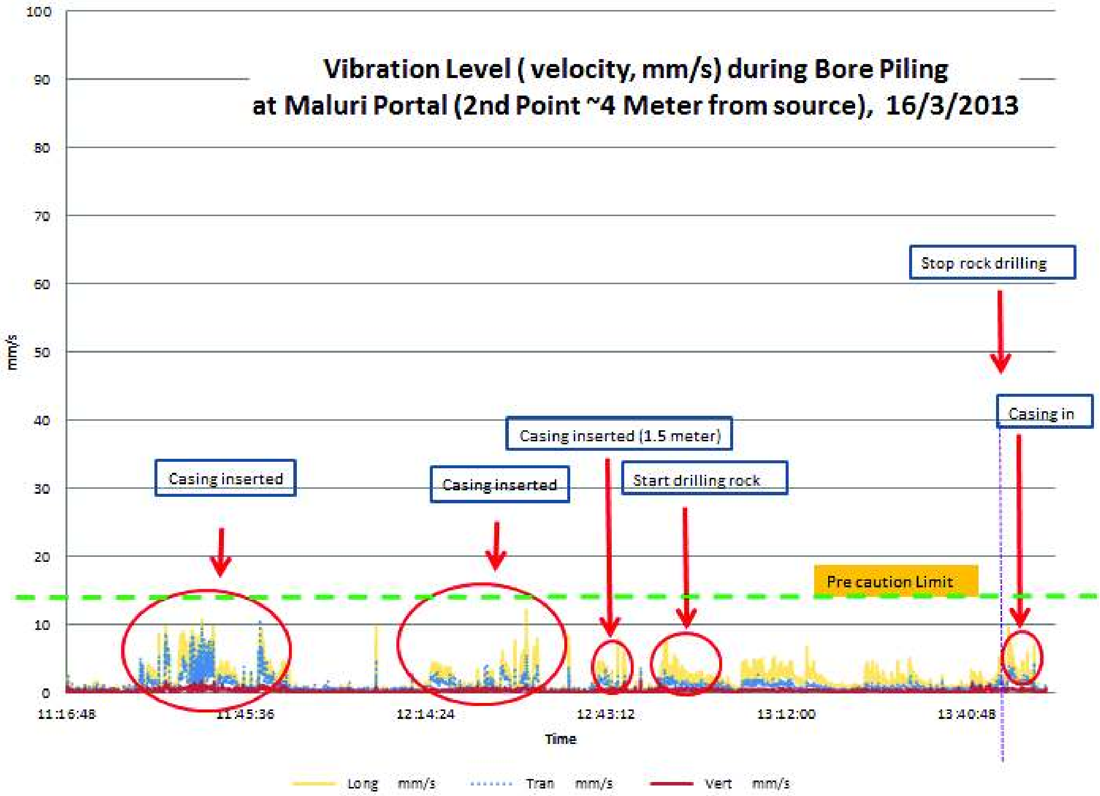


Chart 7-29 : Measured vibration from bored piling in KVMRT Project



With bored piles and other similar low impact piling methods, vibrations from piling are anticipated to comply with limits recommended for human response in buildings. The vibrations while within recommended limits for human response in residential buildings are nevertheless expected to be fellable (perceivable) to human touch, and are significantly higher than normal road traffic and human activities noted in the background vibrations plotted.

Blasting induced vibrations is another potential concern if blasting works are undertaken in proximity of built up areas. Blasting at the tunnels are however away in the remote undeveloped areas, and is therefore not anticipated to be of major concern.

Vibration and airblast levels for a given site are directly dependent on the quantity (weight) of explosives charge per delay (per hole) used and the separation distance from the blast site to the receptors.

7.4.5.1 Segment 1 : Kelantan

a. Assessment Results

Receptors that may be affected by vibrations in Kelantan are in vicinity of the Wakaf Bahru Station where piling works with construction works concentrated within the Station areas. Elsewhere the rural and semi-urban residential dwellings within 75m of the alignment may also be affected by construction vibrations. The receptors that may be affected by construction noise & vibration are tabulated as follows (within 75m of the alignment work sites).

Table 7-59 : Receptors most affected by construction in Kelantan

Ref	Location	GPS Coordinate	
1	Houses at Jalan Salor Pasir Mas	6.06582	102.22514
2	Houses at Kg Tendong, Pasir Mas	6.07274	102.20781
3	Houses at Kg Tendong, Pasir Mas	6.06834	102.2168
4	Houses at Kg Pandang Embong, Pasir Mas	6.0858	102.19869
5	Houses at Kg. Alor Durian, Wakaf Bharu	6.10007	102.19163
6	Houses at Jalan Taliair, Kubang Batang	6.14980	102.15515
7	Houses at Kg. Lati, Wakaf Bharu	6.11221	102.18307
8	Houses at Kg Kubang Batang, Wakaf Bharu	6.13063	102.17481
9	Houses at Kg Bendang, Wakaf Bharu	6.14282	102.16265
10	Houses at Kg Kubang Gajah	6.15817	102.14889
11	Houses at Kampung Teluk	6.16950	102.13942
12	Houses at Kampung Kubang Panjang	6.17681	102.13246
13	Houses at Kg Kok Semru, Tumpat	6.20411	102.10484

7.4.5.2 Segment 2 : Selangor

a. Assessment Results

Segment 2A: Gombak North to Serendah

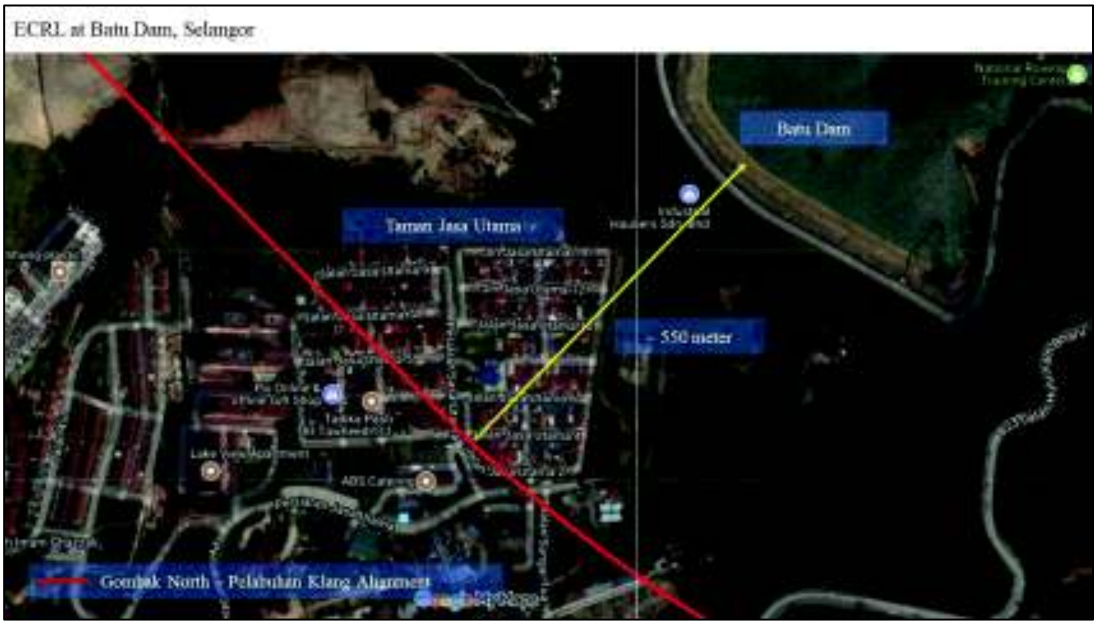
Receptors that may be affected by vibrations are typically receptors in proximity of the alignment and in particular where piling works are carried out. These include several residential receptors as tabulated in the Table below (receptors within 75m of the rail corridor).

Table 7-60 : Receptors most affected by construction in Selangor Gombak to Serendah

No.	Location	GPS Coordinate	
1	Terrace houses at Persiaran Jasa Utama	3.27041	101.68170
2	Apartments at Jalan Jasa Perwira, Gombak	3.27152	101.67949

Another potential concern relates to construction related vibrations to the Batu Dam and water supply pipes routed from the Dam (where the Batu Dam is one of the major water supply dams of the Klang Valley).

Chart 7-30 : Aerial view of Batu Dam and the proposed ECRL alignment



While piling works on the rail corridor are not anticipated to result in high vibrations at the Batu Dam structure / embankment which sufficient buffer distance (approximately 550m away), the concern relates to existing underground pipes (and surface pipes as well) that may be in close proximity of the railway corridor and/or railway crossing. Piling works in such situations shall require close inspection and continuous vibration monitoring to ensure vibration levels shall not be at levels of concern.

Segment 2B: Serendah to Bandar Puncak Alam

Receptors that may be affected by construction noise & vibration along Serendah to Bandar Puncak Alam alignment (within 75m) are tabulated below.

Table 7-61 : Receptors most affected by construction in Selangor Serendah to Bandar Puncak Alam

No.	Location	GPS Coordinate	
1	Houses at Kampung Dato Harun and Taman Tok Pinang	3.36721	101.60313
2	Sri Selva Temple, Serendah	3.36636	101.60407
3	Terrace houses at Jalan Melati 2b, Taman Melati	3.36607	101.59573
4	Houses at Taman Desa Kiambang	3.36480	101.59185
5	Houses at Jalan Bunga Raya 3, Serendah	3.36588	101.56011
6	Terrace houses at Jalan Batu Arang	3.30721	101.47470

Segment 2C: Bandar Puncak Alam to Port Klang

Receptors that may be affected by construction noise & vibration along Bandar Puncak Alam to Port Klang alignment (within 75m) are tabulated below.

Table 7-62 : Receptors most affected by construction in Selangor Bandar Puncak Alam to Port Klang

No.	Location	GPS Coordinate	
1	Houses at Jalan Sungai Saim, Klang	3.05348	101.38959
2	Terrace houses at Lorong Haji Taha, Taman Sri Delek, Klang	3.03201	101.39622
3	Terrace houses at Lorong Haji Ariffin, Klang	3.02673	101.40724
4	Terrace houses at Kampung Sg Sireh Tambahan	3.02160	101.40907
5	Houses at Jalan Sungai Sireh 1, Klang	3.01826	101.40550
6	Sri Perantau Apartment, Kawasan 14, Klang	3.01464	101.40199
7	Terrace house at Kampung Keretapi, Klang	3.01218	101.39938

7.4.6 Waste Management

The Project activities during the construction phase involves site clearing, demolition of buildings, tunneling works as well as the construction of railway tracks, viaducts and stations. One of the major impacts expected from these activities is waste generation. This section describes the waste generation from the Project and its potential impacts to the surrounding environment.

7.4.6.1 Methodology

In order to evaluate the impacts of waste, the generation of each type of wastes has been quantified following the accepted waste generation rate (WGR) from published literature. The aerial size of the affected structures, vegetation, stations, tunnels as well as number of workers was multiplied with the WGR to estimate the generation of wastes. The estimated waste generation (WGR) as well as the category, source and types of waste were described in the sub-sections below and shown in **Table 7-63**.

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Table 7-63 : Category of Wastes

Category of Wastes	Source of Wastes	Types of Waste	Reference	Waste Generation Rate
Demolition wastes	• Demolition of building structures	• concrete blocks • steel reinforcement • wood • glass & plastic • zinc and other metals • piping • ceramic tiles	A survey of Construction and Demolition Waste in Malaysia, Mixed-Use Development • MAH Chooi Mei, Takeshi FUJIWARA	• Demolition waste – 130.86 tonnes/100 m^2
Construction wastes	• Station construction • Railway track construction • Tunnel construction • Viaduct construction	• material packaging • disused formwork • concrete debris • used containers		• Construction waste – 11.79 tonnes/100 m^2
Excavated/ Spoil material	• Tunnel construction • Pier construction	• Excavated material Unsuitable material		Quantity of the wastes depending on the diameter and length of tunnels. Diameter of the tunnel: • Double track tunnel : 11.2 m
Biomass	• Site clearing (oil palm)	• empty fruit bunches • monocarp fruit fibers • palm kernel shells • oil palm fronds • oil palm trunks	Nazlin Asari, Mohd Nazip Suratman, Jasmee Jaafar and Mazzueen Md. Khalid. (2013)	47 tonnes/ha
	• Site clearing (paddy field)	• Rice straw	Laporan Penyiasatan Pengeluaran Padi - Luar Musim 2014, Jabatan Pertanian Semenanjung Malaysia, 2015	5 tonnes/ha

Table 7-63 : Category of Wastes (cont'd)

<table>
<tr><th>Category of Wastes</th><th>Source of Wastes</th><th>Types of Waste</th><th>Reference</th><th>Waste Generation Rate</th></tr>
<tr><td></td><td>• Site clearing (scrubs and forests)</td><td>• Tree trunks</td><td>Hamdan O, Khali Aziz H & Abd Rahman K. (2011). Remotely sensed L-Band SAR data for tropical forest biomass estimation. Journal of Tropical Forest</td><td><table><tr><th>Category</th><th>Range of Biomass</th></tr><tr><td>Small growing tree stands</td><td>26-166 tonnes/ha</td></tr><tr><td>Mixed small, mature tree stands</td><td>130-155 tonnes/ha</td></tr><tr><td>Mature, dense tree stands</td><td>168-414 tonnes/ha</td></tr><tr><td>Mature, very dense tree stands</td><td>427-569 tonnes/ha</td></tr></table></td></tr>
<tr><td>Domestic wastes</td><td>• Operations of site office
• Operations of workers' quarters</td><td>• food waste
• paper
• cans
• bottles and plastics</td><td>Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia, 2013</td><td>0.44 kg/capita/day</td></tr>
</table>

Table 7-63 : Category of Wastes (cont'd)

Category of Wastes	Source of Wastes	Types of Waste	Reference	Waste Generation Rate
Scheduled wastes	• Fuel storage area • Scheduled waste storage area • Maintenance of the construction vehicles	• SW 305 – Spent lubricant oil • SW 306 – Spent hydraulic oil • SW 408 - Contaminated soil, debris or matter resulting from cleaning-up of a spill of chemical, mineral oil or scheduled wastes • SW 409 - Disposed containers, bags or equipment contaminated with chemicals, pesticides, mineral oil or scheduled wastes • SW 410 - Rags, plastics, papers or filters contaminated with scheduled wastes • SW 422 - A mixture of scheduled and non-scheduled waste	Environmental Quality (Scheduled Waste) Reg 2005	Based on waste generation data of other linear project

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7.4.6.2 Results and Discussion

Based on the waste generation rate of each waste category, **Table 7-64** shows the estimated waste quantity for each segment.

Table 7-64 : Estimated Waste Generation by Alignment Segments

Type of Wastes	Alignment – Estimated Waste Quantity				Total
		Segment 2: Selangor			
	Segment 1: Kelantan	Segment 2A: Gombak North - Serendah	Segment 2B: Serendah - Bandar Puncak Alam	Segment 2C: Bandar Puncak Alam – Port Klang	
Demolition	88,000 tonnes	105,000 tonnes	47,000 tonnes	145,000 tonnes	**385,000 tonnes**
Construction	43,000 tonnes	8,500 tonnes	NA (*no construction of station)	20,000 tonnes	**71,500 tonnes**
Biomass	7,500 tonnes	7,000 tonnes	15,000 tonnes	14,000 tonnes	**43,500 tonnes**
Spoil Material	87,570 tonnes	3.4 million tonnes	613,192 tonnes	383,443 tonnes	**4.5 million tonnes**
Domestic waste	Preliminary design stage (approx. 10 workers/ 1km)				
	118 kg/day	105 kg/day	109 kg/day	131 kg/day	**463 kg/day**
	Construction phase (approx. 40 workers/ 1km)				
	480 kg/day	426 kg/day	444 kg/ day	533 kg/day	**1883 kg/day**
	Commissioning period (approx. 3 workers/ 1km)				
	34 kg/day	30 kg/day	31 kg/day	37 kg/day	**132 kg/day**
Scheduled Waste	Approx. 0.3 mt/km/ year				

Note: The estimated volume for wastes is a conservative estimation.

(a) Demolition and Construction Waste

Based on **Table 7-63**, Segment 2C is expected to generate 145,000 tonnes of demolition waste as more buildings or structures will be demolished in comparison to other segments. As for construction waste, Segment 1 is expected to generate the highest quantity which is 43,000

tonnes as two stations will be constructed which are Pengkalan Kubor and Wakaf Bharu in contrary to the construction of one station at Segment 2C. Minimal construction waste is expected at Segment 2B as there will be no construction of station.

(b) Biomass

About 14,000 to 15,000 tonnes of biomass is expected to be generated at Segment 2C and 2B respectively as Segment 2C will pass through mangroves of Sg. Puloh, Klang and oil palm plantations in Bandar Puncak Alam while Segment 2B will pass through southern tip of Rantau Panjang Forest Reserve.

(c) Spoil Material

Tunnels construction at Segment 2A will generate large quantity of spoil material at 3.3 million tonnes as compared to Segment 2B and 2C which are only at 560,000 tonnes and 275,000 tonnes respectively. This is because 7 tunnels will be constructed with a total length of about 14.5 km across 3 forest reserves as well as hilly areas.

(d) Domestic Waste

Generation of domestic waste is expected to vary from time to time depending on the project activities. Domestic waste during construction phase is estimated to generate highest quantity of waste due to the long period of time and also requires high number of manpower.

(e) Scheduled Waste

Scheduled waste is expected to be generated at approximately 0.3 mt/km/ year.

Improper management of the waste generated can contribute to impacts such as water pollution, elevate flood risk, air pollution and aesthetic value. Several factors which can lead to improper waste management include poor site management, lack of waste management plan, lack of workers supervision and improper waste handling and disposal. **Table 7-64** details out the areas of concern and sensitive receptors based on the environmental impacts caused by improper waste management.

Table 7-65 : Potential Impacts from Waste Generation

Impacts	Areas of Concern	Sensitive Receptors
Water Pollution • Organic pollutants from biomass degradation can leach into nearby water bodies • Sediment discharge via surface runoff during rainy events • High organic content of domestic waste lead to increasing concentration of ammoniacal nitrogen, BOD, COD and cause eutrophication, if disposed into the waterways. • Spillage of scheduled wastes may pollute the nearby waterways and if seep through the soil, groundwater reservoir may be affected.	• Segment 1 Kelantan - River crossings and irrigation canals	River crossings in Segment 1 • Sg. Kelantan (CH1700) • Sg. Peng Nangka (CH16792) • Sg. Mentua (CH22492)
	• Segment 2A Gombak North – Serendah	River crossings in Segment 2A • Sg Klang catchment - Sg Salak - Sg Semampus - Sg Batu • Sg Selangor catchment - Sg Udang - Sg Kanching - Sg Kasau - Sg Kasai - Sg Rangkap - Sg Terusan - Sg Baharu

Table 7-65 : Potential Impacts from Waste Generation (cont'd)

Impacts	Areas of Concern	Sensitive Receptors
Flood Risk • During heavy rainfall, biomass can obstruct drains and streams • Blockage of drainage and disrupting the water flow; elevate flood risk at flood prone areas during rainy seasons.	• Segment 1 Kelantan	• Flood prone areas - Kg Gaung Pendek - Kg Tok Buak - Kg Padang Embon - Kg Baroh Kok Pauh
	• Segment 2A Gombak North – Serendah	• Flash flood prone areas : - Kg Sungai Tua - Pekan Batu Arang, Gombak - Surroundings of Block 26, Green Valley
Air Pollution • Open-burning or illegal dumping can cause localised haze or air pollution. • Fugitive dust dispersion from wind blow on the uncovered material stockpile.	• Segment 1 Kelantan -	• Some of the possible areas are residential area and schools within 0 – 200 m • Kg Tendong • Kg Alor Durian • Kg Lati
Aesthetic • Illegal dumping at vacant plots is unsightly and creates a nuisance among the surrounding community.	• Segment 1 Kelantan	• Some of the possible areas - Kg Tendong - Kg Alor Durian - Kg Lati - Taman Kasturi - Kg Kubang Batang
	• Segment 2C Bandar Puncak Alam – Port Klang	- Kg Delek - Kg Kastam - Sg Klang

7.4.7 Flooding

There is a risk of flooding during the construction phase, especially in low-lying areas in Kelantan, where embankments will be built along the railway. Much of these areas experience annual floods, which tend to be severe in some areas, exceeding 5 m in depth. In Selangor, there will also be flood risk in flash flood prone locations.

Flooding may arise from many different activities, such as:

- **The obstruction and/or diversion of floodwaters due to presence of embankments.** Any constriction of the natural flow path can 'back-up' the river and lead to increased flood levels upstream. Construction activities, particularly embankments, in or across a floodplain can increase the flood risk for inland areas and properties upstream.

- **The presence of structures in the flood path**. Presence of buildings/ piers/ bridges will obstruct the flow of the river and increase water levels, which will subsequently cause localised flooding in the event of heavy rainfall.

- **The inadequacy of culverts and bridges**. Bridges and culverts effectively allow unimpeded flow capacity through embankments. Inadequate provision and design of culverts/ bridges will impede the flow of water, potentially causing overtopping of the riverbanks and localised flooding upstream in the event of heavy rainfall.

- **Conflicts between the railway and on-going/ existing flood mitigation works**. The purpose of flood mitigation projects is to reduce the probability of floods and limit the potential damage caused by flooding. Common flood mitigation measures include redirecting flood waters via diversion canals; construction of flood walls including levees, weirs, bunds or berms to keep excess flood waters within the river channel and prevent it from entering inland areas, and; construction of storage detention facilities such as large balancing ponds or in extreme cases, a dam. With the introduction of a large infrastructure project such as the ECRL Phase 2, the railway alignment may alter the hydrological aspects on its surrounding area and potentially render flood mitigation projects ineffective (regardless of status: completed, under construction or for future planning).

- **Blockage and/or diversion of drains and streams during construction**. The chances of flood risk will be increased in the event of work being carried out in an uncontrolled manner resulting in drainage channels to be blocked by biomass/ solids/ construction wastes. Sediment and debris carried by floodwaters can further constrict a channel and increase flooding. This hazard is greatest upstream of culverts, bridges, or other places where debris collects. Small stream channels can be filled with sediment or become clogged with debris. This creates a closed basin with no outlet for runoff.

- **Increased surface runoff due to an increase in impervious areas**. The ECRL Phase 2 project will increase the amount of impervious surface areas – particularly at stations, and maintenance bases. Agricultural and/or vegetated areas will be turned into paved areas – which will directly increase the amount and velocity of surface runoff. This is especially relevant for stations that have large footprints

- **Construction of access roads**. Some waterways, streams or drainage may be blocked or cut in order to construct the access roads. Such free-flowing waterways will no longer be able to channel excess flood waters during heavy rainfall, thus altering the existing hydrological regime and cause localised flooding.

Based on the available flood information (2012 – 2016) obtained from JPS, a list of potential flood hotspots has been identified. These areas are likely to experience flooding if adequate mitigation measures are not provided for by the ECRL Phase 2 project. These hotspots are grouped as below and shown in **Figure 7.4.7-1** to **Figure 7.4.7-2**:

- **Primary hotspot** (High impact): High risk of upstream flood occurrence due to the embankment sections of the alignment.
- **Secondary hotspot** (Moderate impact): Moderate risk of upstream flooding due to elevated sections of the alignment.

In addition to these hotspots, there may be other areas that are at risk of increased flooding, such as those highlighted during focus group discussion (FGD) sessions but are not officially identified by JPS. Such areas will be determined when more detailed analysis is carried out during the detailed engineering design stage..

7.4.7.1 Segment 1 : Kelantan

A substantial portion (approx. 35.9%) of the alignment in Kelantan will be elevated above the current flood levels. However, the construction of the embankments and stations could restrict water flow and aggravate flooding. During flood periods, the rivers may breach their channels, with water spilling out over the floodplains. Although 15 bridges with total length of 8.34 km have been provided and most of the embankments will be provided with balancing culverts to enable flood waters to drain out and recede, the risk of flooding must be treated as a serious issue.

11 areas along the alignment in Kelantan are considered as primary hotspots (**Table 7-66**). For instance, Kg. Manan and Kg. Telaga Bata are considered as primary hotspots as they are flood prone areas located upstream of the ECRL alignment. In addition, Kg. Gaung Pendek and Kg. Resak are categorised as secondary hotspots as they are flood-prone areas located upstream near the elevated section of the alignment.

In terms of increased surface runoff, the Wakaf Bahru station covers a 25.5 ha area, most of which will be impervious. There will be up to three times more surface runoff from these facilities, and this could potential affect streams in the vicinity. The Pengkalan Kubor station is expected to cover 8.18 ha and would similarly increase surface runoff in the local area, contribute to increased flows in the vicinity of Kg. Mentua.

Table 7-66 : Potential Flood Hotspots in Kelantan Adjacent to the ECRL Phase 2

Hotspot	Category	
	Primary Hotspot (High)	**Secondary Hotspot (Moderate)**
Kg. Gaung Pendek		√
Kg. Resak		√
Kg. Tok Buak		√
Kg. Tai Tujoh		√
Kg. Kubang Pak Amin		√
Kg. Kasar		√
Kg. Bechah		√
Kg. Perangkap Benut Susu	√	
Kg. Kayu Tinggi	√	
Kg. Perangkap	√	
Kg. Padang Terang	√	
Kg. Padang Embon		√
Kg. Manan	√	
Kg. Alor Durian		√
Kg. Talak		√
Kg. Cherang Melintang	√	
Kg. Telaga Bata	√	
Kg. Bunohan		√
Kg. Jubakar	√	
Kg Baroh Kok Pauh	√	
Kg. Kaki Itek	√	
Kg Awang En Chong	√	
Kg. Pauh Sebanjan		√
TOTAL	11	12

In addition to these hotspots, the information gathered from FGD sessions also highlighted the following areas as potential flood hotspots:

- Taman Kasturi
- Kg. Tendong
- Kg. Kulim
- Kg. Telok
- Kg. Chabang Empat
- Kg. Nechang
- Kg. Kubang Panjang
- Kg. Kubu
- Kg. Palas Merah

Other than these hotspots, construction of other infrastructures including irrigation structures and roads has the potential to aggravate flooding. One of the main concerns is the construction of the LPT3 expressway that connects Kuala Terengganu to Kota Bharu and Tumpat, which may traverse close to the ECRL Phase 2 alignment. The presence of two linear infrastructures next to each other has the potential to aggravate flooding, therefore the designs of both are recommended to be synchronized to minimize problems.

7.4.7.2 Segment 2 : Selangor

Flooding in Selangor is associated with localized flash floods and the flood situation is not as critical compared to Kelantan. However, based on a discussion with JPS Selangor, there are several locations near the alignment that are prone to flooding during continuous heavy rainfall events and high tide phenomena, especially in Klang. 23% of the railway will be elevated and more than half (53.5%) will be on embankment in Selangor. As such, construction of the embankments and stations could restrict water flow and aggravate flooding at locations that are prone to flash floods based on DID records. These locations are:

1. Kg. Sungai Tua, Gombak
2. Pekan Batu Arang, Gombak
3. Surroundings of Block 26, Green Valley, Gombak
4. Jalan Kuala Lumpur-Ipoh at Serendah
5. Surroundings of Mat Taib Industrial Area, Hulu Selangor
6. Surroundings of Jalan Mawar, Klang
7. Kg. Bukit Kerayong, Klang
8. Kg. Bukit Kapar, Klang
9. Kg. Delek, Klang
10. Kg. Sireh, Klang
11. Taman Tengku Bendahara Azman (Pandaraman), Klang

Based on the FGD sessions in Selangor, flooding was highlighted as major issues nearby the ECRL alignment in some locations such as:

1. Ambang Suria, Kuala Selangor
2. Taman Kapar Setia, Klang
3. Kg Datuk Harun, Hulu Selangor
4. Taman Serendah Utama, Hulu Selangor
5. Kg Tok Pinang, Hulu Selangor
6. Kg Damai, Hulu Selangor
7. Taman Melati, Hulu Selangor
8. Taman Desa Kiamban, Hulu Selangor

Another concern is the construction of the upcoming West-Coast Expressway that aims to connect Ipoh to Banting. The highway may run close and intersect with the ECRL Phase 2 alignment in Kuala Selangor and Klang, which has the potential to further aggravate flash flood in hotspots identified above.

The affected rivers due to the increased surface runoff in Selangor is expected to be Sg. Selangor and Sg. Klang. The two stations that will be built along this stretch, i.e. the Serendah Station and Jalan Kastam station will have development footprints (and impervious areas) of approximately 26 ha and 22 ha respectively.

7.4.8 Impacts on Irrigation Systems

Potential impacts on existing irrigation systems during the construction stage will be erosion from railway embankments, causing siltation and blockage of irrigation canals, as well as diversion of canals. Construction stage activities such as earthworks, piling works, temporary access roads and construction laydown areas could also impact irrigation structures, such as by causing physical damage to canals and pipelines. The assessment of impacts on irrigation systems are confined to the alignment in Segment 1 of Kelantan as only this segment passes through paddy fields and irrigation schemes.

7.4.8.1 Segment 1 : Kelantan

The Project could potentially impact irrigation infrastructure (canals, pipelines, pumphouses, tidal gates) that provide water to the paddy fields in the coastal granary belt of Tumpat, Kelantan, which are served by the irrigation schemes of the Kemubu Agricultural Development Authority (KADA) and the Department of Irrigation and Drainage. The paddy fields (outside of National Granary Areas) in the southern parts of Tumpat district could be affected by the Project alignment. The irrigation canals close to the construction sites of both Pengkalan Kubor and Wakaf Bharu stations may face higher risk of sedimentation.

In total, the ECRL Phase 2 alignment will traverse through 11 irrigation canals (2 primary canals, 4 secondary canals and 5 tertiary canals) under KADA irrigation scheme. Besides being a water source, the irrigation canals also serve as access roads for farmers to move from one field to another. Both DID Tumpat and KADA have highlighted that major concern from the ECRL project is the presence of at-grade embankment that will reduce accessibility of farmers to enter their paddy field and block flow path during storm. As such, poor drainage system may cause water retention by the tracks and formation of puddles which will lead to degradation of water quality.

There are also new and planned irrigation schemes in Tumpat and Pasir Mas, where pump houses, irrigation canals and pipelines, are being planned, committed and/or under construction. These irrigation schemes could potentially be impacted by the Project construction activities if insufficient mitigation measures are implemented.

7.4.8.2 Segment 2 : Selangor

The ECRL Phase 2 will not traverse near any major granary areas served by irrigation schemes. There is only one major granary area in Selangor, the Barat Laut Selangor (BLS) Irrigation Scheme managed by Integrated Agriculture Development Area (IADA) and located about 37 km northwest from the proposed alignment corridor.

7.4.9 Geotechnical and Geological Risks

The greatest potential impact relating to geology and soils is the stability of the cut and fill areas (including related retaining walls) and tunnels along the alignment. Common problems for a railway project may be caused by geoological features such as:

a. faults
b. junctions between hard and soft formations
c. boundaries between porous and impermeable formations
d. spring-lines
e. fractured granites
f. weathered schists/sandstone/phyllite
g. landslide areas
h. areas where beds dip towards the railway line, and
i. peat areas
j. soft and compressible clay.

During construction, major works include tunnelling, pile foundation, excavation and retaining structures for underground construction at the tunnel portals. A few simplified limitations during construction include:

a. Uneven grades of weathering
b. Weak zones such as highly jointed or faulted areas
c. Instability of layered rocks
d. Groundwater seepages
e. Soft soil – clay and peat

All construction works require an understanding of the existing geological conditions, soils and groundwater regime to ensure that the risks associated with the construction and operation of the ECRL line are acceptable. A prerequisite is a comprehensive soil investigation and geological mapping in order to determine the various geological bedrock profile, rocks and soils, and groundwater regimes that will be encountered during the various phases of the works. As of to date, 16 boreholes for the indicative soil investigation works has already been completed and it is expected that extensive additional soil investigation works will be carried out soon to supplement existing information. Detailed engineering geological assessment has to be carried out during the proposal stage and will be continued in parallel with the construction as well as maintenance to ensure safe construction.

Several geological hazards associated with tunnelling include face and sidewall instability, groundwater inflow, surface settlements and sinkholes, rock fall and landslide.

Some of the other concerns when tunnelling would be landslides along the more sensitive alignment segments from Gombak to Bandar Puncak Alam (Segment 2A and 2B) due to vibration during construction or daylighting of the layered rock. Some landslides in the area are entirely composed of soil and some others are mixtures of rock and soil. These landslides occur in unstable hill slopes and brittle rockfalls in the steep slopes.

In a number of locations in Kelantan alignment, the rail line will be sitting on soft clay and peat areas which require treatment during construction.

7.4.9.1 Segment 1 : Kelantan

Groundwater Abstraction Areas

The significance of groundwater, its use and potential risks such as groundwater depletion or recharge, or potential saltwater intrusion of existing aquifers should be appraised.

Kota Bharu is very dependent on groundwater for public water supply systems. Groundwater supply is obtained from production wells near the proposed alignment located at 4 wellfields i.e. Tanjong Mas, Pintu Geng, Chicha and Wakaf Bharu (2 km away). Along this segment, the sand aquifer is considered to be very productive and important to be protected from any contamination during construction. One of the aquifer layers in the Kota Bharu area is known to be saline, as such piling work carried out in the multi-layered aquifer is one of the major potential groundwater contamination as the pile penetration could result in movement of brackish water from one aquifer to another (**Chart 7-31**).

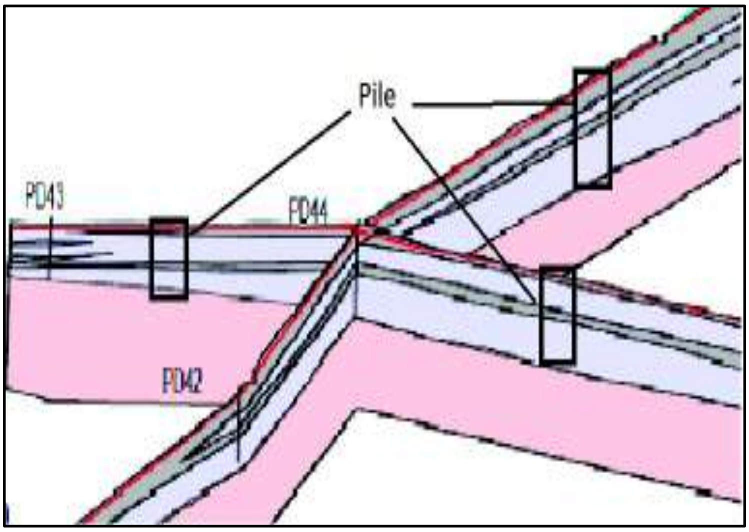

Chart 7-31 : Piling work carried out piercing the multi-layered aquifer could lead to groundwater contamination

Significant numbers of the semi urban and rural dwellers along the alignment use groundwater from the private wells constructed within their compound. Extensive dewatering might influence the groundwater level in the shallow aquifer and wells.

Excavation Work for Elevated Structures

Major excavations required for elevated structures are expected to be carried out for the railway line. The works will be situated in the alluvial layers along the alignment in which geological variability of material is going to be encountered during excavation. Most likely bedrock will not be reached.

Excessive Groundwater Seepage Areas

Groundwater table along this segment is high. Excavation for various structures during construction where seepages of groundwater occurs may lead to short term lowering of groundwater table which may then lead to ground settlement, ground collapse or flooding to excavated areas. This condition will most likely happen in sandy alluvial areas.

Peatland Areas

Even though there is no major peatland areas in the Segment 1, small pockets of peat areas may be encountered along the alignment. The major concerns are the relatively soft peat ground and peat fires during the dry season.

Construction of Long-Span Bridges

The construction of a long-span bridge across Sg. Kelantan is expected.

A site-specific engineering geological investigation report shall be prepared as part of the project design. Evaluation of the presence of soft clay zone in the alluvium shall be undertaken during subsurface geological investigations.

Long-span bridges along the alignment is an acceptable mean to connect rail segments besides encouraging further development and tourism nearby. It should cause least disturbance to the environment and land use, provide considerable savings in time, economically feasible and have least impacts of supports structures (piers/ abutments) on water and aquatic life. The construction should employ best practices in sedimentation and erosion control. Long spans most likely require deeper piling and as Sg. Kelantan at that location is brackish, piling must avoid introducing saline water into the aquifers.

Quaternary Alluvium Areas

The entire Segment 1 will be constructed on Quaternary alluvial soil. They are geologically young, loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a marine and non-marine environment. They also consist of layers of sand and fine particles of silt and clay with variable characteristics and strength. The clay is normally soft and compressible; hence, foundation improvement needs to be carried out as the heavy structure on top will load the soft sediment to make it settle.

A conceptual model is presented as **Chart 7-32** for a project that involves loading the ground in an area where recent sediments are known to overlie granite or other type of rocks. Importantly, the model is largely based on consideration of geological concepts such as age, stratigraphy, rock type, unconformity and weathering. **Chart 7-33** shows the cross-section based on geological mapping and boreholes. Referring to **Chart 7-34** showing the sequence of alluvial layers on the right, piling will most likely punch through the various aquifer layers.

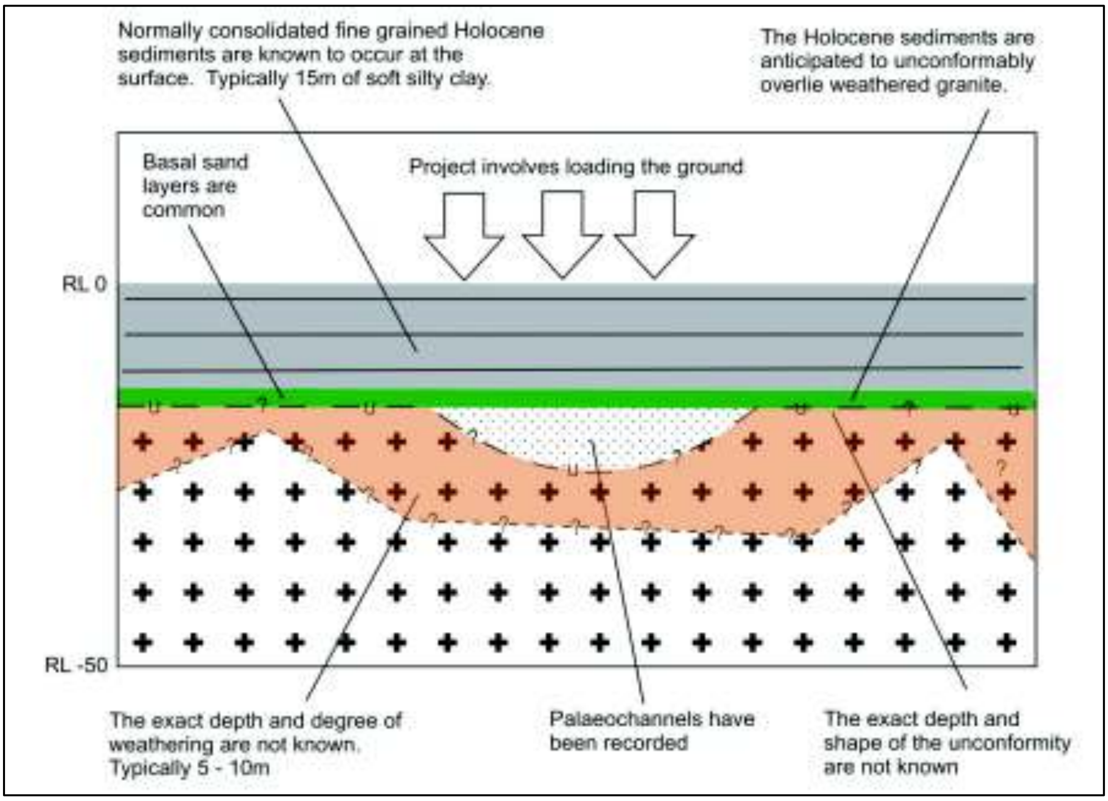

Chart 7-32 : Conceptual engineering geological model for an area where sediments overlie granite (Parry, 2014)

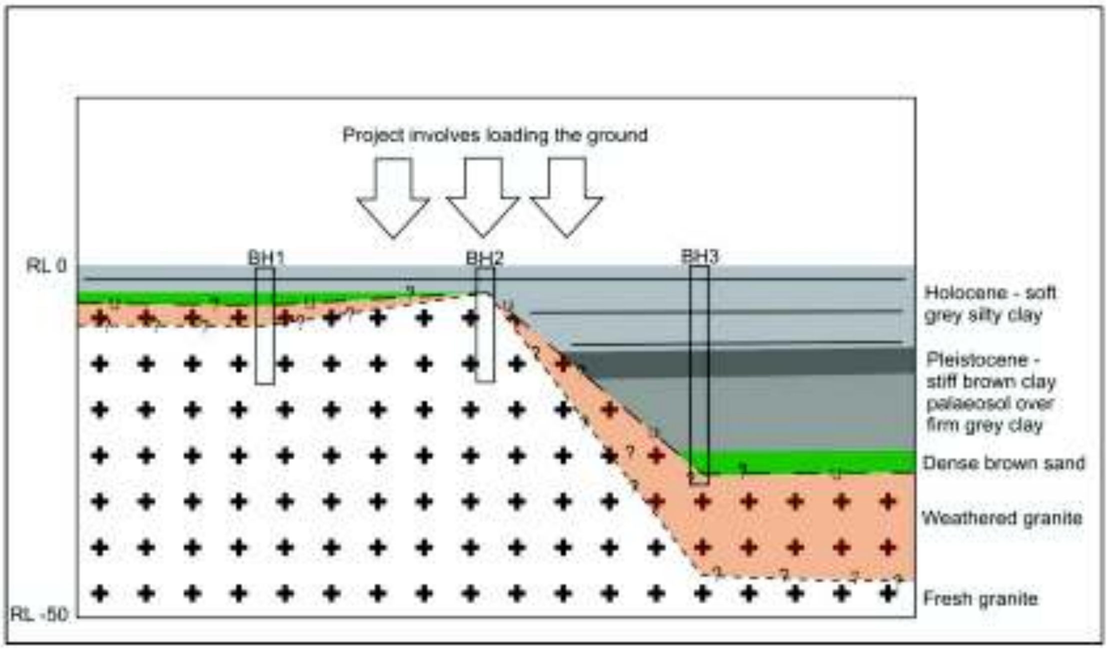

Chart 7-33 : Initial observational model for the project based on mapping and boreholes (Parry, 2014)

Detailed site investigation is not a compromise in the construction of ECRL Phase 2 line through this type of geology. Depending on the design, certain ground characteristics may be more critical to certain infrastructures, by their very nature or setting, will be exposed to more geological risks. This is illustrated schematically in **Chart 7-34** which shows the same geological setting for three different types of projects, a building, a road bridge and a tunnel.

In the Quaternary geology environment, the setting of alluvial plain and floodplain which could be underlain by a buried palaeo-channel. The floodplain also contains abandoned river channels, infilled with organic-rich soils, both at the surface and at depth. The palaeo-channel is associated with a vertical fault and there is a variable depth to rock. The variable geological conditions could create some forms of problem during the construction eg. variable depth of bedrock, layer of soft and hard ground etc.

Variable thickness of the sand and clay, and underlying soil layers might result in some differential settlements, tilt and permanent lateral displacements. These adverse effects are especially pronounced in transition zones where ground conditions change substantially over short distances.

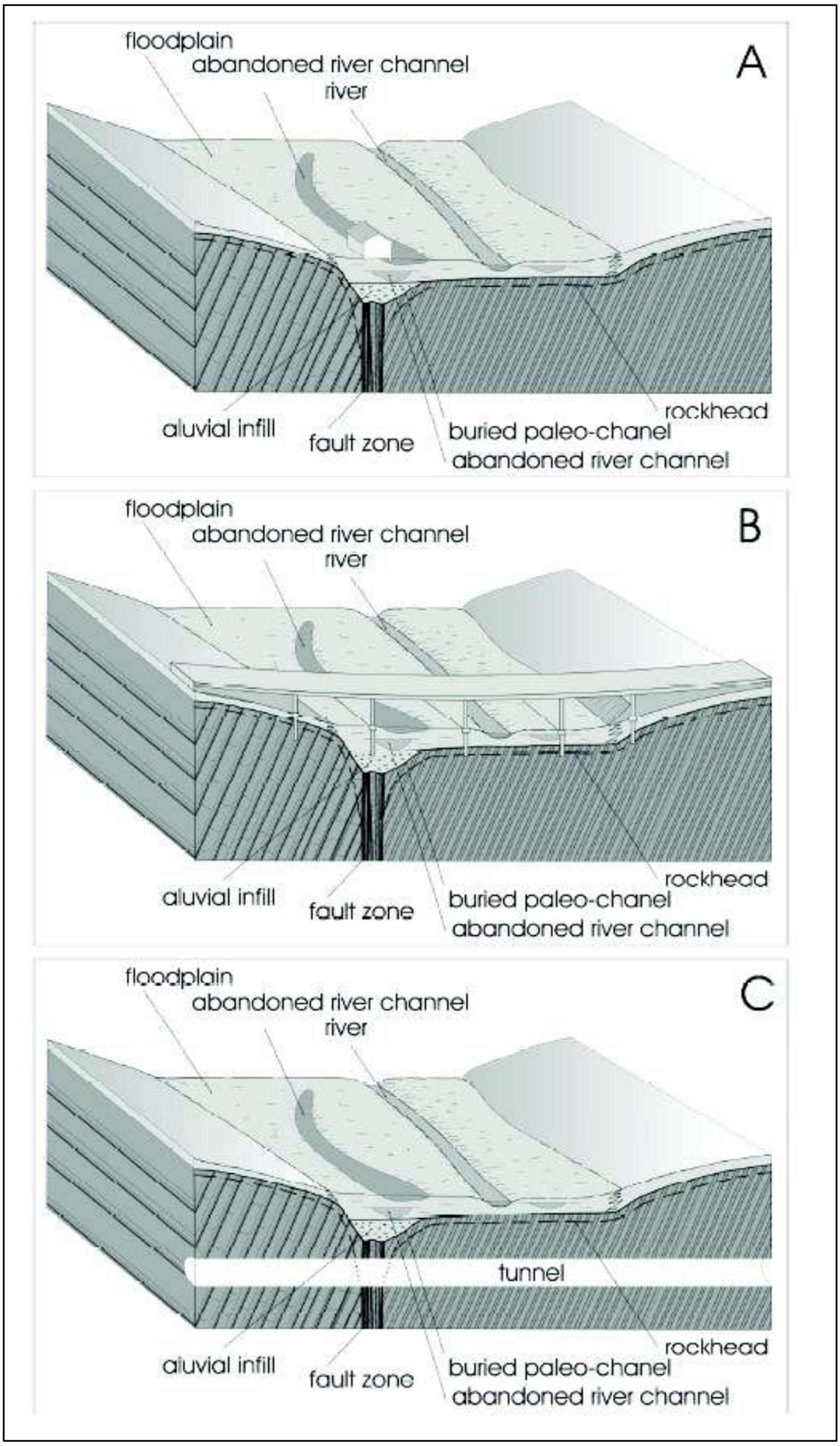

Chart 7-34 : The influence of project type on the engineering geological considerations (Parry, 2014)

7.4.9.2 Segment 2 : Selangor

Tunnelling Work in Granite and Schist (Segment 2A) and Sedimentary and Metamorphic Rocks (Segment 2B & Segment 2C)

Sensitive areas :

1. ***Segment 2A – Tunnels near Batu Dam***
2. ***Segment 2B – Tunnels near Bandar Sg. Buaya and Bandar Puncak Alam***
3. ***Segment 2C – Tunnels near Bandar Puncak Alam***

ECRL Phase 2 traverses through a variety of geological formations and soil profiles. Majority of the short tunnels proposed along Segment 2A would be in granite and schist while Segment 2B tunnels will go through phyllite, slate and sandstone. Segment 2C tunnels will go through shale, sandstone and conglomerate.

For Segment 2A, there are no major geological lineaments along the alignment but smaller lineament should be located and inspected to understand the impact of weak zones on construction. The presence of weak zones will slow down the progress of the tunnelling as excessive groundwater flow and support need to be dealt with.

However,it should be noted that the alignment along Segment 2A will be fully tunnelled under the Selangor Heritage Park and it is located 2 km north of the Gombak Selangor Quartz Ridge (shown in **Chart 7-35**).

Chart 7-35 : Location of Quartz Ridge and ECRL Phase 2 Alignment

Engineering geological characteristic and weathering grades normally dictates the progress of tunnelling in any project. Groundwater is the most difficult parameter to predict and the most troublesome during construction. Instability of the schistose rock such as schist and phyllite will delay the construction of tunnels (Segment 2A). Uneven grades of weathering along Segment 2A will also be challenging for tunnel construction as the materials are not uniform with expected variation in thickness and stiffness of soil layers and weathered rocks. Therefore it is crucial to select the right equipment for tunnelling. Instability of layered rock such as sandstone and phyllite and the presence of highly jointed areas will also delay construction for Segment 2B. Sandstone and conglomerate which are hard could also delay construction where the clastic nature of conglomerate will prolong drilling periods (Segment 2C).

Stability of the tunnel wall would be compromised with the presence of weak zones (a part or zone in the ground in which the mechanical properties are significantly lower than those of the surrounding rock mass). Weak zones can be faults, shears/shear zones, thrust zones, weak mineral layers, etc. The presence of weak zones will slow down the progress of the tunnelling as excessive groundwater flow and support need to be dealt with. If present, construction of supports need to be put up to strengthen the zone. Basically, there are two main groups of weak zones:

1. those, which are formed from tectonic events, and
2. those consisting of weak materials formed by other processes, such as weathering, hydrothermal activity and alteration.

The rail line is also designed about 500 m downstream of Batu Dam in Segment 2A (**Chart 7-36**). Ground vibration from construction works could be one of the limiting factors, and it must be properly controlled within acceptable limits. Tunnelling and other forms of excavation near Batu Dam poses high geological hazards and construction risks that require high safety management.

Chart 7-36 : The alignment downstream of Batu Dam

A thorough geologic analysis is essential to assess the relative risks of different tunnel locations downstream of a dam and to reduce the uncertainties of ground and groundwater conditions at those locations. In addition to soil and rock types, key factors include the initial defects controlling behaviour of the rock mass; size of rock block between joints; weak beds and zones, including faults, shear zones, and altered areas weakened by weathering or thermal action; groundwater, including flow pattern and pressure; plus, several special hazards, such as heat, gas, and earthquake risk.

Drill and blast will be used for tunnel construction. Blasting is carried out in a cycle of drilling, loading, blasting, ventilating fumes, and removing muck. Drilling, blasting, and mucking, and other related activities during the construction of tunnel will result in vibration to the surrounding areas. However, the vibration is still expected to be minimal (500 m away).

Construction in areas underlain by schist also pose the potential of landslide (Segment 2A). Disturbances to the toe of the slope and daylighting of layered rocks are the major cause of landslide.

Excavation and Construction of Slopes and Retaining Wall

Sensitive areas :

1. ***Segment 2A – Viaducts near Batu Dam***
2. ***Segment 2B & Segment 2C – Cut slopes***

Major excavations and retaining wall construction are expected to be carried out for the tunnel portals, stations and cut slopes.

The works will be situated in granite and schist (Segment 2A) and other geological formations along the alignment (Segment 2B & 2C). Irregular depth of bedrock and variability of material are expected to be excavated and is a major concern.

The proposed viaduct downstream of Batu Dam (Segment 2A) connecting the rail line from the east to the west will most likely involve excavation to sit the foundation of the pier as well as for the abutment. The construction should employ best practices in sedimentation and erosion control. Although locations for tunnel portals are identified, the site investigation is yet to be completed. Landslide is one of the potential hindrances at these locations.

Undulating topography along Segment 2B requires extensive excavation and a significant number of cut slope will be constructed along the segment to accommodate the at grade railway line. Cutting of slopes could trigger landslide and rock fall especially when the sedimentary rock layers are exposed to daylight.

Excessive Groundwater Seepage Areas

Sensitive areas :

1. ***Segment 2A – Tunnels near Batu Dam***
2. ***Segment 2B – Tunnels near Bandar Sg. Buaya and Bandar Puncak Alam***
3. ***Segment 2C – Tunnels near Bandar Puncak Alam***

Excavation for various structures during construction where seepage of the groundwater occurs may lead to short term lowering of groundwater table which may then lead to ground settlement, ground collapse or flooding to tunnels and excavated areas. This condition will most likely happen in sandy alluvial areas. Construction of major structures downstream of Batu Dam will most likely encounter this phenomenon, unless the tunnels and portals are above the reservoir level in the dam, where excessive groundwater seepage can be avoided.

<u>**Construction of Elevated Structures**</u>

Sensitive areas :

1. Segment 2A – Viaducts near Batu Dam and Serendah

2. Segment 2B – Viaducts near Serendah, Saujana Rawang, Bandar Tasik Puteri and Bandar Puncak Alam

3. Segment 2C – Viaducts near Bandar Puncak Alam, Kapar and Klang

There will be several elevated structures along the alignment which include viaduct above the valley downstream of Batu Dam and mined out areas near Serendah.

A site-specific engineering geological investigation report shall be prepared as part of the project design. Evaluation of surface and subsurface geological condition along the stretch will be examined.

<u>**Construction of Large-Span Bridges and Viaducts**</u>

Sensitive areas :

1. ***Segment 2C – Sg. Klang crossing***

There will be a major crossing at the Sg. Klang near Kg. Kastam close to Port Klang. Crossing of the major river will require the construction of large-span bridge. On the low-lying areas of the alluvium, some viaducts will also be constructed to avoid flood or very soft ground that will cause some settlement or costly ground improvement.

A site-specific engineering geological investigation report shall be prepared as part of the project design. Evaluation of peat, soft clay or any hazards from the presence of weak zone shall be undertaken during subsurface geological investigations.

Long-span bridges along the alignment is an acceptable mean to connect rail segments. It should cause least disturbance to the environment and land use, provide considerable savings in time, economically feasible and have least impacts of supports structures (piers/ abutments) on land and water (ex-mining pond).

<u>**Limestone Bedrock and Mined Out Areas**</u>

Sensitive areas :

1. ***Segment 2A – Serendah***

In Serendah, the alignment will pass through some limestone bedrock and mined out areas (**Chart 7-37**). Dissolution of limestone in water forms karstic features such as steeply dipping bedrock, cavities, floaters and pinnacles, and is often associated with sinkholes and subsidence. Sitting on top of the limestone is the extremely variable soil properties and most of the time the soil is soft with SPT N-values of <5. Typical piling problems will be encountered during the construction stage due to the presence of karstic features in the limestone and soft soil overlying it.

Mining activities in the past has made the construction works more challenging. **Chart 7-38a** and **Chart 7-38b** show the alignment above the ex-mining lake. There are some other ex-mining areas on the schist and granite but the much-disturbed soil exhibits the same variability of soil properties.

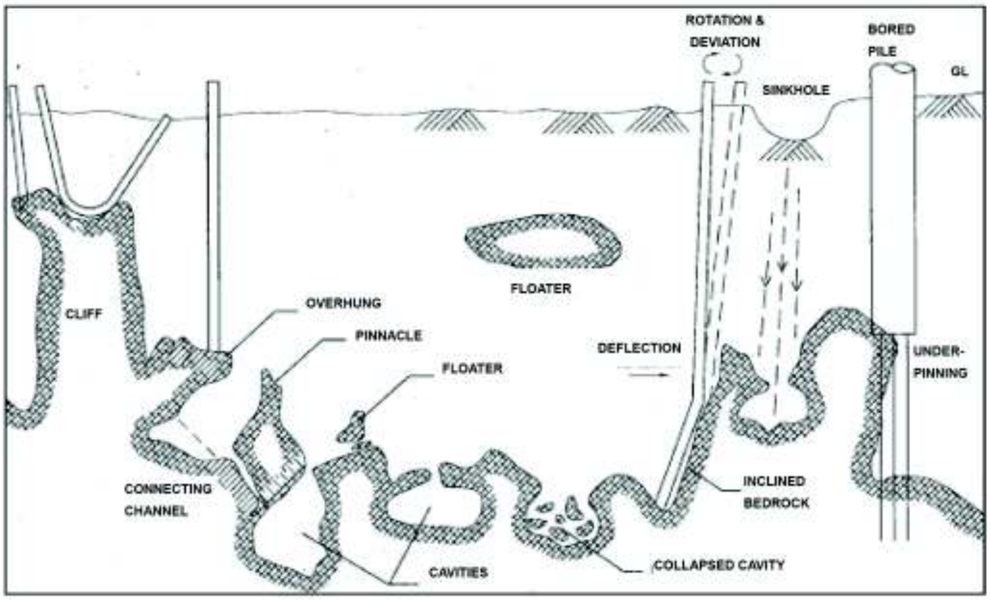

Chart 7-37 : Some piling problems in limestone formation (Neoh, 1998)

Chart 7-38a : Alignment crossing limestone and mined out areas

Chart 7-38b : Ex-mining lake within alignment ROW

Former coal mining areas

Sensitive areas :

1. *Segment 2B – Batu Arang*

Batu Arang is famous for the coal mining activities which started in the early 1900s where a study in 1910 revealed that mining was commercially viable at that area. In June 1913, the Malayan Collieries Ltd was formed to start mining operations in Batu Arang due to the high demand for coal at that time. However, mining operations has ceased in 1960. **Figure 7-39** shows the locations of nearby coal mining relicts.

Both open cast and underground coal mining methods were used in Batu Arang. The open cast mining methods leaves behind large mining pools that could be seen in the area today. Underground mining employed the bord and pillar mining methods. 'Pillars' of coal are left behind to support the roof and prevent collapse. Tunnels with rails were also used in some of the major coal deposits underground. Unfortunately mapping was not carried out during the mining, hence, the actual orientation, length and direction of the tunnels and adits are not known. Based on the extent of the coal seam, the alignment of ECRL Phase 2 is very likely to be away from the underground pillars and tunnels.

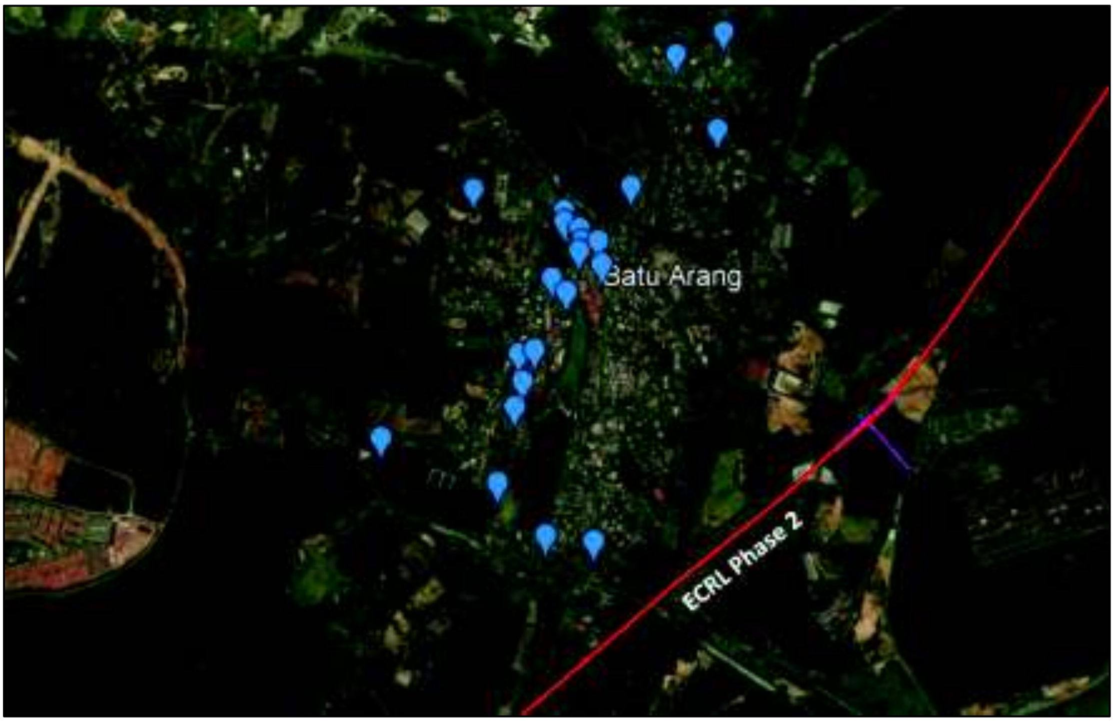

Chart 7-39 : Locations of coal mining relicts in Batu Arang

<u>Peatland Areas</u>

Sensitive areas :

2. Segment 2C – Peat areas from Kapar to Klang

Several locations in Selangor (**Chart 7-40**) are underlain by peatland. However, the railway line will not traverse the major peatland areas as most of the peatland are in the Selangor River Basin in the north and Langat River Basin in the south. However, small pockets of peat soil will be encountered during the construction. It is a major concern when constructing large projects like the ECRL with the presence of soft peat ground and occasional peat fire during dry season which is one of the major hazards in Malaysia.

Typical problems with peat areas are high groundwater table, high mobility flow failure, weak soil strength to support structural loading, excavation instability, consolidation & creep settlement and high permeability. All these properties lead to significant cost and delay in preparing the area and foundation for the railway tracks.

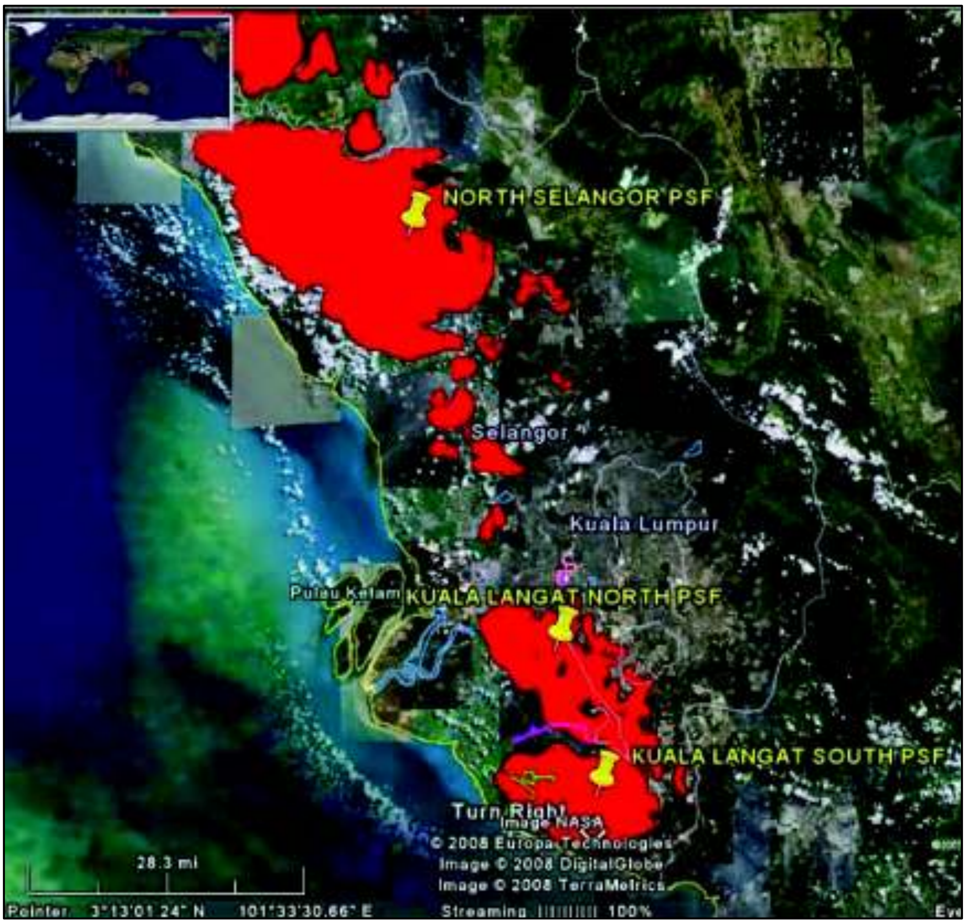

Chart 7-40 : Major peat areas in Selangor (Wetlands International – Malaysia, 2010)

<u>**Quaternary Alluvium Areas**</u>

Sensitive areas :

1. ***Segment 2C –Klang***

In the Klang area, almost 20 kilometres of the stretch of the rail line will be constructed on Quaternary alluvial soil. They are geologically young, loose, unconsolidated (not cemented together into a solid rock) soil or sediments, which has been eroded, reshaped by water in some form, and redeposited in a marine and non-marine environment. It consists of layers of sand, and fine particles of silt and clay with variable characteristics and strength. The clay is normally soft and compressible; hence, foundation improvement needs to be carried out as the heavy structure on top will load the soft sediment to make it settle. Several previous works concluded that the low strength of the clay layer in the Quaternary alluvium in Klang area contributed to certain degree of construction problems. The engineering problems with clay are settlement and stability.

At certain locations, peaty materials of a few meter thick overlain or mixed with the soft clay. Both are compressible, creep with very low strength. The peat is also highly permeable and decomposable. In this situation, it makes the layer even more difficult for construction.

Detailed site investigation is not a compromise in the construction of ECRL Phase 2 line through this soft material. Depending on the structure, certain ground characteristics may be more critical than others and especially big freight station at Kg. Kastam, by their very nature or setting, will be exposed to more geological risks. Proximity of the station to the Sg. Klang even increases the risk of existence of thick soft clay.

7.4.10 Ecology

Potential ecological impacts during the construction stage of the ECRL Phase 2 include disturbances, disruption, or degradation to the ecology of a specific site as well as its surrounding areas. These include deterioration of the ecosystem services a particular habitat may provide, loss of biological resources within a certain habitat, loss of ecological connectivity, as well as loss of beneficial uses by local and indigenous communities. The intensity of the ecological impacts towards a specific site will depend on the type of construction activity and method that will be carried out at the particular area.

Assessment Method

The main objective of the impact assessment is to identify potential ecological impacts the project will have during the construction phase. The purpose of the assessment is to assist in identifying relevant mitigation measures to minimise these impacts.

The main focus is to assess potential impacts at key areas (or hotspots) of concern along the alignment. This assessment was carried out in successive stages which entailed the following activities:

i. *Review of existing ecological information* - The existing ecological information described in Section 6 was reviewed to identify critical areas in Kelantan and Selangor that will potentially be affected during the construction stage. Hotspot areas were selected based on various factors; ecological connectivity, biological resources, ecosystem services and beneficial uses.

ii. *Identification and assessment of construction methods* – The construction methods that will be used specifically at the identified critical areas of concern were identified and assessed to determine the type of potential impacts that may occur, as well as the magnitude of the impact. The individual aspects of the construction method were taken into consideration during the assessments (e.g. cut and fill profile, tunneling methods, site preparation, tunnel portal dimensions etc.) when identifying the potential ecological impacts.

iii. *Review of existing topography and ecological characteristics* – To supplement the identification of the potential impacts, the existing topography and ecological characteristics of the critical areas of concern were also reviewed (via site recce reports as well as Google Earth imagery) to determine the magnitude of the potential impacts. This includes the terrain, density of forest cover, elevation and other characteristics of the area of concern.

iv. *Determining the magnitude of impact* – The magnitude of impact was determined based on the type of major potential impacts. For example, the magnitude of habitat fragmentation will be determined based on percentage of fragmentation over the total area while habitat loss will be determined based on calculation of forest loss in both PRFs and state land forests.

Overview of Major Potential Ecological Impacts

The existing ecological issues described in **Section 6.11.1** and **6.11.2** can be summarised into three major issues; (i) habitat fragmentation; (ii) habitat loss and disturbance; and (iii) human-wildlife conflicts. These issues are expected to potentially increase during the construction of the Project. **Figure 7.4.10-1** shows the major potential ecological impacts from the Project.

Habitat Fragmentation

Habitat fragmentation is the loss of connectivity between habitats due to various activities such as the establishment of linear infrastructures (e.g. highways and railways) and land clearing for agricultural plantations and development. This causes disruption in the natural biological processes, specifically those that depend on movement and connsectivity between habitats. Examples of such processes include pollination, seed dispersal and wildlife movement.

Most of the natural lowland habitats in Peninsular Malaysia have been heavily fragmented over the years due to urbanization and agricultural expansion. For instance, most of the Lowland Dipterocarp Forests in the Peninsular have been cleared, logged or converted into agricultural plantations, resulting in small, forest fragments or 'islands'. Although pristine lowland forests can still be found in the interiors of Peninsular Malaysia, dipterocarp forests in the Peninsular now generally comprises of hill and montane forests.

The construction of the ECRL Phase 2 is expected to result in habitat fragmentation at a few locations in Selangor, which will be described in Section **7.4.10.2**.

<u>Habitat Loss and Disturbances</u>
Construction of linear infrastructures will result in disturbances to natural habitats. However, this may also result in potential habitat loss depending on the severity of the disturbances. Severe habitat loss will not only result in the loss of the entire habitat, but also the loss of the floral and faunal communities that can be found in these habitats. Habitats such as coastal hill forests have been well documented to harbour rare and endemic flora and fauna, which can only be found in that particular habitat.

The construction of the ECRL railway and access roads are expected to result in habitat disturbances within the PRFs and state land forests. Some of these forests harbour plant species, which are in some form of conservation threat, while also serving as viable habitats for important wildlife and foraging grounds for local communities (see **Section 6.12.1** and **6.12.2**). As such, there may also be potential loss of habitats, as well as loss of flora and fauna species.

Based on estimation, the construction of ECRL Phase 2 railway will directly cause 19.6 ha loss of PRFs and 21 ha loss of state land forests. Most of these state land forests are earmarked to be cleared based on Selangor State Structure Plan (SSP), mainly for agricultural purpose. In any way, total forest loss from the Project is estimated to be around 41 ha.

<u>Human-Wildlife Conflicts</u>
Habitat loss and disturbances will result in the displacement of animal populations that will most likely retreat deeper into the surrounding forests. However, if resources are limited in the new foraging areas, some individuals will likely venture out of the forests.

i) In Construction Site

With the increase of human presence during construction, this may potentially result in an increase of human-wildlife conflicts (HWC) in construction site. Conflicts that can be generally expected during construction activities are intrusions/disturbances by wildlife often considered as pests such as wild boars and long-tailed macaques. However, there may also be potential conflicts involving larger mammals such as tapirs if construction activities are carried out in known hotspots for these animals. Conflicts with larger mammals may possibly result in equipment damage and threats to the safety of construction personnel, as well as towards the animal itself.

ii) In Surrounding Areas

HWC could occur in surrounding areas of the alignment corridor and construction site, such as residential areas, roads, and agricultural lands. This would be more critical at potentially fragmented wildlife habitats such as Rantau Panjang FR. These conflicts could result in injury, livestock damage, crop damage or property damage while causing danger to both humans and animals. There could also be vehicle-wildlife collisions during construction, where animals were forced to flee from affected forests to nearby roads. These collisions would result in high likelihood of both injury to the animal and/or people as well as vehicle damages.

Poaching

Site clearing activities during construction of the alignment as well as other infrastructures will result in more exposed and open areas, especially in forested areas. This may potentially increase the likelihood of poaching activities within forested areas, some of which are still hotspots for wildlife that are in some form of conservation threat such as the Malayan tapir. For instance, construction of access roads within forested areas will create easier access for poachers to enter the forest to hunt for wildlife. Poaching can also occur during construction activities, where nuisance wildlife may be killed to prevent future encroachments. In addition, there could be potential on illegal tree felling for fruits such as petai, gaharu from karas or tongkat ali. Forest products could also be harvested illegally for building material.

7.4.10.1 Segment 1 : Kelantan

Assessment Results

Habitat Fragmentation

In Kelantan, the alignment will not traverse through any PRFs. However, it will traverse through small patches of state land forests that mostly comprise of shrubs situated around rural housing areas. As such, construction of the ECRL Phase 2 in Kelantan will generally not result in significant habitat fragmentation.

Habitat Loss and Disturbances

Although the Alignment does not result in significant habitat fragmentation impacts, some habitat loss and disturbances will still be expected during construction. This will entail removal of vegetation at ground level, mostly in shrubs. As such, there will be minimal loss of forest along the alignment.

Human-Wildlife Conflicts

The loss of vegetation will result in the displacement of local wildlife populations that will most likely retreat into other areas to forage. In areas within the railway corridor in Kelantan, wildlife populations mostly consisted of macaques and wild boars which are known to forage in secondary forests as well as the rural community areas. Vegetation removal at the forested areas along the alignment may result in occasional encroachment by these animals, as well as other small mammals during construction.

7.4.10.2 Segment 2 : Selangor

Assessment Results

Segment 2A: Gombak North to Serendah

In between Gombak North and Serendah, the alignment will traverse across three forest reserves, which is part of the Selangor State Park – Ulu Gombak FR, Templer FR and Serendah FR. The alignment will traverse these forest reserves via a 9 km tunnel starting from west of Taman Desa Utama before Ulu Gombak FR and will emerge at the state land forests located west of Serendah FR.

Table 7-67 : Permanent Reserved Forests affected between Gombak North to Serendah

PRF	Type	Classification	ECRL Alignment/Chainage	Loss of PRF	Degree of Fragmentation
Ulu Gombak	Protection Forest	Water Catchment Forest	Tunnel for approx. 700 m CH 1800 – CH 7200	0 ha	Negligible
Templer	Protection Forest	Wildlife Protection Forest	Tunnel for approx. 2.6 km CH 1800 – CH 7200	0 ha	Negligible
Serendah	Protection Forest	State Park Forest	Tunnel for approx. 5 km CH 1800 – CH 7200	0 ha	Negligible

Table 7-68 : State Land Forests affected between Gombak North to Serendah

District	Area	ECRL Alignment/Chainage	Loss of Vegetation
Gombak	State land forest south of Ulu Gombak FR	Tunnel for approx. 4.2 km At-grade for approx. 1.2 km CH 1800 – CH 7200	4.75 ha
	State land forest north of Setia Eco Templer	Tunnel for approx. 800m At-grade for approx. 250 m CH 13000 – CH 13250	0.56 ha
Hulu Selangor	State land forest west of Serendah FR	Tunnel for approx. 400 m At-grade for approx. 1.1 km CH 18900 - 20000	7.0 ha

<u>Habitat Fragmentation</u>

Construction of the railway will not result in habitat fragmentation at the Ulu Gombak FR, Templer FR and Serendah FR as the tunnel will be constructed underground entirely. The tunnel will maintain the integrity of the Selangor State Park and will not hinder wildlife movement.

Habitat Loss and Disturbances

Due to provision of tunnel and tunnel entrances located outside of the forest reserves, there will be zero vegetation loss expected from construction activities. However, the alignment will result in some loss of forest in state/private land, specifically at the area south of Ulu Gombak FR, west of Templer FR and west of Serendah FR. The state land forests surrounding Temper FR is presently undergoing earthworks for development of new residential houses.

It is expected that there will be minimal vegetation loss at tunnel entrances in these state land forests, which will be from ground level up to a height of 8m and an area of approximately less than 0.01 ha. Vegetation removal in state land forests is also expected at the construction of the alignment at-grade before and after the tunnel, which will amount to approximately 12.3 ha.

In addition, the affected area in the state land forests may harbour similar species to the adjacent forest reserves. Loss of fauna is also expected to be minimal in the three PRFs, however tunneling activities may cause temporary vibration and noise disturbances to animal populations. As such, most animals will likely retreat deeper into the surrounding forests and possibly return after completion.

Human-Wildlife Conflicts

In Selangor, most reported human-wildlife conflict cases in Gombak and Hulu Selangor are related to small mammals especially macaques, wild boars, and civets. Vegetation removal in state land forests near the Selangor State Park may result in this wildlife retreating into other areas such as residential houses, plantation land and roads. This could potentially create HWC incidents including road kills. Additionally, there may be potential encounters with small mammals such as macaques and wild boars or reptiles such as snakes during construction, which may potentially lead to injuries if the animals are startled or provoked.

Section 6.11.2.3 describes that there was uncommon human-tiger-conflict case where strayed Malayan Tiger was spotted nearby Templer FR in 2015. But this is an uncommon situation since the areas where the alignment will traverse through is not a known habitat for Tiger according to DWNP Selangor. However, a portion of the alignment (250 m) in state land forests nearby Templer FR would be on at-grade. Therefore, they may be a minimal chance of strayed tiger encountered during construction of the railway.

Poaching

Site clearing activities to build new access road, tunnel entrances and railway in state land forests surrounding the Selangor State Park will create more exposed and open areas. Some of the wildlife that inhabits the Park are species of IUCN concerns such as the rare Clouded Leopard, which exploitation for its pelts are well documented in several countries. Moreover, during wildlife survey, several signs of poaching activities such as old campsite, animal traps and gun pellet casing were spotted by DWNP Selangor especially in Ulu Gombak FR. Temporary access points during construction may increase likelihood of poachers to trespass into the affected forest reserves within the Park.

Segment 2B: Serendah to Bandar Puncak Alam

In between Serendah to Bandar Puncak Alam, the alignment will traverse across the southern tip of Rantau Panjang FR on at-grade. The alignment will also traverse a large patch of state land forest in Serendah before entering the reserve.

Table 7-69 : Permanent Reserved Forests affected between Serendah to Bandar Puncak Alam

PRF	Type	Classification	ECRL Alignment/ Chainage	Loss of PRF	Degree of Fragmentation
Rantau Panjang	Production Forest	Plantation Forest	At-grade for approx. 3.0 km CH 35000 – CH 38000	19.6 ha	55 ha/3431 ha = 1.6%

Table 7-70 : State Land Forests affected between Serendah to Bandar Puncak Alam

District	Area	ECRL Alignment/Chainage	Loss of Vegetation
Hulu Selangor	State land forests adjacent to North-South Expressway	At-grade for approx. 450 m Elevated for approx. 250 m CH 27800 – CH 28500	1.85 ha
	Hutan Sungai Buaya	Tunnel for approx. 1.8 km At-grade for approx. 400 m CH 28500 – CH 30700	1.74 ha
	Private land forest next to Rantau Panjang FR (east)	At-grade for approx. 300 m CH 34700 – CH 35000	0.9 ha

<u>Habitat Fragmentation</u>

Based on estimation, the railway by itself will fragment Rantau Panjang FR by 1.6% i.e. 55 ha of land will be separated from the whole 3431 ha of land of the reserve. However, presently the Rantau Panjang FR have been fragmented by the existing Jalan Batu Arang, which has separated the forest reserve into three 'islands'. Being a plantation forest, there are numerous patches within the reserve that has been converted into agricultural land, most notably rubber plantation in the middle/eastern section and Selangor Fruit Valley in the northern section. Although the alignment is only traversing through the southern tip of the reserve, it is still expected to further fragment the Rantau Panjang FR.

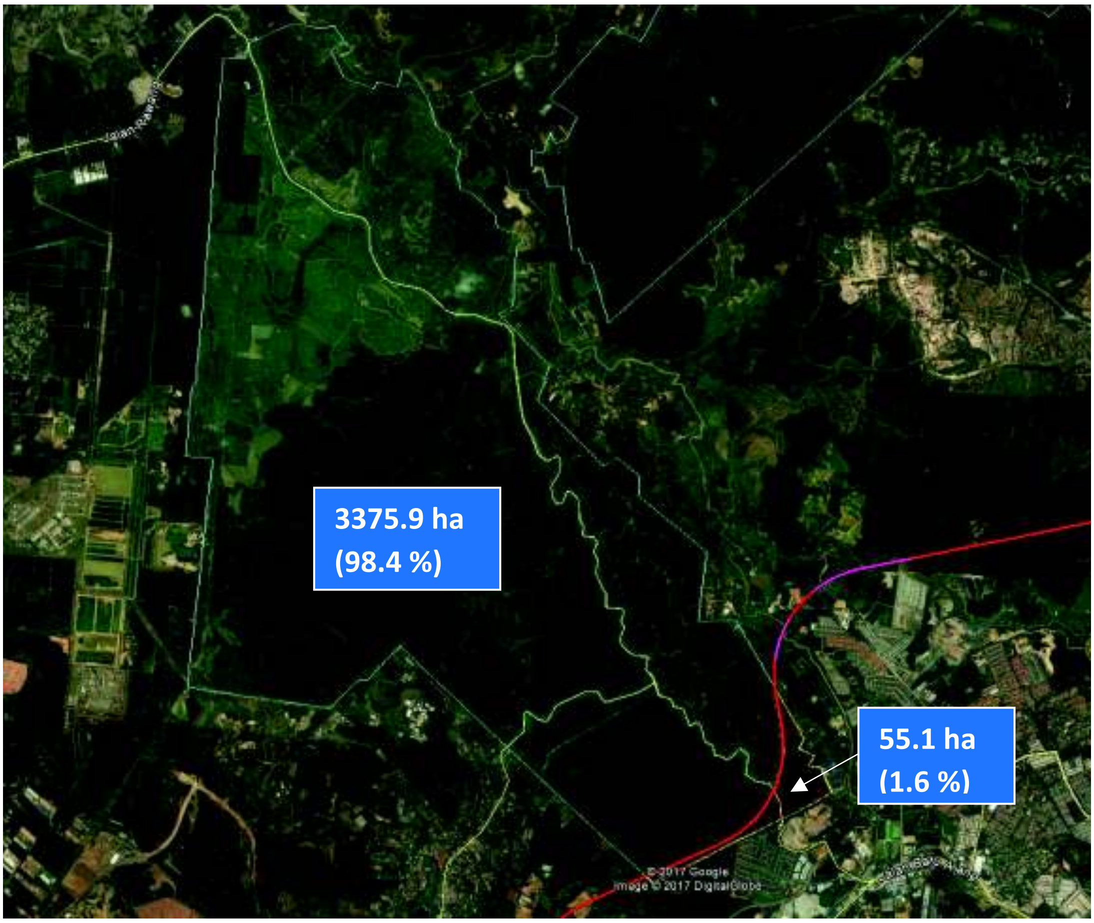

Plate 7-1 : Degree of fragmentation in Rantau Panjang FR

The Hutan Sungai Buaya in Serendah between CH 29600 and CH 30700, which is marked as agricultural land use in Selangor SSP, will experience fragmentation of lowland forests in the western section since the alignment will tunnel through 80% of the forest. However, fragmentation impact is expected to be minimal since a 1.8 km tunnel is provided in the hilly section of the forests.

Habitat Loss and Disturbances

The alignment will directly result in habitat loss and disturbances in Rantau Panjang FR, since the construction of embankment will result in forest loss of approximately 19.6 ha. The area of the alignment corridor within the Rantau Panjang FR does not contain any rare or endemic species, this forest contains few timber species of commercial size and value, as well as rubber trees. Loss of habitats is expected to have direct impact on fauna populations notably endangered mammals such as tapirs, which have been recorded in the proposed affected areas. Besides loss of habitat, construction activities such as building of access road and railway will cause temporary disturbances to animal populations and minimal loss of vegetation.

Human-Wildlife Conflicts

In between Serendah to Bandar Puncak Alam, the Rantau Panjang FR is known to harbour two Malayan Tapirs. Additionally, two human-tapir conflicts have been reported in areas surrounding Rantau Panjang FR between 2012-2016. During construction, common mammals such as macaques and wild boars may be encountered by construction workers. Wild boars can become a problem with construction workers when provoked or startled as they have been known to cause serious injuries to humans. Tapirs on the other hand are generally shy creatures and will most likely retreat further into the forests during construction.

Although the construction of the alignment at Rantau Panjang FR is close to the southern border of the reserve, vegetation removal activities may result in wildlife crossing Jalan Batu Arang to forage into new areas. This may then lead to an increase in animal mortality rates, especially for the Malayan tapir. Road kills are one of the leading causes in the continuous decline of Malayan tapir populations in Peninsular Malaysia. Tapirs have been known to cross roads and expressways which bisect forested areas and have become frequent victims of vehicular collisions at night as their black-and-white markings make it difficult for drivers to spot them from afar. In addition, there would also be potential increase in human-tapir conflicts incident in surrounding areas of Rantau Panjang.

Poaching

The railway in Rantau Panjang FR will be constructed on embankment. Therefore, site clearing activities to build new access road and railway within Rantau Panjang FR will result in more exposed and open areas. This could provide easy access to poachers and illegal hunters to enter the forest reserve. The Rantau Panjang FR have been known to be trespassed frequently in the past, especially by construction workers looking for food during lunch time. During the site visit, several used trails and rubbish were seen up to 80m from the forest edge. Furthermore, during wildlife survey, a poachers camp site was spotted (and demolished) by DWNP Selangor. Without an effective awareness programme, poaching and hunting can also occur during construction activities, where nuisance wildlife may be killed to prevent future encroachments.

In 2017 alone, there have been two cases reported in Peninsular Malaysia where tapir body parts were extracted almost immediately after a road kill incident. Although this is uncommon and the reason for the extraction is still unclear, this creates a major concern for the tapir population in Rantau Panjang FR in the future if there is a demand for tapir body parts for health benefits or other uses.

Segment 2C: Bandar Puncak Alam to Port Klang

Between Bandar Puncak Alam and Port Klang, the alignment will not traverse any PRF or major natural habitats. However, in Klang, the railway will traverse across mangrove areas in Sungai Puloh on embankment (590 m) and elevated (910 m) for approximately 1.5 km.

Table 7-71 : State Land Forests affected between Bandar Puncak Alam to Port Klang

District	Area	ECRL Alignment/Chainage	Loss of Vegetation
Klang	Sg. Puloh Mangrove Forest	At-grade for approx. 600 m Elevated for approx. 900 m CH 69800 – CH 71300	4.0 ha

Habitat Fragmentation
The alignment will affect two parts of Sg. Puloh mangrove forest, the northern and southern section. According to the Selangor State Structure Plan, the northern section is classified as public green space while the southern section is earmarked as development zone for industry. Fragmentation will be a concern in the northern section as opposed to the southern section. In the southern section, a large chunk of mangrove forest is currently being cleared for industrial development. This may affect the ability of the mangroves to function as natural flood mitigation and barriers for the surrounding areas, which include small fishing villages. Animal populations such as wild boars, macaques and kingfishers which inhabit the mangrove may also be isolated as a result.

Habitat Loss and Disturbances
The construction of railway is expected to result in loss of mangrove trees in Sg. Puloh such as bakau minyak (*Rhizophora sp.*), bakau putih (*Bruguiera cylindric*) and nyireh bunga (*Xylocarpus granatum*) that will reduce the size of the existing habitat and affect its multiple functions such as a natural flood control barrier and food resources for wildlife over the long term. Loss of shelter and food resources is expected to affect mangrove residents such as egrets, herons, raptors (birds of prey), mangrove snake, crabs, monitor lizards and mudskippers. There will be approximately 3.5 ha loss of mangrove trees in northern section and 0.5 ha of loss of mangrove trees in southern section of mangrove forest.

Human-Wildlife Conflicts
Human-wildlife conflict involving macaques will be expected during construction activities in Klang. The region of Klang have recorded highest HWC cases (60%) in Selangor from 2012-2016, although 95% of these reported cases involved macaques. Without proper housekeeping and cleanliness in construction site and surrounding environment, there will be huge possibility of macaques encroaching into construction site to forage for food.

Summary

Table 7-72 : Summary of Potential Ecological Impacts during Construction

Potential Impacts	Habitat Fragmentation	Habitat Loss/Disturbances	Human-Wildlife Conflicts/Poaching
Kelantan			
Pengkalan Kubor – Kota Bharu	Low • No major habitat and PRFs affected	Low • No major habitat and PRFs affected	Low • Most existing HWC cases are small mammals.
Selangor			
Gombak North-Serendah	Low • Railway entirely underground through the Selangor State Park • Fragmentation degree is 0%.	Low • Zero loss of vegetation in Selangor State Park and PRFs • Total loss of forest in state land at 12.3 ha	Low • Minimal HWC since tunneling won't result in major habitat disturbances. • Poaching risk during construction
Serendah-Puncak Alam	Low • Alignment fragment the southern part of Rantau Panjang FR • Fragmentation desgree is 1.6%in Rantau Panjang FR	Low • Plantation forest with no species of conservation importance • Loss of PRF at 19.6 ha in Rantau Panjang FR • Total loss of state land at 8.7 ha	Moderate • Possible HWC at construction site and surrounding areas involving small mammals and tapirs • Poaching risk during construction
Puncak Alam-Klang	Low • No significant habitat fragmentation • Most animals are macaques, birds with no large endangered mammals	Moderate • Mangrove forest have been disturbed and of poor quality • Total loss of state land forest at 4.0 ha	Low • Most HWC would be human-macaque conclicts

7.4.11 Socio-Economy

During the construction stage, it is expected most of the issues and concerns during pre-construction have been resolved or actions are being taken to resolve them. At this stage, there are a different set of social impacts that stem from close proximity to the alignment. Many of the negative impacts are expected to be temporary, linked to construction which in the case of ECRL extends over a period of 7 years. This is a lengthy period so the public have to endure considerable disturbances in their daily lives to accommodate construction activity.

During construction, not all impacts are negative. The positive impacts are mostly economic. Construction works bring positive impacts at both national and regional levels. Two benefits are job creation and generation of business opportunities. These will raise GDP and increase income through job creation.

Negative impacts from construction are temporary; linked to construction timeline of 7 years. These negative impacts combine both environmental and social impacts. Due to close proximity to the alignment and construction worksites, people would probably experience negative impacts during construction.

7.4.11.1 Potential Positive Impacts During Construction

The most important positive impacts during construction is the catalytic effect on the economy as monies and investments are pumped into the regional and local economy from construction contracts, purchase of building materials, hiring of workers, both skilled and less skilled, and the acquisition of supplies and goods within the local economy.

Stimulate Direct Growth

It is expected that related construction work will have significant economic impact. The expected activities that would boost the national, regional and local economy are:

- Business opportunities from contractors and subcontractors;
- Trading opportunities;
- Opportunities for provision of basic and other services for the contractors;
- Influx of workers and their expenditures on local goods and services;
- Provision of housing for construction key personnel;
- Increased revenue and taxes from construction activities

The local economy is expected to experience a catalytic effect as the construction of ECRLP2 will increase jobs for local entrepreneurs and sub-contractors and suppliers.

At the same time, local authorities could also benefit-from increased revenue through direct and indirect taxes and other revenue sources.

Creation of Direct and Indirect Jobs

The impact on job creation during construction is likely to be high. It is estimated that during the peak construction period, the demand for workers could touch easily 15,000 and rise to a peak of 30,000. Most of the jobs are temporary but they are significantly huge.

Construction activities will create jobs in the following areas:

- Work on site
- Professionals
- Skilled workers
- Work in trade
- Work in services
- Non-skilled workers

The employment benefits during the construction phase are positive, since it relates to the project activities, induced by increased employee spending. Considering that a bigger proportion of the total population is economically inactive, the project will increase opportunities for a bigger percentage of the population by giving them access to employment opportunities.

7.4.11.2 Potential Negative Impacts During Construction

The most important positive impacts during construction is the catalytic effect on the economy as monies and investments are pumped into the regional and local economy from construction contracts, purchase of building materials, hiring of workers, both skilled and less skilled, and the acquisition of supplies and goods within the local economy.

The negative impacts stem mainly from construction activities being in close proximity to settlements and people. Construction activities change the environment around them as they create noise, dust, and noise. From the potential negative environmental impacts, there are also social concerns over their safety and security, health and tensions with foreign workers.

Degradation of Living Conditions and Erosion of Quality of Life

The risks to existing quality of life relate to disturbances created by construction activities that degrade or damage the existing environment in neighbourhoods that are close to construction sites. This degradation erodes the quality of life of the local population when in the absence of the ECRL development; most people in the ZOI have indicated during the survey that they are satisfied with the current neighbourhood.

The following are the impacts on the living conditions in communities close to construction activities.

a. Dust and air pollution
b. Noise and vibration
c. Flooding
d. Traffic congestion

Risk to Public Safety and Security

a. Site Safety and Security

Most of construction activities along the railway will be safety risks to local residents because they are often located some distance away. Despite this, there could be potential risks, especially if locals are not familiar with site safety procedures and constraints imposed on movements into construction sites. If such rules and regulations are not adhered to or if local population accidently trespasses onto construction sites due to ignorance, then, they will be in danger and run the risk of being hurt. They will be exposed to danger from construction vehicles and falling debris, from construction works.

b. Severance Effects and Road Safety

People staying in close proximity to construction sites fear construction vehicles in their narrow rural roads will pose a danger to them, particularly the young and elderly. Their roads would be damaged by potholes and these, in turn, will be a danger for local road users, especially those using motor bicycles.

c. Petty Crimes and Security Issues

During construction of ECRL, the demand for construction workers is anticipated to rise significantly. While efforts will be taken to recruit local workers, the expectant huge demand during the peak of construction entails hiring of foreign workers. These are to fill vacancies for medium to low skilled workers. The local population, particularly those in Kelantan are apprehensive about having so many foreign workers in their midst. It also appears to be the same among those in Gombak, Serendah, Kapar in Selangor. The concerns stem from fears that foreign workers will be moving freely among local settlements during work hours and off-work hours.

The perception is these workers could contribute to the rise in crime rates in their areas.

Social and Cultural Tensions and Conflicts

The fear over the presence of foreign workers in their midst as a result of ECRL construction is probably because locals in Kelantan tend to associate foreign workers having different cultural and social behaviour that does not align with theirs. They could be prone to alcohol consumption; they are said to disturb local female population, and some behaviour could be intrusive and culturally and socially offensive to the local community.

Risk to Public Health

Construction activities may increase the potential for community exposure to health, safety and security. Health concerns includes exposure to diseases arising from temporary or permanent changes in population; exposure to hazardous materials during construction and transport of raw and finished materials. The presence of a large number of workers can give rise to an increased spread of communicable diseases. Construction projects are commonly associated with social interactions amongst the construction workers and local communities. Thus, their overall health is crucial for the safety of nearby local residents as an outbreak of diseases will be problematic.

The summary of potential impacts during construction stage is described in **Table 7-73**.

Table 7-73 : Potential Social Impacts during Construction Stage

Affected States	Potential Social Impact		
	Positive Impact-Benefits		
Kelantan	1.	Stimulates growth of local economy	Construction activities are expected to stimulate growth of local economy through the provision of business opportunities for local subcontractors, traders and suppliers of local goods and services. The influx of construction workers and other workers generate demand for local goods and services. The net effect will be a rise in income levels among local population. It will improve their standard of living and quality of life.
Kelantan	2.	Creates direct and indirect jobs. reduces youth unemployment, and raises income levels	The creation of jobs, both direct and indirect, by the ECRL construction will help people in the East Coast. It is especially important for unemployed local youths because not only will they find employment, their skills could be enhanced, increasing their long term employability. The overall impact is an increase in income levels.

	Negative Social Impact		
	1.	**Deterioration of living conditions and erosion of quality of life**	
Kelantan Selangor	• Dust and air pollution • Noise and vibrations		Most people in the ECRL ZOI appear to be very satisfied with their neighbourhood and its conditions. Thus, they fear that construction of ECRL will disturb them through disruptions and upheavals to their living conditions. They are worried over dust and air pollution, noise and vibrations, floods and traffic congestion. Concerns over dust and air pollution are exceptionally high among respondents in Kelantan.
Kelantan	• Floods		Flooding is a common in the East Coast states and there are fears it would be aggravated during construction.
Selangor	• Traffic congestion		Disruptions to local traffic are likely to be limited to where the alignment cuts through busy, local roads. Potential affected areas in Selangor where locals believe that traffic here will become congested during construction.
	2.	**Risks to public safety and security**	
Kelantan Selangor	• Site Safety and Security		Most ECRL construction activities are expected to be a distance from settlements and residents but there could be potential areas where they may be in close proximity. A problem with such proximity is the local population may ignore safety rules and trespass into such sites; they could then be in danger. Some people, especially the elderly or schoolchildren, may accidently stray into these areas and are exposed to danger and harm. There are safety procedures in place for construction workers; non-workers are usually prohibited from entering construction sites. However, in predominantly rural areas, it is feared that local population may not be aware of this safety rule. Daily, there are risks at construction sites and it is not easy to ensure these places are always accident- free.
Kelantan Selangor	• Severance effects and road safety		Construction activities could also result in severances in neighbourhoods. Local roads could be blocked and communities may be fragmented by construction works temporarily. These severances affect both people and even farm animals. Mobility is restricted; people's daily routine is disrupted. They have to take detours to reach local destinations. Some local people could ignore these blockages and attempt to continue with their routine and in doing endanger their lives. Business and farming activities could be restricted and hindered. Access to shops and businesses could be blocked. Access to agricultural holdings may also be blocked. Even the aboriginal groups may find their access to their orchards and jungles being restricted during construction. Rural roads are usually narrow and may not accommodate heavy construction vehicles. People worry that such

<table>
<tr><td></td><td></td><td>vehicles will damage their roads, cause accidents and are a hazard to local motorists and motorcyclists.

All these will alter people's usual lifestyle. It will lead to general unhappiness among the local population when they cannot see the direct benefits to them.</td></tr>
<tr><td>Kelantan
Selangor</td><td>• Petty crimes and security issues</td><td>The potential influx of foreign construction workers makes some rural communities in Kelantan apprehensive over any possible negative impacts on the safety and security of their villages. The same view is held by those in Gombak. There is a fear that petty crimes may increase. It is perceived that foreign workers may freely move around and intrude into villagers. The village folks fear that foreign workers may be involved in petty crimes or they may engage in hostility among themselves and these conflicts spill into nearby local communities.</td></tr>
<tr><td rowspan="2">Kelantan
Selangor</td><td colspan="2">3. Social and cultural tensions and conflicts</td></tr>
<tr><td colspan="2">The local population in Kelantan have indicated that they prefer not to have foreign construction workers living in their midst. The differences in cultural and social behavior would create tensions among them resulting in social conflicts. A major fear is for the safety of the local female population. Similar reservations over foreign workers can be found among some stakeholders in Selangor.</td></tr>
<tr><td rowspan="2">Kelantan
Selangor</td><td colspan="2">4. Risks to public health</td></tr>
<tr><td colspan="2">Endangerment to public health is crucial for the welfare of the entire community. The risk stems from foreign workers who could spread communicable and infectious diseases as well as bring into the local community, diseases that are no longer present. The local population is afraid of being exposed to communicable diseases from foreign workers.

Dirty work sites which may be breeding grounds for diseases like Malaria and Dengue can add to the problem.</td></tr>
</table>

7.4.12 Traffic

Traffic congestion is one of the major impact resulting from the roadside construction. Construction work at the roadside and/or shoulder will reduce the effective lane width of the road which causes capacity reduction. In addition, the access of the construction traffic on roads which move at a slower speed creates temporary moving bottleneck that causes the queue to build up quickly. Traffic congestion causes traffic delay and inconvenient to the road users especially to those who are regular users.

The existence of construction traffic with heavy vehicles and construction material is expected to impose traffic safety to the vulnerable road users, such as motorcyclist, bicyclist, and pedestrian. This is especially important as some of the access roads in concern are single carriageway, narrow and with unpaved shoulder. In addition, some of these roads are the major access roads to the residential areas.

The major impact caused by the proposed construction works for stations involves reduction in terms of lane width and working area being located on the road shoulder. Effectively, this reduction in lane width and road shoulder would cause an impact in terms of reducing capacity of carriageways. It is assumed that the reduction of lane width (from approximately 3.25m-3.5m to 2.75m-3.0m) would reduce the effective lane capacity by 15%. Insufficient road capacity will cause temporary bottlenecks that disturb smooth flow of vehicles. In addition, traffic safety risks would arise as a result of reduction in lane width and road shoulder closure. Vehicles will be forced to squeeze into narrower lanes whilst motorcyclists will find difficulties to maneuver in between traffic. Construction traffic access to the site imposes safety risks to the road users, especially vulnerable road users such as pedestrians, cyclists and motorcyclists. This is especially a concern if the access roads used are local streets in the vicinity of residential or school areas. Excavation activities are heavy on the underground segment and station construction.

The concern during construction stage is described in the following sections.

7.4.12.1 Segment 1 : Kelantan

The alignment traverses along green field areas away from major roads. The concern of roadside construction that will obstruct traffic is insignificant in this context.

The construction traffic is expected to come from Jalan Pengkalan Kubor and Jalan Kota Bharu – Pengkalan Kubor which is a 2-lane single carriageway. It is the major access road to the commercial and residential area in the vicinity of the station. This is because drivers tend to slow down and reduce speed when traveling through construction areas. In addition, the presence and/or access of construction traffic (such as trucks) to the site creates temporary bottlenecks that will block the smooth flow of traffic. This escalates the congestion problem. Residents staying along these roads or the ECRL alignment corridor, such as Kampung Kok Semru, Kampung Kok Serai, Kampung Pauh Sebanjan, Kampung Ketil, Kampung Telaga Lanas, Kampung Belukar, Taman Sri Rokma, Kampung Lati, Kampung Delima and others, are more likely to be affected.

7.4.12.2 Segment 2 : Selangor

The 4 stations in Selangor are located away from major roads. The concern of roadside construction that will obstruct traffic is insignificant in this context.

Segment 2A: Gombak North to Serendah

Serendah Station

For the Serendah Station, construction traffic is expected to come from Federal Route 1 (north or south) and turn into Jalan Indah, a 2-lane single carriageway, which is the major access road to several residential areas such as Laman Serendah, Taman Melati, Kampung Damai, Taman Desa Kiambang, and Taman Serendah Indah. The road is narrow with unpaved shoulder. The existence of construction traffic might pose safety risks to the residents in these areas.

Segment 2B: Serendah to Bandar Puncak Alam

Puncak Alam Station

As for the Puncak Alam Station, construction traffic is expected to access the construction site through Persiaran Puncak Alam 6 (dual-2 carriageway) and Persiaran Puncak Alam 10 (dual-2 carriageway). These roads are the main access roads to the residential areas in Bandar Puncak Alam. Although the existing traffic volume is low, the existence of the construction traffic on these roads poses higher accident risks on the vulnerable road users.

Segment 2C: Bandar Puncak Alam to Port Klang

Kapar Station

For the Kapar Station, construction traffic access road to Jalan Haji Abdul Manan might cause some disruption to the road and junction nearby considering that the road is narrow and with no shoulder. Besides, the junction of Jalan Meru Tambahan/Jalan Haji Abdul Manan is congested during peak hours. Jalan Haji Abdul Manan is currently performing at level of service F during peak hours. With the existence of construction traffic, it could be anticipated both the road and the junction would further deteriorate with traffic congestion.

Jalan Kastam Station

For the Jalan Kastam Station, construction traffic is expected to access the construction site via Jalan Kurau or Persiaran Raja Muda/Jalan Kapar. Jalan Kapar is a major access road to the commercial and residential area in its vicinity. The existence of construction traffic on these roads pose accident risks on the vulnerable road users.

In addition, the presence and/or access of construction traffic (such as trucks) to the site create temporary bottlenecks that block the smooth flow of traffic. This escalates the congestion problem. Most of these roads will be performing at LOS C or LOS F during the construction stage.

Table 7-74 shows the summary of the critical concern for these stations while **Table 7-75** shows the road performance during construction stage.

Table 7-74 : Critical Issues and Impacts for Railway Segments

Station	Construction Access Road	Issue/Impact
	Kelantan	
Pengkalan Kubor	Jalan Pengkalan Kubor	• 2-lane single carriageway with low capacity. • It is a major access road in the area connecting to local villages. • Potential safety risk to the vulnerable road users of the road.
Wakaf Bharu	Jalan Kota Bharu-Pengkalan Kubor	• 2-lane single carriageway with low capacity. • Traffic condition will deteriorate with slow moving heavy trucks. • It is a major access road in the area connecting to local villages. • Potential safety risk to the vulnerable road users of the road.
	Selangor	
Serendah	Jalan Indah	• 2-lane carriageway, narrow and with unpaved shoulder with low capacity. • It is a major access road in the area connecting to local residential areas. • Potential safety risk to the vulnerable road users of the road.
Puncak Alam	Persiaran Puncak Alam 10	• It is a major access road in the area connecting to the residential areas. • Potential safety risk to the vulnerable road users of the road.
Kapar	Jalan Haji Abdul Manan	• Existing traffic condition at level of service F is expected to deteriorate further with the existence of construction traffic. • Congested junction at the major access road. • Roadside construction of station access road would escalate traffic delay and congestion.
Jalan Kastam	Jalan Kastam	• 2-lane single carriageway with narrow lane width. • It is a major access road in the area connecting to the residential areas. • Potential safety risk to the vulnerable road users of the road.

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Table 7-75 : Road Performance during Construction Stage

Station Location	Road Between Station	No of lanes for existing condition	Capacity Veh/hr	Existing v/c ratio (worst case)	No. of lanes during construction	Capacity during Construction	Construction Stage Vol/Cap Ratio	Level of Congestion
Kelantan								
Pengkalan Kubor	Jalan Pengkalan Kubor	2	2,200	0.15 (A)	2	2,000	0.16 (A)	Low
Wakaf Bharu	Jalan Kota Bharu	2	2,200	0.23 (A)	2	2,000	0.25 (A)	Low
Selangor								
Serendah	Federal Route 1 (FR 1)	4	4,800	0.58 (C)	4	4,000	0.69 (D)	Medium
Puncak Alam	Persiaran Puncak Alam 10	2	3,600	0.28 (B)	2	2,000	0.51 (C)	Medium
Jalan Kapar	Jalan Haji Abdul Manan	2	2,200	1.13 (F)	2	2,000	1.24 (F)	High
Jalan Kastam	Jalan Kastam	2	2,200	0.45 (C)	2	2,000	0.50 (C)	Medium

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7.4.13 Hazards & Public Safety

It is important that the construction of the Project is accompanied by adequate public safety considerations. This is crucial for people living or working close to the Project site. Road users along roads where the alignment and stations will be constructed are also at risk. Inadequate consideration of public safety during construction may cause the following:

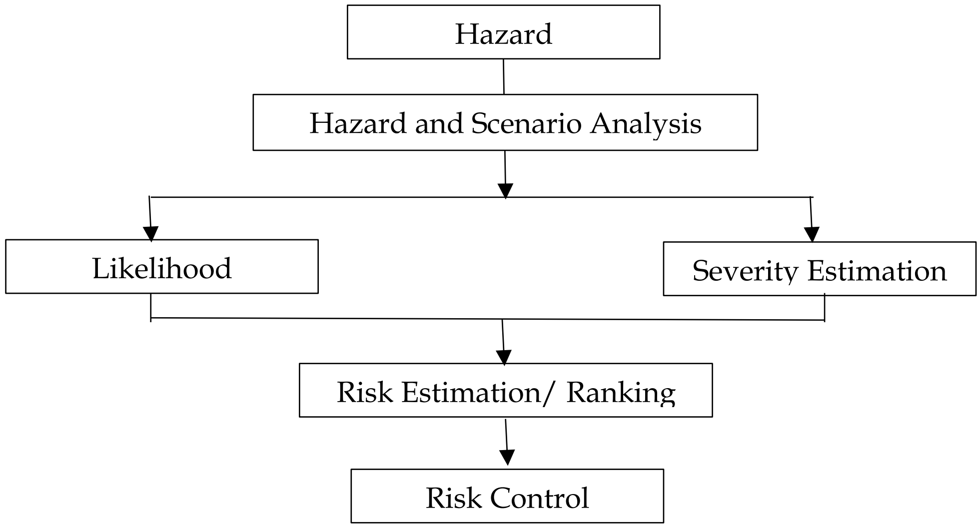
- Increased risk of injuries or fatality to public
- Damage to property
- Increased risk of accidents associated with transportation of construction materials and machinery.

7.4.13.1 Methodology

A risk assessment was carried out based on the Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC), 2008 published by the Department of Occupational Safety and Health (DOSH). The methodology for risk assessment is based on the following stages (**Chart 7-41**):

- Hazard identification – to identify all major potential hazards related construction of the Project;
- Frequency estimations – to estimate the likelihood of the hazards/ rates of occurrence;
- Consequence estimation – to estimate the severity of the damage due to the hazards;
- Risk estimation and ranking – integration of frequencies and consequences to produce a ranking through risk matrix;
- Risk control – proposed mitigation measures to reduce and minimise the potential hazards.

Chart 7-41 : Risk Assessment Methodology



<u>Hazard identification</u>

This step involves the identification of hazardous events, their potential causes and consequences of such events. During the construction stage, the Project activities can be further divided into different stages. These include the following:

- Utilities relocation
- Tunnel construction
- Railway and spurline construction near to existing roads, crossings or intersections
- Elevated works such as bridge, viaduct and road over bridge construction
- Station construction

The major hazards which may potentially arise from the various construction works or activities are summarized in **Table 7-76**.

Table 7-76 : Hazard Identification

HAZARDOUS EVENT	POSSIBLE CAUSES	POSSIBLE CONSEQUENCES
(A) Utilities Relocation		
(1) Leakage of natural gas from gas pipeline relocation/ working on gas pipeline right of way	• Collision impact • Valve failure • Human error/ negligence	• Release of flammable vapour • Fire from immediate ignition • Explosion upon delayed ignition • Injury/ fatality to public & workers on site • Damage to property and other utilities
(2) Exposed utilities wires/ cables from relocation exercise	• Collision impact • Human error/ negligence	• Electrocution • Injury/ fatality to public and workers on site • Damage to property
(3) Vehicular accident	• Temporary closure/ diversion of road • Road diversion • Speeding • Human error/ negligence	• Traffic congestion • Injury/ fatality to public
(4) Flash flooding at the construction area	• Heavy rain • Clogging of the drainage system	• Loss or damage of construction material • Injury due to slipperiness, falling in ditches • Health impact such as dengue
(5) Occupational & safety hazard	• Use of heavy machinery • Working within enclosed areas	• Injury/ fatality to public and workers on site
(B) Tunnel Construction		
(1) Sudden settlement	• Weak foundation of soil/rocks due to varying geological conditions of site	• Landslide/ tunnel collapse • Damages to properties • Injury/ fatality to public and workers on site
(2) Blasting effect	• Improper use of explosive material • Human error	• Vibration • Property damage
(3) Flooding in the tunnel	• Inadequate tunnel lining • Heavy rain, groundwater seepage & high-water table	• Loss or damage of construction material • Injury (from falling and others) • Health impacts such as dengue

Table 7-76 : Hazard Identification (Cont'd)

HAZARDOUS EVENT	POSSIBLE CAUSES	POSSIBLE CONSEQUENCES
(3) Flooding in the tunnel	• Work areas near to stream	• Health impacts such as dengue
(4) Occupational and safety hazard	• Heavy machinery • Impact by falling objects • Loading and unloading of construction material • Malfunction of machinery and equipment	• Injury/ illness/ fatality to public and workers on site •
(C) Railway and Spur Line Construction	•	•
(1) Vehicular Accident	• Temporary closure/ diversion of road • Loading and unloading of construction material	• Injury/ fatality to public • Traffic congestion
(2) Occupational and safety hazard	• Heavy Machinery • Loading and unloading of construction material • Malfunction of machinery and equipment	• Injury/ illness/ fatality to public and workers on site
(3) Flash flooding of the construction area	• Heavy rain • Clog drainage system	• Injury due falling and others • Loss or damage of construction material • Health impact such as dengue
(D) Elevated Works (Bridge, Road Over Bridge & Viaduct Construction)		
(1) Vehicular accident	• Temporary closure/diversion of road • Loading and unloading of construction material • Impact by falling objects	• Traffic congestion • Injury/ fatality to public
(2) Occupational and safety hazard	• Heavy machinery • Impact by falling objects • Loading and unloading of construction material • Impact of falling from working at height • Malfunction of machinery and equipment	• Injury/ fatality to public and workers on site

Table 7-76 : Hazard Identification (Cont'd)

HAZARDOUS EVENT	POSSIBLE CAUSES	POSSIBLE CONSEQUENCES
(E) Train Stations Construction		
(1) Vehicular accident	• Temporary closure/diversion of road • Loading and unloading of construction material	• Traffic congestion • Injury/ fatality to public
(2) Occupational and safety hazard	• Heavy machinery • Impact by dropped objects • Loading and unloading of construction material • Malfunction of machinery and equipments	• Injury/ fatality to public and workers on site
(3) Flash flooding of the construction area	• Heavy rain • Clogging of drainage system	• Health impact such as dengue • Loss or damage of construction material • Injury due to slipping or falling

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Likelihood and Severity Estimation

The likelihood and severity of the identified hazards were estimated. Rating value of 1-5 were used to quantify the likelihood or severity of the hazard scenario (**Table 7-90**) where value 1 indicates that the event is unlikely to happen or to cause injury while value 5 indicates that the event is almost certain to happen or cause fatality (**Table 7-91**).

Risk Evaluation (Risk Ranking)

After carrying out the likelihood and severity estimation for each hazard event/ scenario, the risk evaluation/ ranking was carried out. Risk was calculated using the following formula:

Risk = Likelihood x Severity

The result of risk evaluation is tabulated in **Table 7-77**. The hazardous events can be categorized into 3 categories, i.e. low risk (1-5 score), medium risk (6-12 score) and high risk (13-25 score) (**Table 7-78**).

Table 7-77 : Likelihood and Severity Categories

Likelihood	Description	Rating	Impact Severity	Description
Almost Certain	Happens frequently (>10 times within the project)	**5**	Severe	Widespread permanent damage with fatality case
Very Likely	Could happen frequently (>3 times within the project)	**4**	Major	Significant permanent damage with serious injury
Likely	Could happen occasionally (<3 times within the project)	**3**	Moderate	Moderate to high damage requires specialist to repair, medical treatment required
Unlikely	Could happen rarely (1 time within the project)	**2**	Minor	Minor damage with some repair required, first aid required
Very Unlikely	Probably will not happen (has never occurred)	**1**	Minimal	Negligible damage with none medical treatment required

Table 7-78 : Likelihood and Severity Score of Potential Hazard

Scenario	Hazardous Event	Score*		
		Likelihood	Severity	Risk
A1	Leakage of natural gas pipelines	2	5	10
A2	Exposed utilities wire/cable	3	3	9
A3	Vehicular accident	3	4	12
A4	Flash flooding	3	3	9
A5	Occupational and safety hazard	3	4	12
B1	Sudden settlement	2	3	6
B2	**Blasting effect**	**3**	**5**	**15**
B3	Flooding in tunnel	2	3	6
B4	Occupational and safety hazard	3	4	12
C1	Vehicular accident	3	4	12
C2	**Occupational and safety hazard**	**3**	**5**	**15**
C3	Flash flooding	3	3	9
D1	Vehicular accident	3	4	12
D2	Occupational and safety hazard	4	5	**20**
E1	Vehicular accident	3	4	12
E2	**Occupational and safety hazard**	**4**	**5**	**20**
E3	Flash flooding	3	3	9

A=Utilities Relocation; B=Tunnel Construction; C=Railway and Spur Line Construction D=Elevated Works (Bridge, Road Over Bridge, and Viaduct Construction); E=Train Stations Construction
*Rating score values are based on professional judgement with reference to past experience of other similar project and analysis.

Table 7-79: Risk Ranking

	Probability				
Severity	**1**	**2**	**3**	**4**	**5**
1	-	-	-	-	-
2	-	-	-	-	-
3	-	B1, B3	A2, A4, C3, E3	-	-
4	-	-	A3, A5, B4, C1, D1, E1	-	-
5	-	A1	B2, C2,	D2, E2	-

Risk Ranking:

Low	Medium	High

7.4.13.2 Segment 1: Kelantan

a. Assessment Results

Based on the risk assessment carried out (**Table 7-79**), occupational and safety hazard during the construction of Wakaf Bharu Station and Pengkalan Kubor Station, elevated works at Kg. Pauh Seberang (CH 2000), Kg. Kubang Panjang (CH 7000), Kg. Kubang Gajah (CH 8900), Kg. Kubang Batang, (CH 13100), Kg. Alor Durian (CH 17500), and Kg. Tendong (CH 20600) will pose high safety risk to the public since the population is within 100 m of the construction sites.

Other construction activities along the alignment were assessed to have medium safety risk. Flash flood may potentially occur which may pose danger to public if the temporary or existing drain nearby is not provided or properly maintained.

7.4.13.3 Segment 2 : Selangor

a. Assessment Results

The construction activities at the following areas in Selangor segment was assessed to pose high safety risk to public:

- Serendah Station and Jalan Kastam Station;
- Elevated works at Hospital Orang Asli Gombak (CH 500), Kg. Batu Dua Belas Gombak (CH 800), Taman Jasa Utama (CH 7400), SJK (C) Serendah (CH 22500), Kampung Tok Pinang (CH 22800), SJK (T) Sg. Choh (CH 27000), Kampung Koksan (CH 27500), Taman Kapar Setia (CH 63300), Kapar Indah Industrial Park (CH 66000) and Kampung Sireh (CH 76700);
- Tunneling works at 10 tunnels in this segment, with tunnel lengths ranging from 0.32 km to 5.64 km. The tunneling works which involve controlled blasting also pose high safety risk especially near to Batu Dam.

The railway alignment near at-grade section at CH 60050 and CH 65290 will cross the PGU pipeline while some parts of future Kapar Station are located very near to the PGU pipeline. Extra caution is needed when working within the natural gas pipeline ROW or relocating the pipeline as any accidents can cause injuries or even fatality to the public in the surrounding areas.

Other construction activities along the alignment was assessed to have medium safety risk. Flash flood may potentially occur which may pose danger to public if the temporary or existing drain nearby is not provided or properly maintained

7.4.13.4 Summary

According to occupational accident statistics by DOSH, about 233 accidents with fatalities were reported in year 2016 where construction sector is one of the sectors which recorded the highest number of fatalities. The Construction Industry Development Board (CIDB) has identified six major causes of accidents at construction sites, i.e. fall from a height, hit by objects, pinned by building materials or machinery, buried under collapsed holes, fire and electrocution.

From the assessment, it showed that blasting activities during tunneling and occupational and safety hazard for the construction poses high risk that could result in fatality. Other hazard scenarios such as utilities relocation, flash flood and vehicular accident poses medium risk. Public safety will be compromised in the event any hazardous events occurred during construction, particularly if such event take place near populated areas.

The safety risk can be controlled with various measures to reduce or avoid risk from occurring. The proposed control measures are described in **Section 8**.