CHAPTER 7

EVALUATION OF IMPACTS

7.1 IDENTIFICATION AND PREDICTION OF IMPACTS

7.1.1 Introduction

This chapter describes impacts associated with the activity in the execution of land preparation activity and forest plantation. These are typically temporary, short-term impacts and probably can be long term impacts with improper management. These impacts are discussed in this chapter together with its mitigation measures in **Chapter 8** that proposed to reduce the impacts.

The potential impacts will be identified under the following environmental factors:

- Soil erosion and sedimentation
- Hydrology
- Water quality
- Air and noise pollution
- Wildlife management
- Flora and fauna
- Human and Socio-Economic
- Flood risk

7.1.2 Basis of Assessment

The assessment of potential impacts is based on the project activities as outlined by the project proponent. Each activity is determined using the methods that will be employed together with the work schedule. Potential and significant impacts are identified, analyzed and appropriate mitigation measures recommended.

There will be some alteration of the land forms in the project site. All the activities must be performed during the relatively dry season.

Table 7.1.1 shows the matrix of the major development activities and the critical issues identified which are discussed further in subsequent paragraphs. All the impacts from the project activities are significant but manageable.

Table 7.1.1: Basis Assessment Matrix

Key

Insignificant and excluded from Matrix

± Environmental impact that is potentially but on a temporary basis and will assue equilibrium after certain period of time

X Environmental impact that is potentially significant but about which there is insufficient data to make a reliable prediction. Close monitoring and control is recommended.

√ Potentially significant adverse environmental impact for which a design solution has been identified.

* Residual and significant adverse environmental impact

Ø Significant environmental enhancement

				PROJECT ACTIVITIES														
				SITE INVESTIGATION			CONSTRUCTION							OPERATION AND MAINTENANCE				
				SURVEY	INVESTIGATION	LAND ACQUISITION	ACCESS ROADS	SITE CLEARING	EXCAVATION	DRAINAGE	EROSION CONTROL	UTILITIES	ABANDONMENT	EQUIPMENT OPERATION	WASTE DIPOSAL AND RECOVERY	PRODUCT STORAGE	SPILLS AND LEAKS	ABANDONMENT PLAN
			Identification of Activities															
ENVIRONMENTAL COMPONENTS	PHYSICOCHEMICAL	LAND	Landforms															
			Soil Profile				√			√								
			Soil Compaction															
			Slope Stability				√			±	x							
			Subsidence and Compaction															
			Seismicity															
			Flood Plains/Swamps															
			Land use															
			Engineering and Mineral Resources															
			Buffer Zones															
		SURFACE WATER	Shore Line															
			Bottom Interface															
			Flow Variation															
			Water Quality				x			±	x							
			Drainage Pattern							√								
			Water Balance															
			Flooding															
			Existing Use															
		GROUND WATER	Water Table															
			Flow Regime															
			Water Quality															
			Recharge															
			Aquifer Characteristics															
			Existing Use															
		ATMOSPHERE	Air Quality				√											
			Air Flow															
			Climatic Changes															
			Visibility				√											
		NOISE	Intensity				√											
			Duration															
			Frequency															
	BIOLOGICAL	SPECIES AND POPULATION	Terrestrial Vegetation				Ø											
			Terrestrial Wildlife				Ø											
			Other Terrestrial Fauna				Ø											
			Aquatic/Marine Flora															
			Fish															
			Other Aquatic/Marine Fauna															
			Marine Habitats															
			Marine Communities															
	HUMAN	HEALTH AND SAFETY	Physical Safety				±					±						
			Psychological Well-Being															
			Parasitic Disease															
			Communicable Disease															
			Physiological Disease															
		SOCIAL AND ECONOMIC	Employment									x						
			Housing															
			Education															
			Utilities															
			Amenities															
			Property & Settlement															
		ASTHETIC AND CULTURAL	Landforms															
			Biota															
			Wilderness															
			Water Quality															
			Atmospheric Quality															
			Climate															
			Tranquility															
			Sense of Community															
			Community Structure															

7.1.3 Zone of Impact

The significant impact of the project site has been identified from a broad perspective and it has been expressed in **Figure 7.1.1**. For the project development, all these mentioned impacts below were considered and significant:

i. In worst case scenario, the erosion and surface water runoff from the project site will finally flow into Sg. Gesau tributaries and Sg. Slim. The guideline by Department of Drainage and Irrigation (DID) in order to preserve the river buffer zone must be followed.

ii. Wildlife habitat and their ecosystem will definitely have affected by forest plantation. It will stress them out and felt threatened. As mentioned in **Chapter 6** under **Subchapter 6.4 - Biological Study**, there is totally protected (TP) and protected (P) species of mammals and avifauna has been found in this project site.

iii. Human-wildlife conflict is expected to occur since monkey (long-tailed macaque and pig-tailed macaque) and wild boar were found in this project site. The nearest settlement area is about 3 km radius from the project site.

The other potential impacts will be discussed in next paragraph. However, all the mentioned impacts can be manageable with the proposed mitigation measures as discussed in this report.

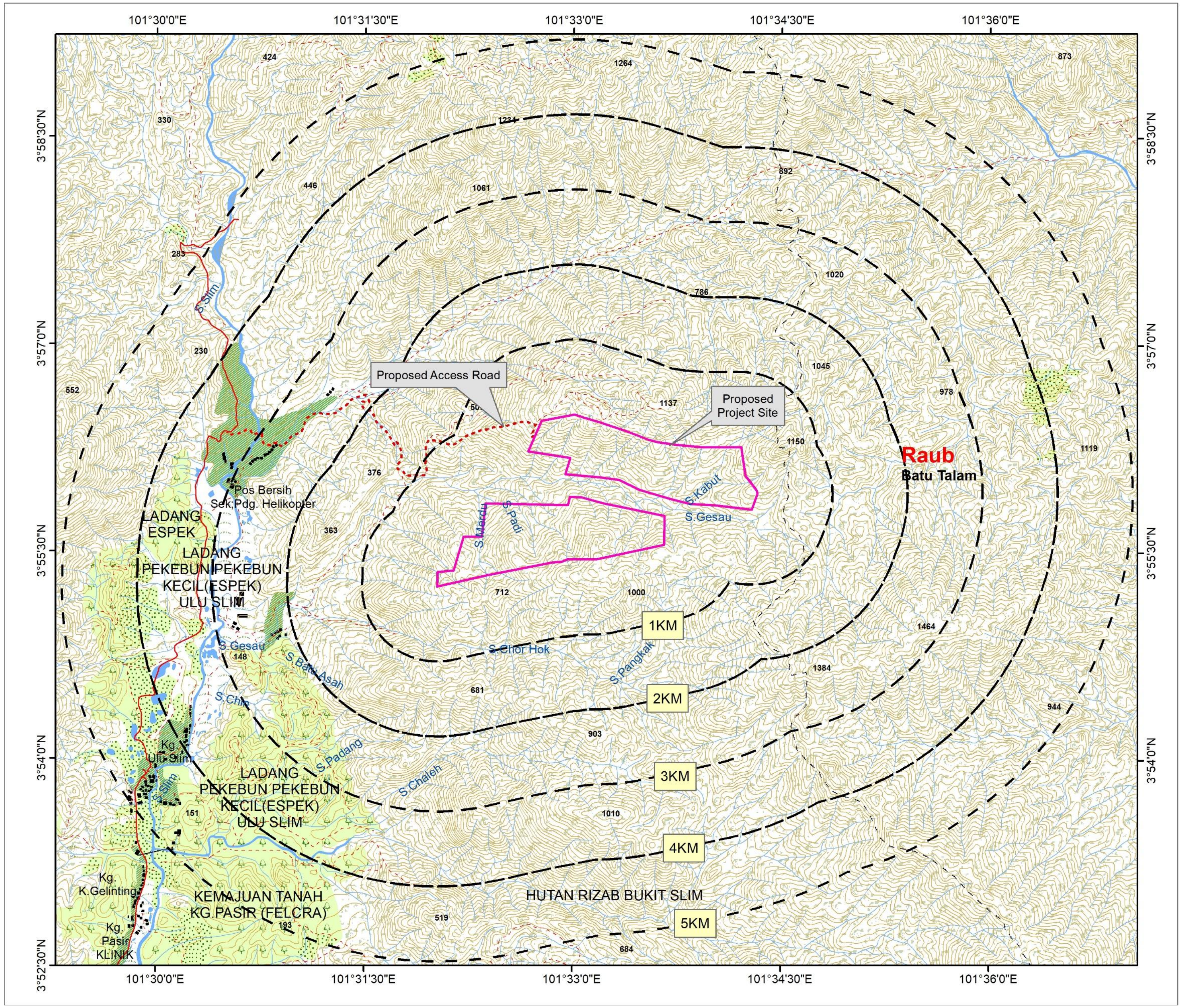


Figure 7.1.1: Zone of Impacts

7.1.4 Nature of the Environmental Effects

During project development, especially during construction and operational phase, there will be slight changes towards environment. The changes might occur in air quality, water quality and ambient noise.

a. Air Quality

- The air quality will slightly decrease due to the present of vehicles and machineries used in the project site within the development period.
- The dust from unsealed road will be dispersed and suspended in the air.
- The quality of air also disturbed by the emission of exhaust gas from the combustion of hydrocarbon fuels.
- The disturbance towards the air quality will involve in short period of time as the project goes by. The air quality will back to normal after the abandonment program start.

b. Water Quality

- Diminution of water quality might happen due to the application of fertilizer, pesticides and agricultural chemicals.
- Excessive of phosphate lead to eutrophication.
- Sewage from the project site will lowering the water quality and emits bad odor.
- Accident spillage from skid tanks, oil and grease potentially happen due to improper management/handling of the component.
- Degradation of water quality will leave impact to the aquatic lives.

c. Noise

- The machineries and vehicles used will increase the ambient noise.

d. Flora & Fauna

- Disturbance towards fauna will happen in and surround the project site.
- Migration and encroachment of fauna on the project site will occur throughout the development phase.

7.1.5 Sources of the Impacts

It might be different sources of impacts come from the project site activities. However, the expected impacts can still be prevented if the mitigation measures are carried out properly. Thus, in this section it highlights the source of impact of the project site.

a. Soil erosion

- Mainly caused by the development in the project site
- Exposure on forest floor towards rainfall
- The surface runoff will lead to sedimentation to the rivers

b. Water Quality

- Improper surface runoff from the land preparation activity will results in declining water quality.
- Improper sewage management will decline the water quality.

c. Air Quality

- Dispersed dust from the road surface.
- Vehicle and machineries operated inside the project site appeal to become major contributor to air pollution.

d. Noise Pollution

- Increase the ambient noise level in the project site.

7.2 DETAILED EXAMINATION OF IMPACTS

Predicted potential impacts involve the surrounding elements such as water quality, air quality, ambient noise, soil loss, fauna and flora. Impacts are assessed through different methods for different aspects to be studied.

7.2.1 Potential Impacts during Project Development

7.2.1.1 Soil Erosion and Sedimentation

Soil erosion and sedimentation is major potential impacts that will occur from unmanageable development and preparation activity of forest plantation. The long duration of exposure before establishment of the cover crops and indigenous seedling itself may cause significant deterioration of soil structure and affect the water quality in adjacent water body due to erosion and sedimentation processes. Sg. Gesau as well as its tributaries and Sg Slim will potentially be affected. There will be an increase in the turbidity level, changes in color and reduction in water visibility. The soil erosion processes will also reduce soil nutrients in the project site.

The uncovered soil surface for prolonged period will extend the exposure time to the weather elements that lead to soil erosion process. The direct impacts of water droplets increase soil dispersion, surface sealing, runoff, erosion and crusting. Soil crusting processes will turn the soil particle into a soil crust which is much more compact. A surface crust indicates poor infiltration and increase runoff and erosion, a problematical seedbed, and reduced air exchange between the soil and atmosphere. Excessive tillage tends to break up soil clods into smaller sizes more susceptible to breakdown, bury most plant residue and accelerate decomposition of organic matter. The poor function will restrict seedling emergence. The phenomenon is likely to happen in bare area such as access road, skid trail and landings/log yard area.

The loose and friable soil is extremely convenient to be washed out by the surface runoff during heavy rainfall and enter the river system. The sedimentation process in the receiving rivers affects the water quality and aquatic ecosystems. The sedimentation that occurs can cause disturbance of aquatic ecosystem such reduction of fish spawning areas. Excessive sedimentations will reduce river depth or drain capacity and aggravate higher flood peak that causes higher flood damages.

a. Soil Erosion Risk

The estimation of soil loss during the development phases are based on four conditions as follows:

1. Scenario 1: During construction (without BMPs)
2. Scenario 2: During construction (with BMPs)
3. Scenario 3: During operation
4. Scenario 4: Worst case

The results of the soil loss potential calculations in the project site for all the scenarios are shown in **Table 7.2.1**. The amount of soil loss was calculated for each phases development. High amounts of soil loss are expected to occur in the worst case scenario when conservation practices are not adopted. The detailed calculations are shown in **Appendix 7**.

Table 7.2.1: Estimation of Soil Loss by Phase Development (With Mitigation, Zero Mitigation, Operation and Worst Case)

STAGE	PETAK	AMOUNT OF SOIL LOSS (TONNE/HECTARE/YEAR)			
		DID METHOD			
		WITH MITIGATION MEASURES	ZERO COST MITIGATION MEASURES	OPERATION	WORST CASE
1	1	19.33	108.26	15.47	386.66
	2	11.34	63.48	9.07	226.70
2	3	24.53	137.35	19.62	490.55
	4	23.15	129.64	18.52	463.00

Source: Consultant's Calculation

Note: For DID method, the R value was taken from the Guideline for Erosion and Sediment Control in Malaysia, (DID Malaysia).

The details of calculation can be referred in **Appendix 7**.

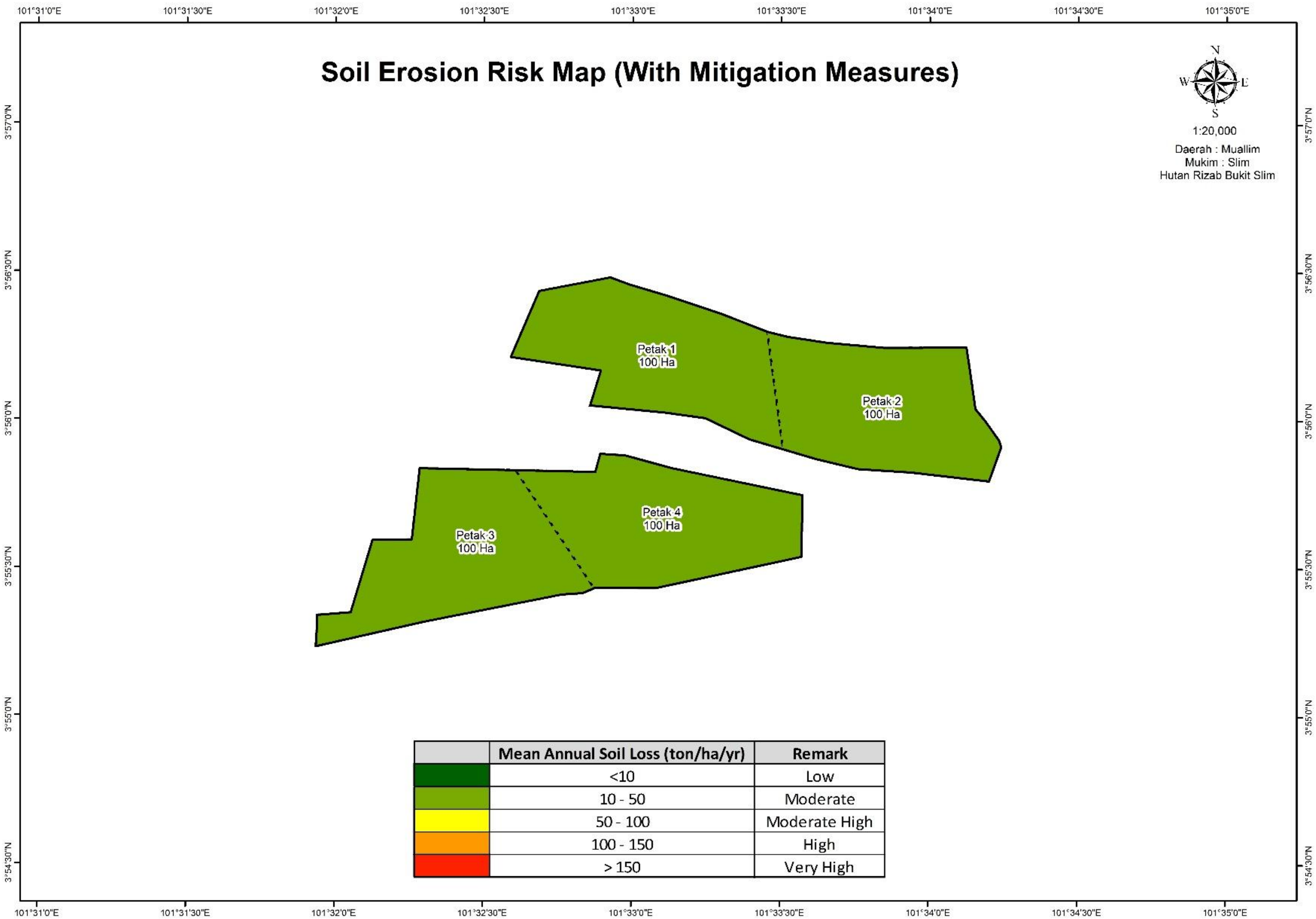


Figure 7.2.1: Soil Erosion Risk Map (With Mitigation Measures)

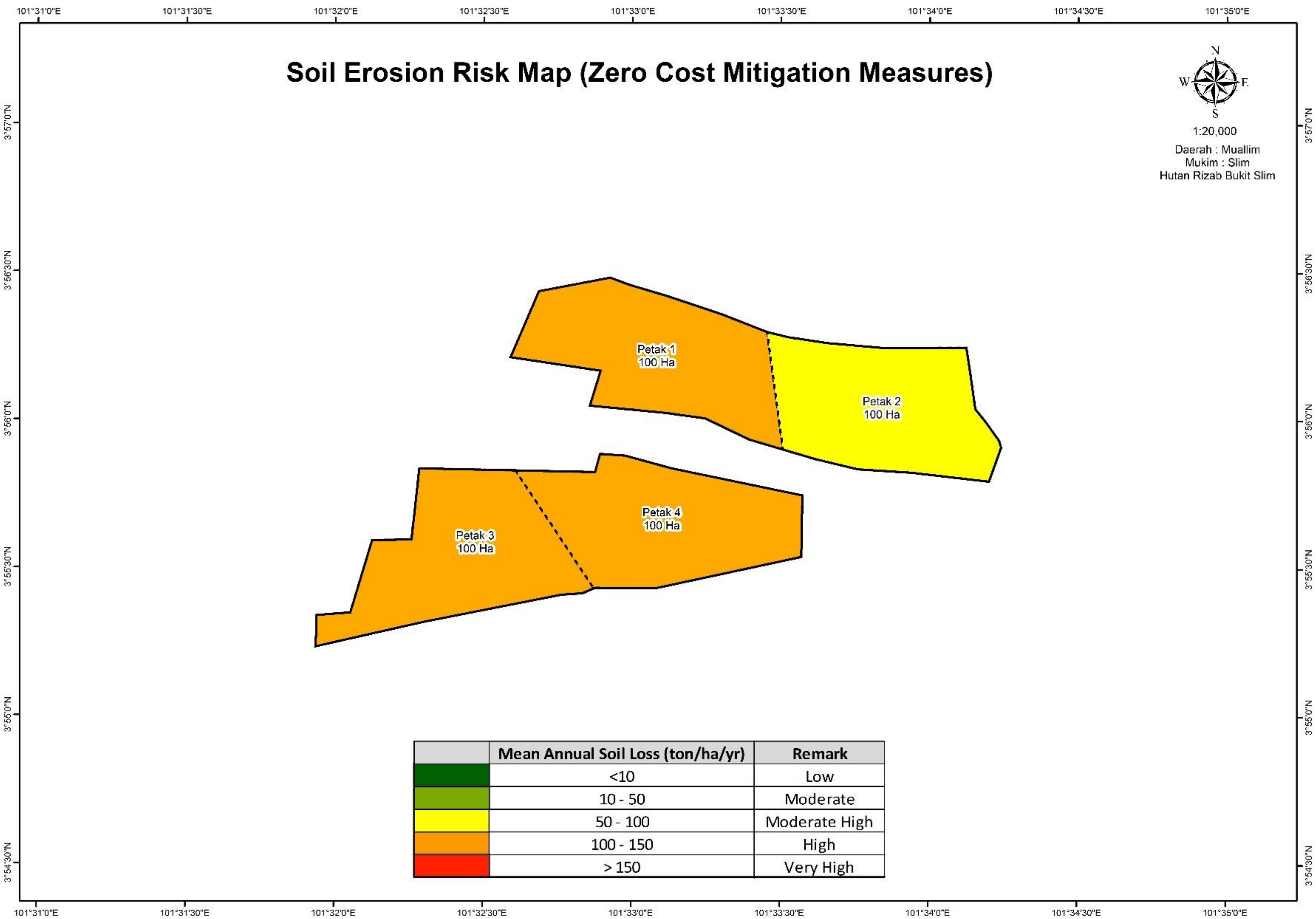


Figure 7.2.2: Soil Erosion Risk Map (Zero Cost Mitigation Measures)

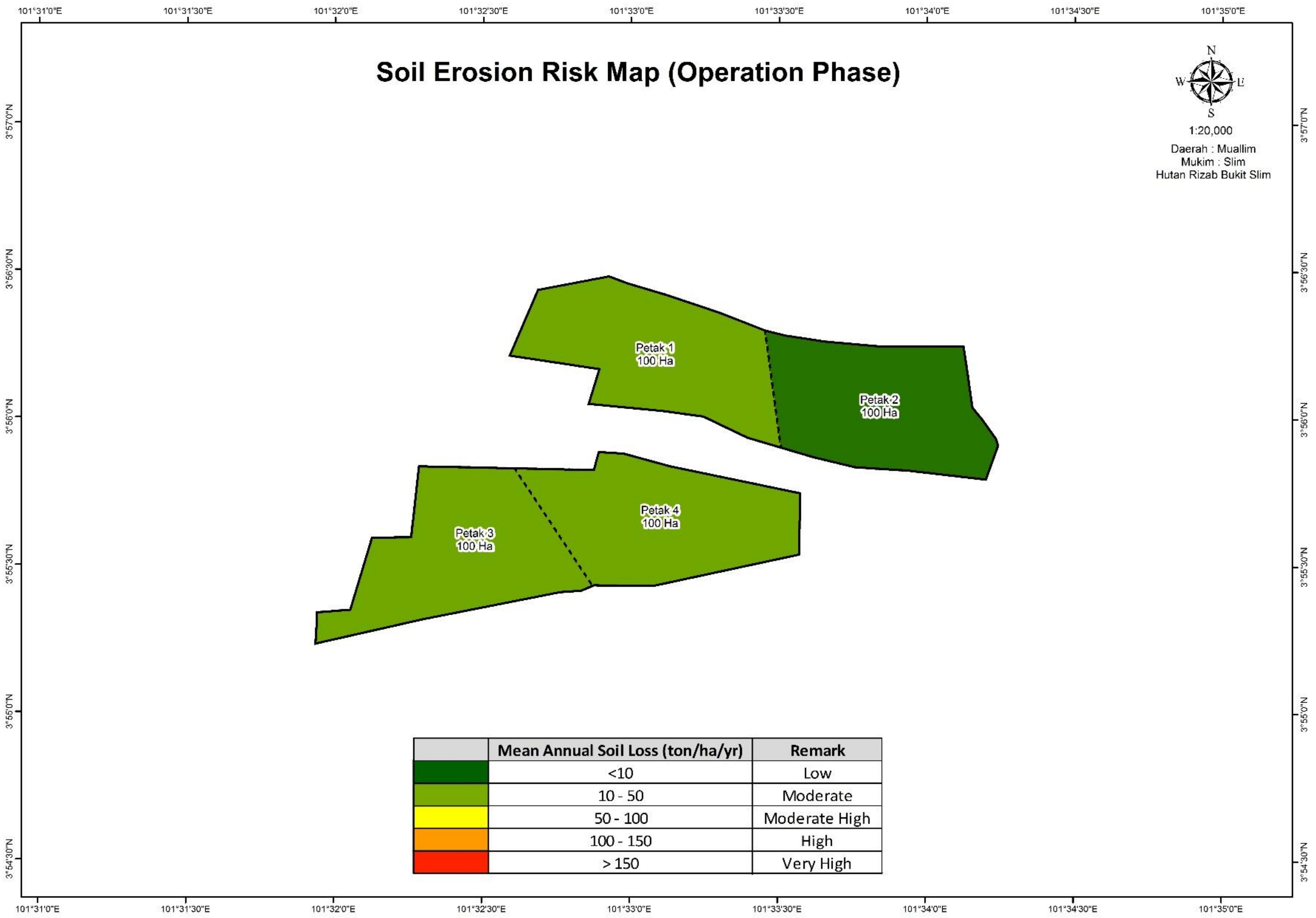
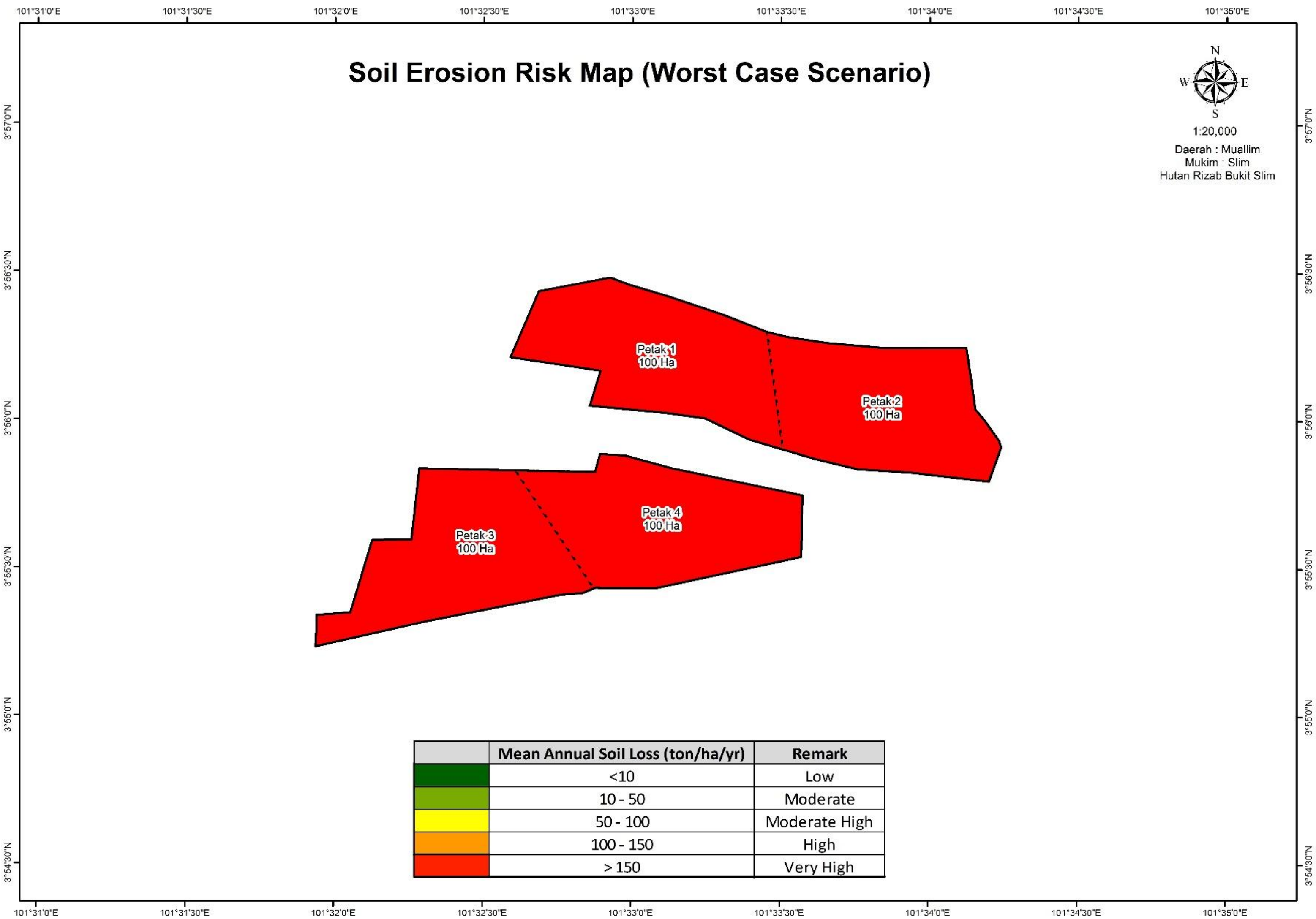


Figure 7.2.3: Soil Erosion Risk Map (Operation Phase)



	Mean Annual Soil Loss (ton/ha/yr)	Remark
	<10	Low
	10 - 50	Moderate
	50 - 100	Moderate High
	100 - 150	High
	> 150	Very High

Figure 7.2.4: Soil Erosion Risk Map (Worst Case Scenario)

b. Sediment Yield Risk

The results of sediment yield estimations, Y is as shown in **Table 7.2.2**. Sediment yield was calculated to estimate the amount of solids loading in the adjacent rivers. The amount of potential sediment yield is expected to increase without any control measures (such as BMPs and LD-P2M2 tools) are in place. The details of the calculations are shown in **Appendix 7**.

Table 7.2.2: Estimation of Total Sediment Yield for All Soil Series

PETAK	TOTAL SEDIMENT YIELD FOR ALL SOIL SERIES (TONNES/EVENT)		
	With Mitigation Measures	Operation	Worst case
1	242.0	224.9	7217.3
2	141.9	131.8	4231.6
3	307.1	285.3	9156.6
4	289.8	269.2	8642.3

Source: Consultant's Calculation

7.2.1.2 Waste Production

Waste production can be derived from the project site itself and workers camp site. It can be defined as unwanted materials left over from forest plantation activities and have non-marketable value. As for the project site, it may leave a biomass waste, solid waste, schedule waste and sewage.

a. Biomass Wastes

In development of forest plantation, there must be site preparation which involves in land preparation activities. Therefore, this kind of land preparation activities will result in the generation of large quantities of biomass. During land preparation, the biomasses are in the form of re-usable/marketable trees and non-economic vegetative wastes. If not properly managed, it may cause blockage of the natural drainage system.

Total Above Ground Biomass (TAGB) estimation:

The volume of each tree (D^2 x H) was used to calculate the biomass (dry matter weight of above-ground organs). To estimate the TAGB, the following coefficients of allometric equations of Kato *et.al.* (1978) was used.

$$Y = 0.2544 * DBH^{2.3684}$$

DBH = Diameter Breast Height

The estimated TAGB for trees above than 5 cm in project area is 188.44t/ha.

In Malaysia, open burning is prohibited under law. The Environmental Quality Act, 1974 Schedule 29A (1) states that "Notwithstanding anything to the contrary contained in this Act, no person shall allow or cause open burning on any premises". (**Plate 7.2.1**)

Plate 7.2.1: Example "No Burning" Signage

b. Solid Waste

Generally, two types of solid wastes will be generated from the workers camp namely degradable and non-degradable waste materials. Degradable solid waste is categorized as organic materials such as food wastes, paper and wood wastes. Non-degradable solid wastes (non-organic material) include plastics, food containers, food and drink cans, glass, and bottle drinks.

The cleanliness of the base camp is vital in order to avoid any proliferation of disease vectors occurrence which might also affect the local community. The solid wastes have to be collected and kept in the proper bins; otherwise there will be scavenge by the rodents that could carry diseases such as *leptospirosis* in the water. Mosquitoes can also cause diseases such as malaria and dengue.

c. Scheduled Wastes

The use of heavy vehicles and machinery during the land preparation such as tractors and bulldozers will produce the scheduled waste such as lubricant oil, grease and contaminated soil, etc.

Improper storage, handling and disposal of used agrochemicals containers and packaging will cause ground contamination, potential water pollution and toxicity to soil organisms. These pollutants can accumulate in animals that eat contaminated pests and soil organisms. Therefore, scheduled waste must be properly handled to avoid pollution to the Project site and its surroundings.

All SW 103, SW 305, SW 408 and SW 425 describe below are the type of waste that usually found during the development phase.

Table 7.2.3: The Type of Scheduled Waste Usually Found at Project Area

ENVIRONMENTAL QUALITY (SCHEDULED WASTES) REGULATIONS 2005, FIRST SCHEDULE (REGULATION 2)	
SW 1	**Metal and metal-bearing wastes**
SW 103	Waste of batteries containing cadmium and nickel or mercury or lithium
SW3	**Waste containing principally organic constituents which may contain metals and inorganic materials**
SW 305	Spent lubricating oil
SW 4	**Waste which may contain either inorganic or organic constituent**
SW 408	Contaminated soil, debris or matter resulting from cleaning-up of a spill of chemical, mineral oil or scheduled wastes
SW 425	Waste from production, formulation, trade or use of pesticides, herbicides or biocides

Penalty: Every offence which consists of any omission or neglect to comply with, or any act done or attempted to be done contrary may be compound under section 45 of the EQA 1974 (Act 127). The person reasonably suspected of having committed the offence a sum of money not exceeding two thousand ringgit.

7.2.1.3 Water Pollution

There are four (4) potential water pollution impacts (**Figure 7.2.5**) have been identified with respect to the development of this project.

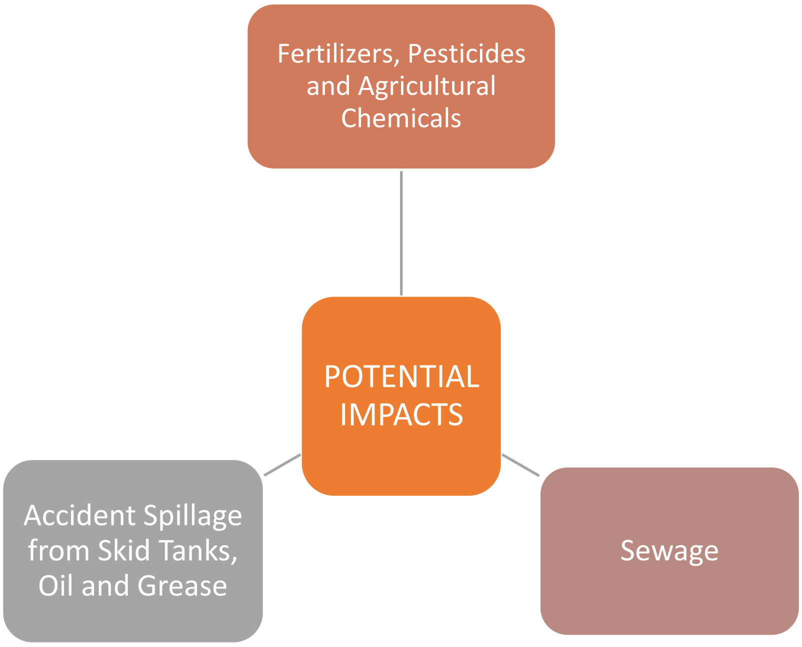


Figure 7.2.5: Water Pollution Impacts

a. Fertilizers, Pesticides and Agricultural Chemicals

Fertilizers, pesticides and agricultural chemicals would be one of non-point sources of water pollution where it is difficult to identify, measure and control. The fertilizers are necessary for plant growth. The use of fertilizer with sufficient quantities at the correct time will reduce the excessive amount of fertilizers in environment as it will fully absorb by the trees. Proper storage of fertilizers will prevent spillage and on the ground contamination. The impacts of fertilizers in forest plantation activities are less significant. Herbicides are widely used in agriculture compared to pesticide. As a result, the impacts of pesticides are also less significant.

b. Sewage

Sewage is originating primarily from the kitchen, bathroom and laundry sources activities such as food preparation, dishwashing, garbage-grinding, toilets, baths, showers and sinks. Typically, sewage will be generated at the base camp and site office during the site preparation and field maintenance stages.

The direct discharge of untreated sewage into the water body is potentially harmful to aquatic life and may affect humans and animals. The raw sewage contains biological agents such as bacteria such as *E. coli*, viruses, fungi and parasites that can cause serious illness and even death. The sewage also may contain elevated of nutrients (nitrates and phosphates) from the detergents and large amounts of waste matter. The elevated levels of nutrients will provide food for the bacteria to thrive and spread in the water.

Microbes in raw sewage can enter the body via nose, mouth, and open wounds or by inhalation. The most common modes of infection are through drinking contaminated water or hand to mouth transmission. The waste matter will add the suspended material in the water. This increases the turbidity of the water, blocking out sunlight which necessary for all forms of life to exist in the water. The excess nutrients cause massive algal growth which uses up the dissolved oxygen in the water and causes eutrophication which destroy aquatic ecosystem (disrupt breeding cycles and populations of sensitive organisms will decline).

c. Accident Spillage from Skid Tanks, Oil and Grease

Spills may include liquids or solid/semi-solid materials that potentially cause water pollution to the river and water channel nearby. Improper management of skid tank or fuel tank and machineries could lead to water pollution when there is oil and grease leakage and spillage.

Any breakdowns, minor repairs and maintenance of machineries on site, there will be oil and grease pollution occurs due to the improper handling of fuels, waste oils and lubricants. The oil and grease might be washed out into the water body during the heavy rainfall. This will degrade the water quality and affect the aquatic lives.

d. Water Quality Modelling

Water quality modelling is a useful tool to predict pollutants fate in a river. The QUAL2K is one of river water quality simulator that use uni-directional model in river system. This model is able to show contaminants transportation along river stretch and river assimilation rate. The model which was developed by United State Environmental Protection Agency (USEPA) uses 1-D modeling principle, of which the river is assumed to be fully-mixed vertically and laterally. The model also works in steady-state hydraulic and steady flow. A steady-state flow balance is implemented for each model reach as follows.

$$Q_i = Q_{i-1} + Q_{in,\,I} – Q_{out,I} – Q_{evap,\,i}$$

Q_i = Outflow from element I into the downstream element I + 1 (m^3/day)

Q_{i+1} = Outflow from reach i+1 (m^3/day)

Qi_{-1} = Inflow from the upstream reach i-1(m^3/day)

$Q_{in,i}$ = Total inflow into the reach from point or nonpoint sources (m^3/day)

$Q_{evap,i}$ = is the outflow due to evaporation (m^3/day).

Thus, the downstream outflow is simply the difference between inflow and source gains minus withdrawal and evaporation losses.

Objective

The objective for this study is to observe the TSS and Turbidity pattern during the development of the proposed project site to the affected rivers. The simulated level of TSS and Turbidity shall be compared with National Water Quality Standard (NWQS) to estimate river quality which is referring to NWQS (50 mg/L, & 50 NTU of Class II)

Potential Point Source and Selected Scenarios

i. Potential Point Source

Potential point source is a point where pollutant load namely TSS been discharged into the river. The point sources referred in this study represent the discharge from the project site.

ii. Performed Scenarios

Four (4) scenarios were performed to be simulated which are:

Scenario 1: Baseline Conditions

- Natural TSS and Turbidity content.
- The values were obtained from baseline field sampling.

Scenario 2: Pollutants Fate with LDP2M2 Measures

- Assume development activities follow LDP2M2 working recommendation.
- The discharge from the project site is comply with the discharge limit of less than 50 mg/l.
- Estimation of Turbidity is based on the TSS value.

Scenario 3: Pollutants Fate with Zero Cost Method

- Assume development activities Zero-Cost Method working recommendation.
- Zero-Cost Method is a natural practice which includes preservation of natural vegetation, allocate river buffer zone of about 20m for each side of stream, and no development is allowed at the area of more than 35° terrain. No physical structures involved.
- Estimation of Turbidity is based on the TSS value.

Scenario 4: Worst Case Scenario

- Assume Zero-Cost Method or LDP2M2 measures failed to be implemented.
- Phase of development failed to be executed.
- Estimation of Turbidity is based on the TSS value.

Methodology

i) Study Area

The rivers underlain the project site are tributaries of Sg Gesau. The project has been divided into four (4) phases of development. Sg Gesau will flow to Sg Slim in northwest direction. Water Intake Sg Slim has been identified at the downstream of the proposed project site.

ii) Methodology

The project site will be divided into several blocks, the discharge from the respective block will discharge to a different stream through the river sub-catchment. **Table 7.2.4** shows the river and the source of potential discharge (point source), while **Table 7.2.5** indicates the estimated TSS Discharge from the related blocks to the respective river. **Table 7.2.6** indicates the estimated of Turbidity from the generation of TSS via equation **[ln TSS=0.7042*ln (Turbidity)+0.3302]** **(*Reference: 2nd International conference of Water and Environmental Engineering (iCWEE2019) entitled Using Turbidity to Estimate TDS in a stream*)**

The estimation of discharge value from each block is based on the rational method and sediment yield calculation. **Figure 7.2.6** shows the schematic flow from the respective block to the affected rivers.

Table 7.2.4: River length and Point Source

River	Point Source (PS)	Location of Point Source	Length of River, km
Sg Gesau	Block 1 Block 2 Block 3 Block 4	2 km 2.5 km 2.7 km 3 km 3.2 km 3.8 km 4 km 4.2 km 4.4 km 4.8 km 5.4 km 5.8 km 5.9 km 6 km 6.2 km 6.8 km	8 km
Sg Slim	Final Discharge from Sg Gesau	1.5 km	3 km

Table 7.2.5: Estimation of TSS Discharge

River	Point Source (PS)	Source of PS	TSS Discharge, mg/l		
			Worst Case	Zero-Cost	LDP2M2
Sg Gesau	PS1	Part of Block 2	580	152	28
	PS2	Part of Block 4	237	62	11
	PS3	Part of Block 2	580	152	28
	PS4	Part of Block 4	711	187	34
	PS5	Part of Block 4	118	31	6
	PS6	Part of Block 1	594	157	28
	PS7	Part of Block 4	355	93	17
	PS8	Part of Block 1	396	105	19
	PS9	Part of Block 4	355	93	17
	PS10	Part of Block 1	396	105	19
	PS11	Part of Block 1	297	78	14
	PS12	Part of Block 1	297	78	14
	PS13	Part of Block 4	118	31	6
	PS14	Part of Block 3	1004	264	48
		Part of Block 4	474	125	23
	PS15	Part of Block 3	1004	264	48
	PS16	Part of Block 3	502	132	24
Sg Slim	PS1	Final Discharge from Sg Gesau	548	94	21

Table 7.2.6: Estimation of Turbidity from the generation of TSS

River	Point Source (PS)	Source of PS	Turbidity, NTU		
			Worst Case	Zero-Cost	LDP2M2
Sg Gesau	PS1	Part of Block 2	823	39	216
	PS2	Part of Block 4	336	16	88
	PS3	Part of Block 2	823	39	216
	PS4	Part of Block 4	1009	48	265
	PS5	Part of Block 4	168	8	44
	PS6	Part of Block 1	842	40	222
	PS7	Part of Block 4	504	24	132
	PS8	Part of Block 1	561	26	148
	PS9	Part of Block 4	504	24	132
	PS10	Part of Block 1	561	26	148
	PS11	Part of Block 1	421	20	111
	PS12	Part of Block 1	421	20	111
	PS13	Part of Block 4	168	8	44
	PS14	Part of Block 3	1425	68	374
		Part of Block 4	673	32	177
	PS15	Part of Block 3	1425	68	374
	PS16	Part of Block 3	712	34	187
Sg Slim	PS1	Final Discharge from Sg Gesau	624	165	31

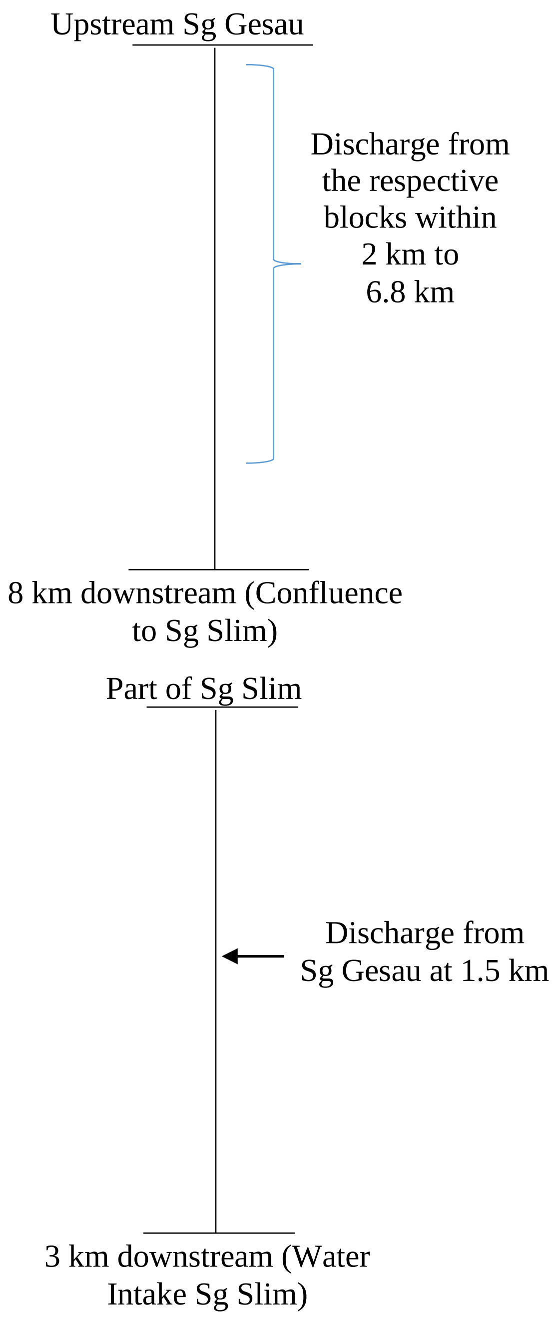


Figure 7.2.6 (a): Schematic Flow

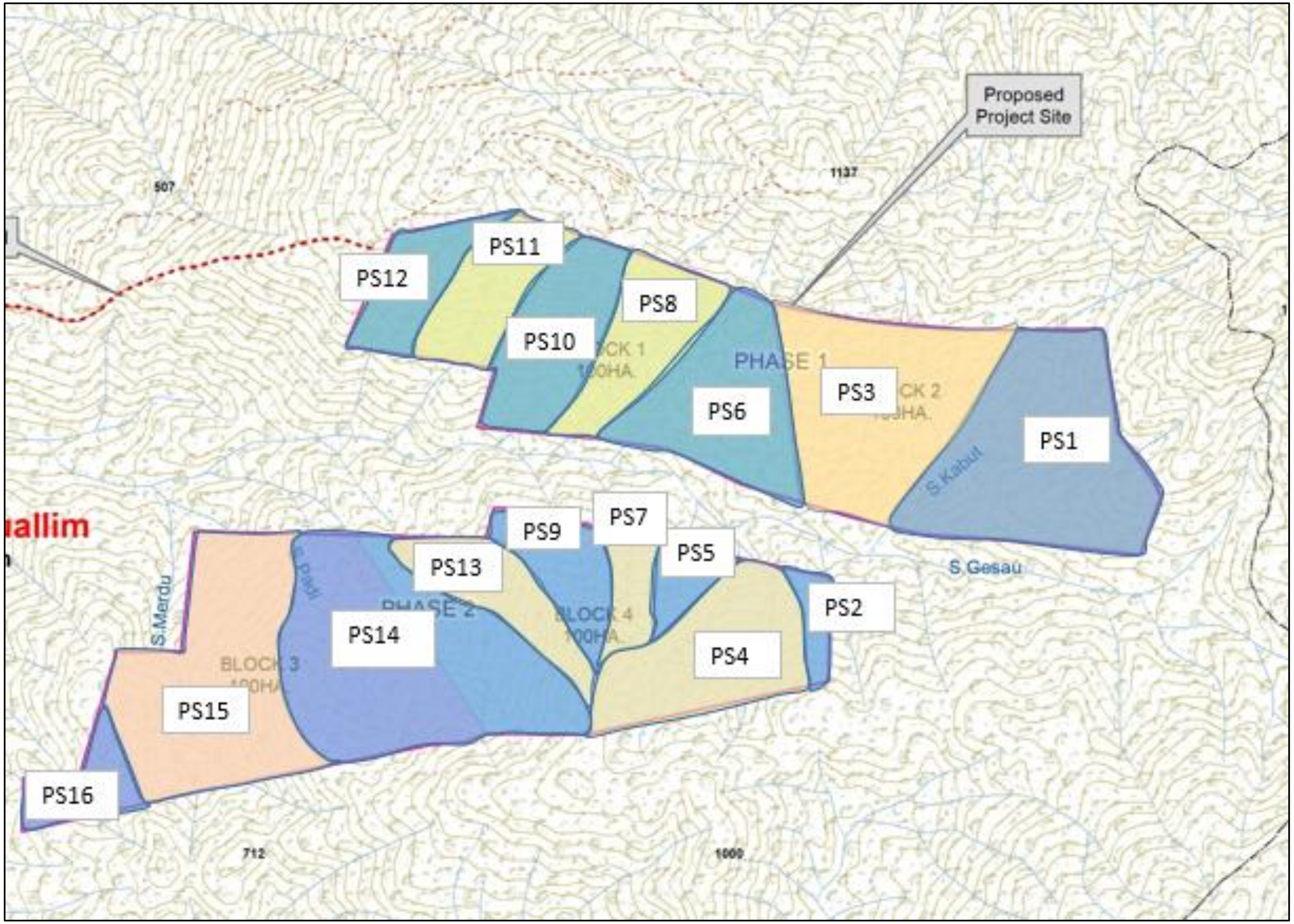


Figure 7.2.6 (b): Schematic Flow

Result and Discussion

The following **Figure 7.2.7** to **Figure 7.2.8** indicate the TSS profile in four (4) selected scenarios namely Existing, With LDP2M2, Zero-Cost Method and Worst Case of the respective river. Meanwhile **Figure 7.2.9** to **Figure 7.2.10** indicate the Turbidity profile.

Total Suspended Solid (TSS)

i) Sg Gesau

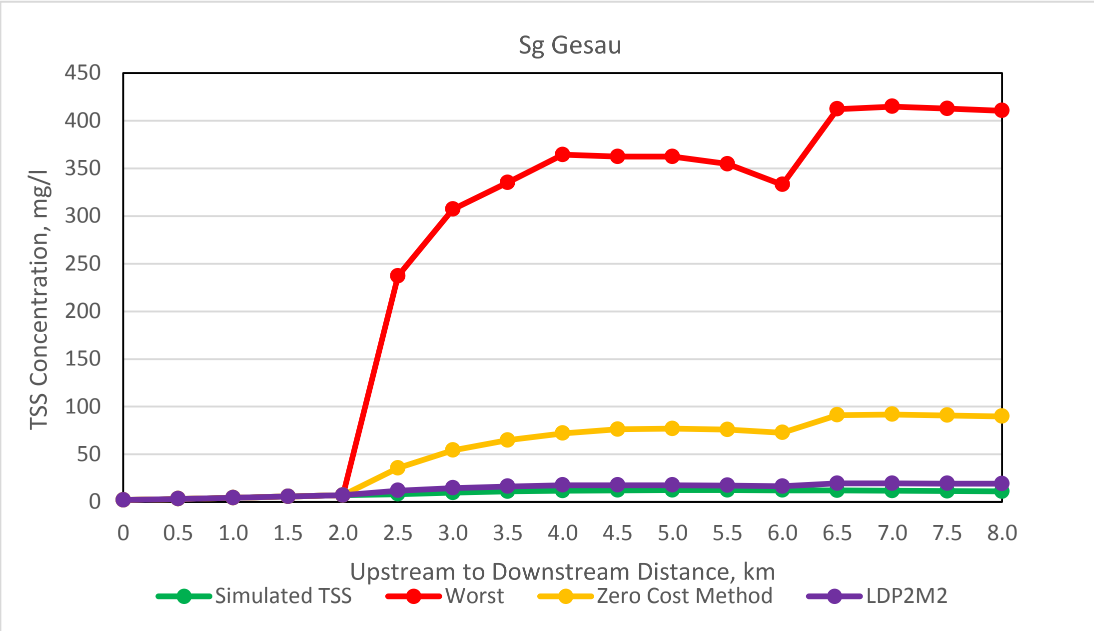


Figure 7.2.7: TSS Profile of Sg Gesau

For Scenario 1, Existing Condition, the model has been calibrated and simulated following the trend of the baseline TSS data and river profile. The baseline value in Sg Gesau ranged within 2 mg/l to 12 mg/l. Simulated TSS concentration at the confluence to Sg Slim is about 11 mg/l. The TSS are within Class I of NWQS (25 mg/l).

Scenario 2, the development implements the measures component recommended in LDP2M2 plan. The concentration of TSS along the stretch are close to the existing value, and the TSS along Sg Gesau are well within Class II of NWQS (50 mg/l). The TSS concentration at the confluence to Sg Slim is about 19 mg/l. LDP2M2 measures are important to control the run-off or erosion from the project site to be at minimal level. Whereas any run-off shall be contained within the project site i.e., Sediment Trap, prior to be released into the respective river.

Scenario 3, the development implements a Zero-Cost Method, which is basically a natural preservation. The TSS along Sg Gesau varied within Class II to Class III of NWQS (50 mg/l-150 mg/l). The TSS concentration at the confluence to Sg Slim is about 90 mg/l. From the simulation, it can be observed that, by preserving natural vital components such as vegetation, river buffer zone at each of the affected river and conserve the area of more than 35° terrain, the rate of erosion can be greatly minimized. About 80% of TSS reduction from the worst-case scenario can be expected through the implementation of Zero-Cost Method.

Scenario 4, Worst Case Scenario, the TSS level along the stretch has slightly reached Class V (above 300 mg/l). The TSS concentration at confluence to Sg Slim is about 411 mg/l. Without implementation of LDP2M2 or Zero-Cost Method, soil erosion and TSS discharge will be severely occurred.

ii) Sg Slim

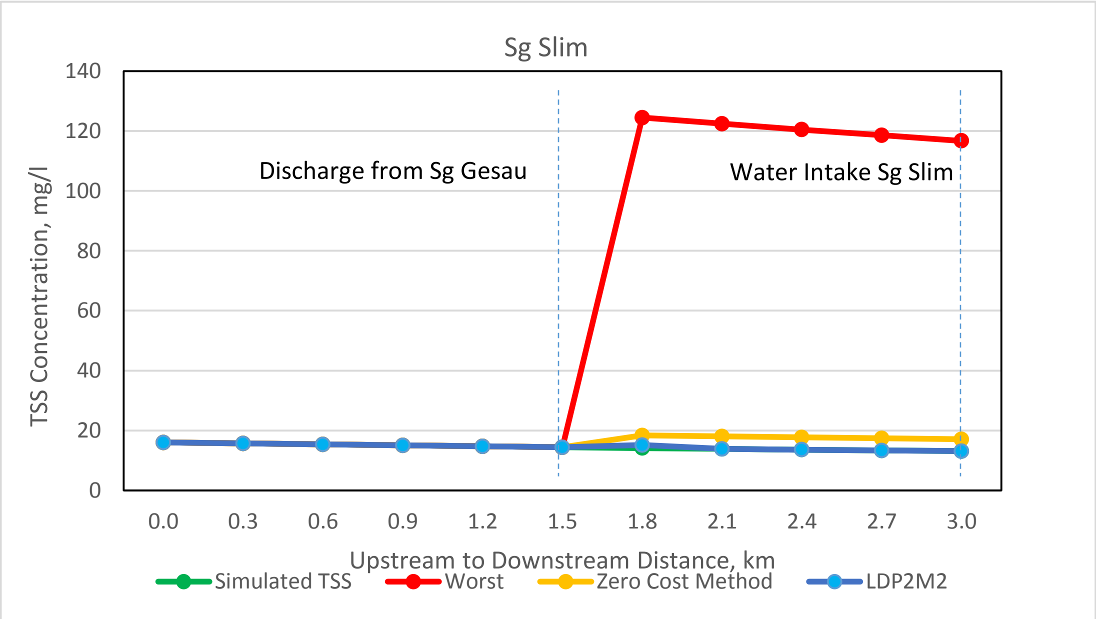


Figure 7.2.8: TSS Profile of Sg Slim

For Scenario 1, Existing Condition, the model has been calibrated and simulated following the trend of the baseline TSS data and river profile. The baseline value in Sg Slim ranged within 13 mg/l to 16 mg/l. Simulated TSS concentration at the Water Intake is about 13 mg/l. The TSS are within Class I of NWQS (25 mg/l).

Scenario 2, the development implements the measures component recommended in LDP2M2 plan. The TSS concentration along part of Sg Slim are well within Class I of NWQS (25 mg/l). The TSS concentration at the Water Intake is about 13 mg/l. With proper implementation of LDP2M2, no impact is expected at the Water Intake.

Scenario 3, the development implements a Zero-Cost Method. The TSS along part of Sg Slim varied within Class II of NWQS (50 mg/l). The TSS concentration at the Water Intake is about 17 mg/l. With the implementation of Zero-Cost Method, minimal impact to the water intake is expected.

Scenario 4, Worst Case Scenario, the TSS level along the stretch has slightly reached Class III (150 mg/l). The TSS concentration at the Water Intake is about 117 mg/l. The distance from the end of Sg Gesau to the Water Intake is relatively short, which is only about 1.5 km. Therefore, without implementation of LDP2M2 or Zero-Cost Method, severe impact to the Water Intake is expected.

Turbidity

i) Sg Gesau

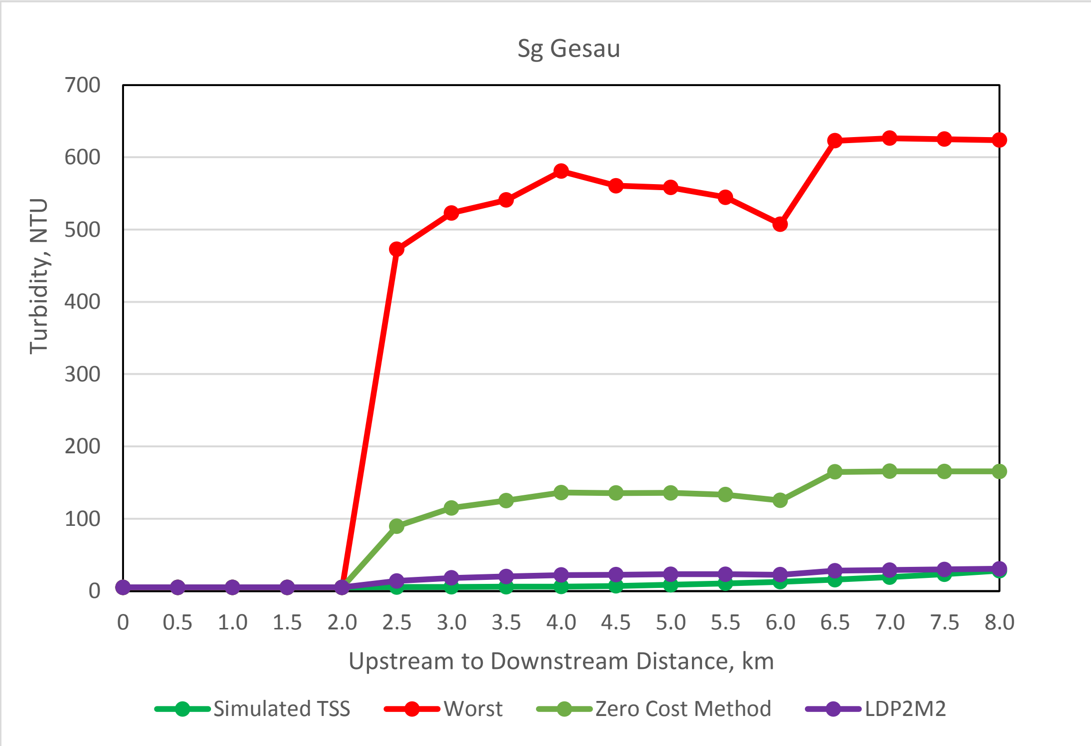


Figure 7.2.9: Turbidity Profile of Sg Gesau

For Scenario 1, Existing Condition, the model has been calibrated and simulated following the trend of the baseline Turbidity data and river profile. The baseline value in Sg Gesau ranged within 5.11 NTU to 28.2 NTU. Simulated turbidity clarity at the confluence to Sg Slim is about 28.2 NTU which are within Class II of NWQS (50 NTU).

Scenario 2, the development implements the measures component recommended in LDP2M2 plan. The clarity of Water along the stretch are within Class II of NWQS (50 NTU). The Turbidity at the confluence to Sg Slim is about 31 NTU. LDP2M2 measures are important to control the run-off or erosion and therefore minimize the light scattering in water. Light scattering is caused by the incremental of suspended particles in cloudy appearance.

Scenario 3, the development implements a Zero-Cost Method, which is basically a natural preservation. The Turbidity along Sg Gesau varied exceeded Class of NWQS (50 NTU). The Turbidity at the confluence to Sg Slim is about 165 NTU. From the simulation, zero cost mitigation greatly reduce the rate of erosion. Hence, decrease the formation of cloudy particles in water.

Scenario 4, Worst Case Scenario, the Turbidity along the stretch has extremely exceeded Class II (50 NTU). The Turbidity at confluence to Sg Slim is about 624 mg/l. Without implementation of LDP2M2 or Zero-Cost Method, generation of massive TSS will severely increase the turbidity and reduce water clarity.

ii) Sg Slim

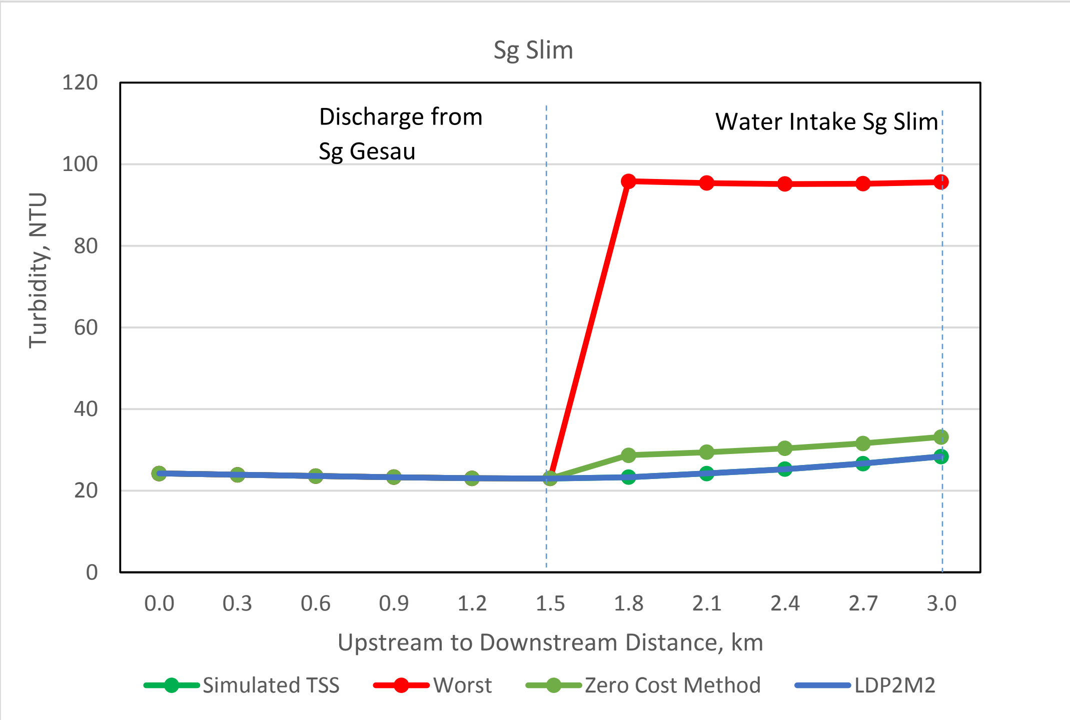


Figure 7.2.10: Turbidity Profile of Sg Slim

For Scenario 1, Existing Condition, the model has been calibrated and simulated following the trend of the baseline Turbidity and river profile. Turbidity value at the Water Intake is about 28.4 NTU. The Turbidity are within Class II of NWQS (50 NTU).

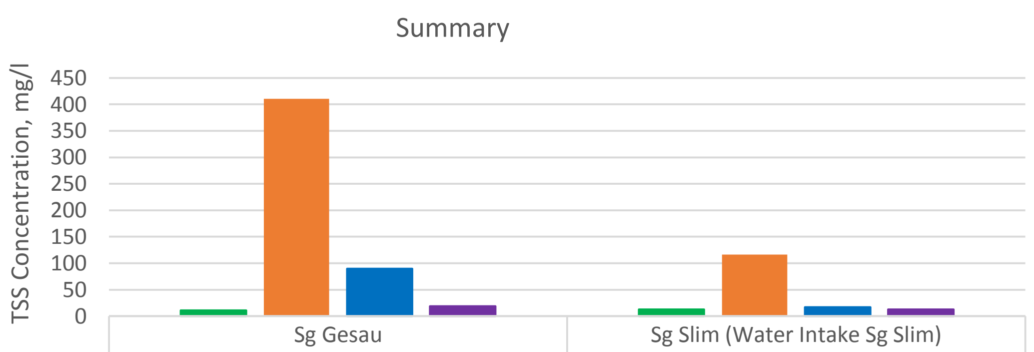
Scenario 2, the development implements the measures component recommended in LDP2M2 plan. The Turbidity along part of Sg Slim are within Class II of NWQS (50 NTU). The TSS concentration at the Water Intake is about 28.4 NTU. With proper implementation of LDP2M2, no impact is expected at the Water Intake.

Scenario 3, the development implements a Zero-Cost Method. The Turbidity along part of Sg Slim varied within Class II of NWQS (50 NTU). The clarity value at the Water Intake is about 33 NTU. With the implementation of Zero-Cost Method, minimal impact to the water intake is expected.

Scenario 4, Worst Case Scenario, the Turbidity along the stretch has slightly exceeded Class II (50 NTU). Turbidity value at the Water Intake is about 96 NTU. The scattered particles are minimal in Sg Slim due to higher flow, width and depth. The maximum capacity of Turbidity for Water Intake Operation is about 1000 NTU following National Drinking Water Quality Surveillance Program, thus, adverse impact to Water Intake Sg Slim is unlikely.

Conclusion and Recommendation

TSS discharge from the project site will potentially affect Sg Gesau and the tributaries, and Water Intake Sg Slim which is located at the downstream of Sg Slim. **Figure 7.2.11** shows the summary of the TSS simulation at the end point of Sg Gesau and at the Water Intake and **Figure 7.2.12** shows the summary of Turbidity profile.



	Sg Gesau	Sg Slim (Water Intake Sg Slim)
Baseline	11	13
Worst	411	117
Zero-Cost Method	90	17
LDP2M2	19	13

Baseline Worst Zero-Cost Method LDP2M2

Figure 7.2.11: Summary of TSS Profile

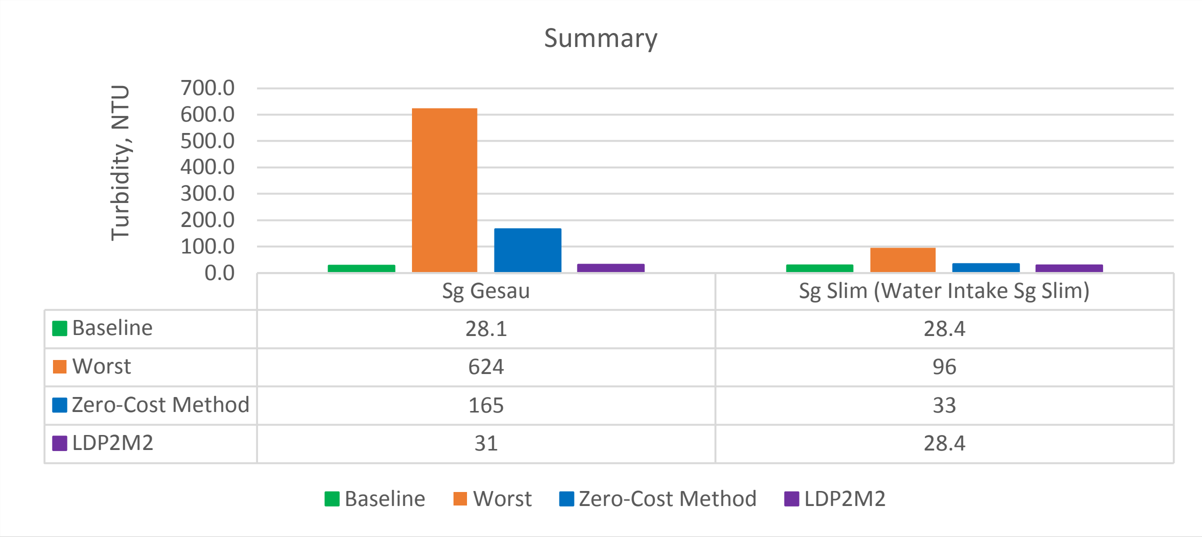


Figure 7.2.12: Summary of Turbidity Profile

Therefore, the river water quality should be preserved, through the execution of the following measures.

- The LDP2M2 measures must be implemented during all stage of development. Strict commitment on the designated LDP2M2 will benefit to minimize the impact on the respective rivers.
- Allocation of river buffer zone or riparian zone area of about 20m each side is compulsory. Preserving Riparian zone is one of the best zero-cost method to provide filtration of runoff from the project site. Monitoring of riparian zone is highly recommended, whereby pictures of the riparian zone at a few points of both river side must be taken before development, during earthwork and during operation. The pictures shall be compared and reported in quarter or half-year basis.
- The LDP2M2 helps to reduce the scattering of suspended particles in water, thus minimize the reduction of water clarity. The impact from the project site is not expected to affect the water clarity at the Water Intake Sg Slim.
- The progress of development, and the installation of LDP2M2 are recommended to be monitored at regular basis i.e. by using UAV Drone technology.
- River buffer zone must be strictly allocated in accordance with the required buffer length delineated by Department of Irrigation and Drainage (DID).

- The component which has been elevated in LDP2M2 measures must be abided, to ensure any possible runoff can be contained on-site, prior to be released into the respective river.
- Phase of development must be well planned to ensure every phase is equipped with adequate LDP2M2 measures.
- River crossing MUST be well constructed and maintained in accordance with the specification by Forestry Department and Department of Irrigation and Drainage (DID).
- Based on this water quality modelling, it shows that the Water Intake Sg Slim will not affected by the proposed Project even in the worst case scenario. In addition, based on the letter from LAP, this water intake is not yet operating at this time.

7.2.1.4 Flood Risk

In worst case scenario, a significant impact of land preparation activities and plantation and other acts such as removing the surface ground cover will decrease rain interception and surface retention of rain water. An inversely proportional relationship between the amount of runoff and time of concentration (collection) of rain water in catchments will occur. The amount of runoff will increase and the time of concentration (collection) of rain water in catchments will decrease. Other than that, improper management of biomass will cause clogging of the drainage systems, hence increase the potential for flood occurrence.

Unsuitable drainage design can also contribute to the overflow issue i.e. the drainage system may fail to cater for the volume of water during the rainy season thus causing floods to occur in the proposed plantation area. However, if proper mitigation measures are applied and best management practices to be used during the project development, it will help to improve the water flow.

Hydrology & Hydraulic Modelling

a) Introduction

Low flow of natural streams depends on the recharge from groundwater to the stream. The rate of recharge from groundwater to streams depends on the catchment area, geologic condition, land use and mean annual rainfall of the catchment area. It also depends on the hydraulic gradient toward the stream and hydraulic conductivities of the aquifer to the stream.

A low flow characteristic can be defined as the minimum average flow for a selected consecutive day period for a given recurrence interval. For example, if a 7Q10 for Sg. Gesau is 0.5 meter3/second, it indicates that the annual minimum flow for 7 consecutive days is equal or less than 0.5 meter3/second, on average once in 10 years. In Malaysia, the water authority and DOE uses the 7Q10 as criteria for surface water withdrawals and allowable pollutant loads to be discharged to the rivers.

The critical low flow could be determined from a review of the existing hydrological conditions of the river basin and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 can be used as a guideline for ungaged catchment. The historical record of the stream flow at gaged locations will be utilized when it is available. Frequency analyses will be used to establish minimum flow at gaged catchment. In sub-catchment where there is no stream flow records, the estimation of low flow can be carried out following the procedure for the ungaged sites at gaged catchment. The methods used in this study to estimate 7Q10 are suitable for natural, unregulated or partially regulated and non-tidal streams. Low flow frequency analyses of stream flow data is not valid for catchment where 45% of the drainage area is regulated.

The reduction of natural detention storage due to reclamation of the existing low-lying area (valley) could result in the tremendous increase in surface runoff. The problem may aggravate due to tidal influence. This phenomenon could result in extensive flooding where property damage and loss of lives is imminent. Both studies require general hydrologic data such as rainfall, stream flow and evaporation data. It also depends on the catchment and channel characteristics. However, each study might require different spatial and temporal data resolution.

The development of forest plantation may expose the large tract of bare soil to erosion if there is no erosion control adopted on site. The increase in sedimentation rate at the nearby river may reduce the river conveyance capacities. The reduction in conveyance capacities may result in the occurrences of flash flood.

b) Study Objectives

The objectives of the study are:

- To determine flooded area and low flow at various locations within the study area before the development.

- To determine flooded area and low flow at various locations within the study area after the proposed project was developed.
- To determine flooded area and low flow at various locations within the study area during the development.

c) Scope of Works

The proposed project is located in the upstream area of tributaries of Sg. Gesau that lies within the Sg. Gesau catchment which is part of Sg. Slim River Basin. The scope of works for this study involves field data collection and data collation. The collected and collated would be used for further analyses. The analyses would cover impact of development to minimum flow and high flow.

The scope of work for the study will be as follows:

- Collate and review historical flow data in the river basin where the study area is located and collect additional data when necessary
- Perform frequency analyses on the historical stream flow data
- Carry out analyses using appropriate methods and procedures (HP 12)
- Define the existing drainage system in the study area and identify its inadequacies, constraint and potentials of the existing drainage system
- Identify and evaluate the cause of future flooding and drainage problems encountered in the study area due to the proposed project
- Carry out hydrological and hydraulic analyses using appropriate methods and procedures
- Propose feasible structural and related non-structural works for immediate implementation to alleviate the flooding problems in the Study Area and enhance its drainage systems.

d) Methodology

Low Flow

Various techniques based on the Hydrological Procedure (HP) No. 12 were used to estimate low flow at various locations downstream of the proposed project. Low flow estimation at these locations will be estimated before, during and after the completion of the project. The estimation of low flow at various locations downstream of the project will be based on the following methods: 1) frequency analyses on individual gauged streams

Low Flow Estimation for Ungauged Site at Gauged Stream

The critical low flow could be determined from a review of the existing hydrological conditions of the river basins and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 is used. In sub-basins where there are no stream flow records, the estimation is carried out following the procedure for the ungauged catchment as described in HP 12. Occasionally, streams are gauged at certain locations that are not necessarily the point where the minimum flow would be determined. Therefore, ungauged method was applied to determine the low flow at that particular location even though just upstream or downstream of that location there is a gauged station

In this study, the estimation of flow for ungauged sites at gauged catchment is based on the procedure as described HP No 12. The purpose of applying gauged method to ungauged catchments is to test the reliability of the result obtained from the ungauged method when compared to the result obtained from observed low flow data. For the case of ungauged catchment, the regional low flow frequency regions (RC Regions) are based on the region developed in HP 12. Peninsular Malaysia is divided in to four low flow frequency regions, RC1, RC2, RC3 and RC4. The parameters of the regional frequency low flow curves, and the regional $\frac{Q_{D,T}}{MAM}$ values for various ARI are listed in table 2.1 of the manual.

In order to obtain low flow for various consecutive numbers of days and various ARI, the MAM has to be correlated to the catchment characteristics. Regions for MAM may not have the same boundaries as in region for RC. Therefore, another set of regions was delineated for developing the regional MAM equation. The regional **mean annual minimum flow** (MAM) equation based on HP 12 is shown below;

MAM = a(X1)b1 (X2)b2…..(Xn)bn (7.4.4)

X1,X2,……Xn are catchment characteristics and b1, b2, ……bn are constants to be estimated. Catchment area (AREA) and the Mean Annual catchment Rainfall (MAR) are the only two variables considered in developing the equation. The Mean Annual Rainfall (MAR) shall be adopted from the rainfall stations located near and within the river basin. MAR is required in order to calculate the Mean Annual Minimum Flow (MAM). The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation $Q_{D,T}$ for the ungaged site are presented as average values, in which *D* is number of day and *T* is recurrence interval.

The general MAM flow equation based on HP No 12 is,

$$MAM = a\,(AREA)^{b1}\,(MAR)^{b2} \quad (2.3)$$

Where AREA is the catchment area in km^2; MAR is the mean annual rainfall; a, b_1, b_2 are coefficients. In this study, rainfall record is available to estimate the MAR for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. Results of dimensionless regional frequency analysis for various regions are available in HP No 12. Values of $\frac{Q_{D,T}}{MAM}$ for various ARI (T years) can be determined. $Q_{D,T}$ for various ARI can be obtained by multiplying the $\frac{Q_{D,T}}{MAM}$ against MAM.

Methodology of Study (Rainfall-Runoff)

HEC-HMS and HECRAS model will be used in this study to analyze the hydrologic and hydraulic behavior of present catchment characteristics, and to simulate the impact of future development to the flooding problem. It is always a good practice the model be calibrated first prior to its simulation of future scenarios. The calibrated model could be used to predict the impact of future development to the flow hydrograph at the outlet. Proposed flood mitigation alternatives will be simulated and evaluated to determine the most suitable alternative.

Hydrologic Modelling

The purpose of hydrologic modeling is to estimate flow hydrograph from tributary catchment for various ARI's. The estimated flow hydrograph serve as an input to the hydraulic modeling of the study area. The hydrologic model in HEC-HMS is available and can be downloaded from the US Army Corps website. There are plenty of options available in this module for calculating catchment losses, transformation of excess rainfall and base flow estimation. The options for estimating hydrologic losses include Initial Constant Loss Method, Horton, Philips and Green & Ampt Method. The options for rainfall excess transformation include kinematic wave U – H methods and Non-Linear Reservoir method. The synthetic U-H and quasi U-H method that are available includes Snyder, Clark Time Area, SCS and Santa Barbara U-H. These empirical, conceptual or mathematical models have coefficients or parameters that need to be verified or quantified. Most of these parameters/coefficients are not measurable at site.

It is always good that the hydrologic and hydraulic model parameters be calibrated first prior to applying it for simulation of future scenarios. The purpose of calibration and validation of model parameters is to ensure the accuracy and reliability of flow estimation for the existing and future condition of the study area. If there is no gauged stream flow station in the study area, other prediction methods have to be employed in order to ensure the reliability of the simulated result. The method includes using calibrated parameters from nearby gauged catchment. The calibrated parameters will be extrapolated to the ungauged catchment in the study area, which is in the same river basin of the gaged catchment. The results obtained will be compared with other empirical methods such as HP 4, 5 and 11. The calibrated model parameters will be used to simulate for future land use flow hydrograph.

For the purpose of modeling, the catchment was divided into several sub-catchments. These sub-catchments are represented as nodes in HEC-HMS. The selections of nodes are based on the consideration of certain aspects of the catchment characteristics and locations where determination of flow is required. Each sub-catchment is given a name and provided with a link number for connectivity among the nodes.

Additional Flow Estimation Methods for Comparison

To justify the results obtained from Hydrologic Model (HEC-HMS), comparison will be made with other acceptable procedures In Malaysia. The methods that will be used are HP – 4, Hp – 5, Hp – 11 and Clark Time - Area Method. HP 4 is the Regional Flood Estimation Method. HP – 5 is Rational Method of Flood Estimation for Rural Catchment in Peninsular Malaysia. HP – 11 is Design Flood Hydrograph, Estimation for Rural Catchments in Peninsular Malaysia

The Regional Flood Estimation Method (HP – 4) gives the magnitude and frequency of floods for the ungaged catchment by using regional analyses. The regional analyses carried out by this procedure generally consists of a set of regional dimensionless flood frequency curves and a set of regional regression equations relating mean annual flood to the catchment characteristics (catchment area and mean annual catchment rainfall). Based on the flood frequency region and the mean annual flood region, a catchment of interest that belongs to the design flood of that catchment can be estimated by using the regional flood frequency curve and the regional mean annual flood equation.

HP – 5 is based on the Rational Method for flood estimation. The method is based on statistical approach. The method was adopted and used for flood estimation in small rural catchment in Malaysia. There are some limitations in this procedure especially on the area of the catchment. The results obtained should be compared to other methods.

HP – 11 gives both, peak discharge estimation and an idealised hydrograph. The method is simulated by the characteristics of catchment lag time, which is dependent on the size and slope of catchment as well as catchment topography. The lag parameter reflects the influence of catchment storage in modifying the slope of hydrograph and has been established by studies on selected representative of 12 gaged catchment in Malaysia. This procedure was developed based on the recorded data until the year 1982 from these gaged catchment.

Clark Unit Hydrograph (U-H) represents translation and attenuation of precipitation as it flows across the catchment to the outlet. Translation is based on the synthetic time – area and the time of concentration. Flow attenuation to the outlet is modeled by using linear reservoir theory. Clark U – H theory maintain the fundamental properties of a unit hydrograph in that the sequence of runoff is the result of a unit have uniformly generated excess precipitation. The excess precipitation is applied uniformly over a watershed, which is broken into time – area increments.

The proposed development will definitely change the stream flow at the outlet. The land cover changes from pervious to impervious will result in increase of surface runoff. As specified in the new drainage manual (MASMA), the developer is responsible in controlling the increase of surface runoff. The design storm selected for this study depends on the time of concentration of the study area (tc). The tc was estimated by using the Barnsby William formulae (Equation 1).

$$t_c = \frac{F_c \, . L}{A^{1/10} \, S^{1/5}} \qquad \text{……………………} \qquad \text{Eqtn. 1}$$

Where,

tc = the time of concentration (minute)

Fc = a conversion factor, 58.5 when area A is in km2, or 92.5 when area is in ha

L = length of flow path from catchment divide to outlet (km)

A = catchment area (km2 or ha)

S = slope of stream flow path (m/km)

The equation used to derive the rainfall intensity is shown in equation 2. There are a number of IDF curves developed at various rainfall stations within the state of Perak (**Table 7.2.7**). The closest IDF curve available for this study area is at JPS Teluk Intan.. Therefore, in this study, the IDF derived for the JPS Teluk Intan will be used for the simulation of surface runoff as the study area is also located further inland. The temporal pattern used for this study is based on the temporal pattern developed for the states of. Region 3 - Perak, Kedah, Pulau Pinang and Perlis. The design storm hyetograph of 2, 5, 10 ,50 years and 100 years ARI will be used in this study.

$$i = \frac{\lambda T^{\kappa}}{(d+\theta)^{\eta}} \qquad (2.0)$$

where,

i = Average rainfall intensity (mm/hr);

T = Average recurrence interval - ARI (0.5 T 12 month and 2 T 100 year);

d = Storm duration (hours), 0.0833 d 72; and

λ, κ, θ and η = Fitting constants dependent on the rain gauge location

Table 7.2.7: IDF Curves Coefficients for Various Stations Within the State of Perak

State	No.	Station ID	Station Name	Constants			
				λ	κ	θ	η
Perak	1	4010001	JPS Teluk Intan	54.017	0.198	0.084	0.790
	2	4207048	JPS Setiawan	56.121	0.174	0.211	0.854
	3	4311001	Pejabat Daerah Kampar	69.926	0.148	0.149	0.813
	4	4409091	Rumah Pam Kubang Haji	52.343	0.164	0.177	0.840
	5	4511111	Politeknik Ungku Umar	70.238	0.164	0.288	0.872
	6	4807016	Bukit Larut Taiping	87.236	0.165	0.258	0.842
	7	4811075	Rancangan Belia Perlop	58.234	0.198	0.247	0.856
	8	5005003	Jln. Mtg. Buloh Bgn Serai	52.752	0.163	0.179	0.795
	9	5207001	Kolam Air JKR Selama	59.567	0.176	0.062	0.807
	10	5210069	Stesen Pem. Hutan Lawin	52.803	0.169	0.219	0.838
	11	5411066	Kuala Kenderong	85.943	0.223	0.248	0.909
	12	5710061	Dispensari Keroh	53.116	0.168	0.112	0.820

Hydraulic Modelling

The simulated hydrograph from hydrologic modeling serves as an input to the hydraulic model. The objective of the hydraulic modeling is to perform hydraulic routing of flood flow in the drainage system, which uses the upstream inflow hydrograph generated from the hydrologic model and tidal flow as the downstream boundary condition. The main issues related to the project is flood at the Kg Orang Asli. The hydraulic flow routing model in HEC-RAS will be used to route the flow hydrograph. The modeling scenarios will include existing and future conditions of the study area plus with existing and future flood mitigation facilities. The scenarios considered in this study are as follows:

(a) Existing condition

(b) Future condition with existing channel capacity

(c) Future condition with upgraded facilities (construction of sediment ponds as detention ponds)

HEC-RAS developed by the Hydrologic Engineering Center. This software allows you to perform one-dimensional steady flow, unsteady flow calculations, sediment transport/mobile bed computations and water temperature modeling.

The HEC-RAS modeling system was developed as a part of the Hydrologic Engineering Center's "Next Generation" (NexGen) of hydrologic engineering software. The NexGen project encompasses several aspects of hydrologic engineering, including: rainfall-runoff analysis (HEC-HMS); river hydraulics (HEC-RAS); reservoir system simulation (HEC-ResSim); flood damage analysis (HEC-FDA and HEC-FIA); and real-time river forecasting for reservoir operations (CWMS).

The model is based on gradually varied one- dimensional flow. The channel cross sections would be obtained from field measurement (cross-section survey). The provided river cross sections along the main channel and its tributaries will be used as data input in the model hydraulic simulation. This information will help determine water surface profile spatially (along the channel) and temporally (along the simulation period).

Scope of Study

The study area covers downstream area of the proposed project site. The surface runoff from the site will be drained toward the Sg Gesau, before discharging toward Sg. Slim. The existing low flow will be determined at gaged stations downstream of the proposed site. The methods used in this study to estimate 7Q10 are suitable for natural, unregulated or partially regulated and non-tidal streams. Low flow frequency analyses of stream flow data are not valid for catchment where 45 percent of the drainage area is regulated.

Stream Flow Measurement

The nearest gaged station is located at Sg Slim at Slim River. The flow data at this station could be used for analyses as it is located near the project site. Since there is no stream flow data within the study area, stream flow measurement was conducted at a few locations within the proposed site and a few locations downstream of the site. **Table 7.2.8** shows the low flow for streamflow station of Sg Slim at Slim River.

Table 7.2.8: Low Flow for station Sg Slim at Slim River (3814416)

Region	StationID	AREA	RAINFALL	COMPUTED MEAN FLOW				RECORDED MEAN FLOW			
				1 DAY	4 DAY	7 DAY	30 DAY	1 DAY	4 DAY	7 DAY	30 DAY
2	4023412	13200	2305	105.1003	112.2717	118.669	150.4262	98.37	102.11	106.95	136.93
2	4121413	7320	2270	56.54067	60.48842	63.87144	80.8762	92.61	95.73	97.62	109.59
2	4218416	2630	2480	25.99116	27.81362	29.27803	36.97738	32.29	33.38	34.07	38.68
2	4223450	5050	2435	47.0924	50.34718	53.07885	67.1321	52.83	55.28	58.66	74.36
2	4324454	2700	2540	28.38209	30.35609	31.94687	40.3444	31.76	33.9	35.91	48.59
4	3813414	65.8	2750	0.902431	0.970849	1.013197	1.26945	0.66	0.7	0.73	0.98
4	3814413	321	2625	3.803225	4.082416	4.276401	5.376477	3.83	4.08	4.21	5.4
4	3814415	41	2795	0.590999	0.636201	0.663195	0.83006	0.94	0.99	1.01	1.11
4	3814416	455	2625	5.360857	5.750379	6.027826	7.583734	6.77	7.04	7.26	8.55
4	3911457	479	2765	6.454644	6.915739	7.245639	9.113986	4.98	5.55	6.03	8.01
4	3913458	289	2760	3.907526	4.191049	4.386634	5.51225	5.32	6.16	6.63	8.22

e) Result and Analysis

Low Flow Estimation for Ungauged Site

The critical low flow could be determined from a review of the existing hydrological conditions of the river basins and their sub-basins. To obtain the minimum flow, the Hydrological Procedure (HP) No 12 is used. In basins or sub-basins where there are no records, the estimation is carried out following the procedure for the ungauged catchment. The 7-day minimum flow for 10 years recurrence interval (Q7,10) could be used as criterion in determining the sustainability of flow assimilative capacity.

For the case of the ungauged catchment, the Mean Annual Rainfall (MAR) shall be adopted from Water Resources Publication No 12 (Average Annual and Monthly Surface Water Resources of Peninsular Malaysia), in order to calculate the Mean Annual Minimum Flow (MAM). If the rainfall data is available, the MAR is the average mean annual rainfall for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation for the ungauged site are presented as average values to represent both wet and dry season condition, in which D is number of day and T is recurrence interval.

The general MAM flow equation based on HP No 12 is,

[illegible] (2.3)

where AREA is the catchment area in km^2; MAR is the mean annual rainfall; a, b1, b2 are coefficients. The historical rainfall data is available to estimate the MAR for the particular catchment. The MAR is entered in the low flow equation in order to determine the MAM. The low flow estimation for the ungauged site are presented as average values to represent both wet and dry season condition, in which D is number of day and T is recurrence interval. **Table 7.2.9** shows the estimated mean annual minimum flow.

Table 7.2.9: Estimated Mean Annual Minimum Flow

Catchment	Area	MAM
Tributaries	**km^2**	**m^3/s**
Sg Gesau	**12.07**	**0.01131426**

The estimated 7Q10 at the upstream and downstream of the project site is 0.0113 m^3/s. The estimated low flow using HP 12 is normally more conservative and the value serves as a guide for the condition of minimum flow for the study area.

Regional Low Flow Estimation Using Gauged Site

Several gauged stations available in Perak are used in the regional correlation study due to the absence of long stream flow records in the study area. Results of correlation are used for evaluating river characteristics.

Results of 7-day average flow estimation due to a 10-year storm (designated as Q7,10) are used to establish the relationship between $Q_{7,10}$ and catchments areas (**Table 7.2.10**).

Table 7.2.10: Estimated $Q_{7,10}$ for Sg Slim at Slim river

River	Q $_{7,10,}$ (m^3/s)*	Catchment area,(km^2)
Sungai Slim at Slim River (3814416)	7.26	455

* Based on Gumbel method.

The Gringorten formula is used to determine the plotting position for stream flow records exceeding 20 years while the Weibull formula is used for records less than 20 years. Graphs of $Q_{D,T}$ vs. T (Recurrence Intervals) are plotted. For the gauged sites, critical low flows are estimated.

From the analysis, a relationship between $Q_{7,10}$ and the catchments area (AREA) is established as follows:

$$Q_{7,10} = 0.0009\ (AREA)^{1.1614}$$

The coefficient of regression obtained is R^2 = 0.76. The equation is applicable to catchment area less than 1000 km^2. Based on the derived equation above, low flows (annual minimum) are estimated for the rivers in the study area and the results are shown in **Table 7.2.11**.

Table 7.2.11: Low Flow Estimation Based on Regional Analysis

Sub-catchment	Area (km2)	Q7,10 (m3/s)
SG GESAU	**12.07**	1.09965

The result shows that the estimated low flow using gaged stations within Perak (1.09965 m^3/s) is higher than HP 12 (0.01131426 m^3/s).

Hydrologic Modelling

The river within the catchment area (Sg. Gesau) originates from the nearby hills with an elevation of about 1150 m to 300 m. That is to say that tributary of Sg. Gesau originates from the nearby hills, flows through the project site, and then finally drained into Sg. Slim in the downstream area. **Figure 7.2.13** shows the representations of the catchments in HEC-HMS. The characteristics of the catchment are listed in **Table 7.2.12**.

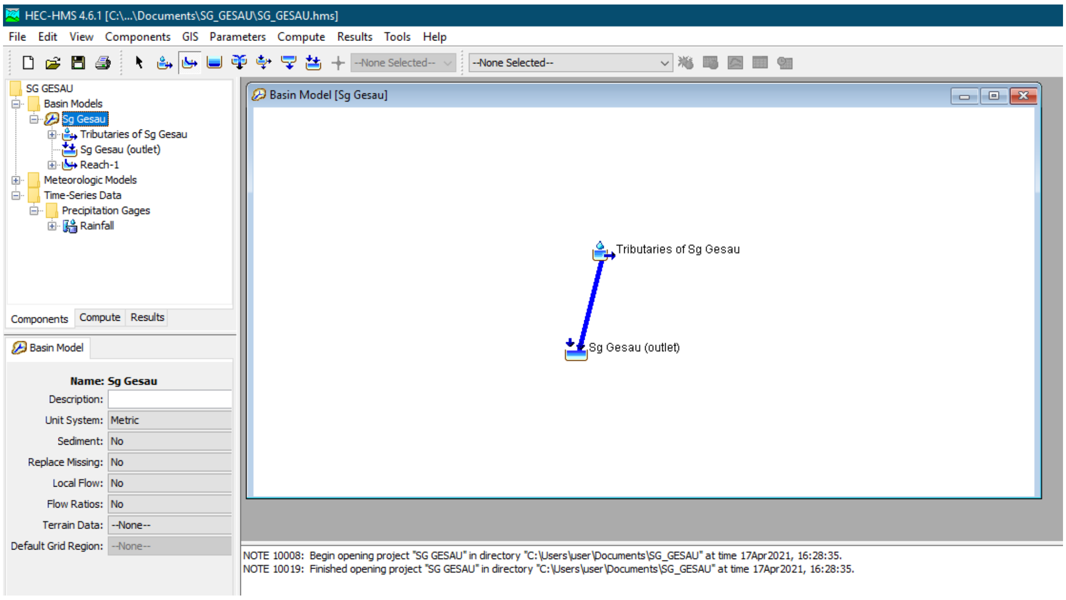


Figure 7.2.13: Representations of Catchment Characteristics in HEC-HMS

Table 7.2.12: Characteristics of Sg. Gesau Catchment Area

Catchment	C. A. (ha)	L.C. (km)	U/S Chan. Elevation (m)	D/S Chan. Elevation (m)	Channel Slope (%)	Channel Slope (m/km)
Sg Gesau	1207	2.1	40	20	3.98	20

The landuse condition of this proposed project will not change from existing to future development since the forest will be replant. However, changes during the timber harvesting and the site will be stabilized. About 400 hectares of the land in this catchment would be converted to forest. In anticipation of the increase in surface runoff, the project proponent has therefore proposed to build a sediment pond that will be function as temporary detention pond. However, due to very limited space within proposed development site, it is not possible to provide a flood detention pond to regulate the excess storm flow. The proposed flood control is to utilize the channel storage and the buffer strip that serves as flood storage during high storm flow. The buffer strip measures 20 m on each side of the river bank and length of about 500 meter with maximum depth of 3 meter. All surface runoff from the proposed development will be channeled into tributary of Sg. Gesau and allowed to flood the buffer strip during high storm flow for better onsite storm water management.

Hydrologic modelling of the pre and post-development flows for the catchment area was carried out using HEC-HMS model. The design storm selected for this study depends on the time of concentration of the study area (tc). The tc was estimated by using the Barnsby-William formulae (Equation 1). The estimated tc at the outlet and sub-catchment is listed in **Table 7.2.13**.

$$t_c = \frac{F_c . L}{A^{1/10} S^{1/5}}$$ ....Equation 1.

where,

t_c = the time of concentration (minute).
F_c = a conversion factor (58.5 for area A in km^2, or 92.5 for A in ha.)
L = length of flow path from catchment divide to outlet (km).
A = catchment area (km^2 or ha).
S = slope of stream flow path (m/km).

Table 7.2.13: Estimated t_c values

Catchment	Tc (min)	Tc (hr)
Sub 1	58	1

Therefore, the design storm used in this study for the catchment area is 2 hours. The closest IDF curve available for this study area is that for JPS Teluk Intan. Therefore, in this study, the IDF derived for JPS Teluk Intan will be used for the simulation. The coefficient adopted for the JPS Teluk Intan IDF curve is shown in **Table 7.2.14**.

Surface runoff and the proposed detention pond is designed for the return period of 5 years and checked with 10 years ARI. **Table 7.2.15** and **Table 7.2.16** listed the rainfall intensity and rainfall depth used in this study for various ARI's.

Table 7.2.14: IDF Coefficient for Stor JPS Teluk Intan

λ	κ	θ	η
54.017	0.198	0.084	0.790

Table 7.2.15: Rainfall intensity used in the study for Various ARI's

ARI (yrs)	Storm Duration (min)					
	30	60	90	120	180	360
	Rainfall Intensity (mm/hr)					
2	82.4	54.1	41.0	33.4	24.6	14.4
5	97.1	63.8	48.3	39.3	29.0	16.9
10	109.9	72.2	54.7	44.5	32.8	19.1
20	124.4	81.7	62.0	50.4	37.2	21.7
50	146.6	96.3	73.0	59.3	43.8	25.5
100	166.0	109.0	82.6	67.2	49.6	28.9

Table 7.2.16: Rainfall Depth used in the study for Various ARI's

ARI (yrs)	Storm Duration (min)					
	30	60	90	120	180	360
	Rainfall Depth (mm/hr)					
2	41.2	54.1	61.5	66.8	73.8	86.4
5	48.55	63.8	72.45	78.6	87.0	101.4
10	54.95	72.2	82.05	89.0	98.4	114.6
20	62.2	81.7	93.0	100.8	111.6	130.2
50	73.3	96.3	109.5	118.6	131.4	153.0

100	83	109.0	123.9	134.4	148.8	173.4

The temporal pattern used for this study is based on the temporal pattern developed in MASMA 2nd Edition for Perak, Kedah, Pulau Pinang and Perlis (**Table 7.2.17**). The temporal pattern is developed for rainfall duration of 15 minutes to 72 hour. Therefore the 60 minute storm duration would be adopted. The design storm hyetograph of 5 years and 10 years ARI's for 1 hour storm duration is also shown in **Table 7.2.18**.

Table 7.2.17: Region 3 Temporal Patterns – Perak, Kedah, Pulau Pinang and Perlis

No. of Block	Storm Duration								
	15-min	30-min	60-min	180-min	6-hr	12-hr	24-hr	48-hr	72-hr
1	0.215	0.158	0.068	0.060	0.045	0.040	0.027	0.015	0.021
2	0.395	0.161	0.074	0.085	0.070	0.060	0.031	0.020	0.023
3	0.390	0.210	0.077	0.086	0.078	0.066	0.033	0.026	0.024
4		0.173	0.087	0.087	0.099	0.092	0.034	0.028	0.025
5		0.158	0.099	0.100	0.113	0.114	0.035	0.038	0.028
6		0.141	0.106	0.100	0.129	0.166	0.036	0.039	0.031
7			0.104	0.100	0.121	0.119	0.039	0.045	0.044
8			0.098	0.088	0.099	0.113	0.042	0.046	0.049
9			0.078	0.087	0.081	0.081	0.044	0.052	0.058
10			0.075	0.085	0.076	0.066	0.053	0.057	0.063
11			0.072	0.063	0.047	0.046	0.056	0.069	0.074
12			0.064	0.059	0.041	0.036	0.080	0.086	0.081
13							0.076	0.073	0.078
14							0.055	0.060	0.070
15							0.048	0.056	0.058
16							0.044	0.046	0.050
17							0.041	0.045	0.044
18							0.039	0.044	0.044
19							0.036	0.039	0.030
20							0.034	0.035	0.026
21							0.033	0.028	0.025
22							0.032	0.021	0.024
23							0.031	0.017	0.022
24							0.023	0.014	0.008

Table 7.2.18: Temporal Pattern for Design Storm of 60 Minute

Pattern	5 Year	10 year	50 Year
0.068	4.34	6.55	7.41
0.074	4.72	7.13	8.07
0.077	4.91	7.42	8.39
0.087	5.55	8.38	9.48
0.099	6.32	9.53	10.79
0.106	6.76	10.21	11.55
0.104	6.64	10.02	11.34
0.098	6.25	9.44	10.68
0.078	4.98	7.51	8.50
0.075	4.79	7.22	8.18
0.072	4.59	6.93	7.85
0.064	4.08	6.16	6.98

The hydrologic losses for the area will be based on initial and continuing loss method. The initial loss is assumed to be 10 mm and the continuing loss is assumed to be 15 mm/hr. It is also assumed that the pre-development land cover consists of 5% impervious area, and the post-development consists of 10% impervious area. The transformation of effective rainfall to the outlet area will be based on Clark time-area method. The two parameters used for the development of this synthetic unit hydrograph are T_C and R. These two parameters can be obtained from observed hydrograph. In the absence of the observed hydrograph, the parameters can be estimated from regression equations derived areas with gauged data. The regression equation used in this study is derived from a study in small rural watersheds in Illinois, USA (Straub, Melching and Kocher, 2000). The regression equations are as listed below.

$T_c = 1.54\ L^{0.875}\ S^{-0.181}$ ....Equation 2.

$R = 16.4\ L^{0.342}\ S^{-0.790}$ ....Equation 3.

The T_C and R for the pre and post-development f are listed in **Table 7.2.19**.

Table 7.2.19: Tc and R during pre and post project development

Catchment	Pre-Development		Post-Development	
	Tc (hr)	R	Tc (hr)	R
Sg Gesau	1	1.5	1	1.5

The base flow for the area is assumed to be constant at 0.05 m^3/sec (measured normal flow). Based on these input data, the result obtained from the simulation is shown in **Table 7.2.20**. Comparison of estimated flow with other method such as Rational Method is also shown in the table. The flow hydrograph generated at the outlet for pre and post-development based on various storm duration and average recurrence interval is listed in **Table 7.2.20**.

Table 7.2.20: Comparison of estimated flow using Time-Area Method with Rational Method (10 Year ARI)

Catchment	Qpre (HMS) (m^3/s)	Qpost (HMS) (m3/s)	Qpre (Rat, C=0.35 (m^3/s)
Sg Gesau	23.25	26.81	38.67

The new drainage manual specifically mentioned that the post-development flow at the outlet must be equal to or less than the pre-development level. The result clearly shows that the post-development peak flow exceeds the pre-development peak flow by about 3 m^3/sec. The proposed sediment pond that also function as detention pond intends to bring down the post-development flow to the pre-development level. Since the proposed site is located at the upstream area, the area serves as a natural storage. The flood storage within the buffer zone would provide temporary storage for the excess runoff during storm event. The existing storage has ample space for future expansion of the detention storage whenever it is necessary in the event of expansion of the development of the upstream area in the future. Detention storage normally consists of storage area, inlet to the storage area and outlet out of the storage area. The proposed detention storage in the study area is a wet storage. Therefore, there is a permanent water pool in the storage area even during dry period. The permanent water pool is maintained at 0.5 meter. The storm flow from the project area and from the upstream area flows in to the detention storage, while the outflow from the detention storage flows to the nearest river (Sg. Gesau).

The design storm should accommodate storm of 5-year ARI, while its spillway should be able to cater for 10-year storm. Therefore, enough storage volume within the ponds should be provided in order to control flood of 10-year ARI. The required storage volume can be estimated by using the linear regression formula developed by USDOT (Eqn 4). The preliminary required storage volume for these ponds is listed in **Table 7.2.21**.

$$V_s = \frac{1}{2} t_i (Q_i - Q_o) \quad \text{..............................Equation 4.}$$

Where,

V_s = estimated storage volume (m^3/s)

Q_i = inflow hydrograph peak flow rate (m^3/s)

Q_o = allowable peak outflow rate (m^3/s)

t_i = time base of the inflow hydrograph (minutes)

Table 7.2.21: Preliminary Estimation of storage volume Based on 10 Year ARI

Catchment	Area (km2)	Pre-D (m3/s)	Post-D (m3/s)	Required Pond Storage Volume (m3)
Sg Gesau	12.07	23.25	26.81	1060.8

The off-line detention storage located at the lowest point with effective average depth of the pond does not exceed more than 3.0 meter. The natural shape flood storage has a surface area of about 0.5 hectare is also shown in **Table 7.2.22**. The surface area of 1 hectare provided by the project proponent for flood storage pond is more than the 0.5 hectares that are required for flood control.

Table 7.2.22: Proposed Design of Storage Volume

Sediment Pond	Q_{pre} m^3/s	Q_{post} m^3/s	Depth (m)	SA (ha)
Sg Gesau	23.25	26.81	2	0.5

Based on this required storage volume, the outlet for the pond is designed in order to develop the Storage Indication Curve. The proposed outlet from the detention storage is a series of multiple orifices (2 nos) measuring 0.5 meter diameter to cater for major storm and a 5 meter broad crested weir to cater for rare storm of 10 year. Using these data, the flow routing for the off-line storage is modeled using HEC-HMS. Figure 14 shows the representation of the off-line storage. The routed flow through the storage is shown in **Table 7.2.23**. The result also clearly shows that the post-development with pond outflow is less than the pre-development flow.

Table 7.2.23: Pre and Post-Development Flows with and without Ponds

Sediment Pond	Q_{pre} m^3/s	Q_{post} m^3/s	Q_{post} + pond m^3/s
Sg Gesau	23.25	26.81	22.73

The objective of constructing a detention pond is to meet the condition where the post-development peak outflow at the outlet is less than or equal to the pre-development condition. The result shows that this objective can be achieved through the proposed design of the community pond. This will help authorities control flooding downstream of the project area. The efficiency of the off-line storage in peak flow reduction is shown in **Table 7.2.24**.

Table 7.2.24: Peak Flow Reduction

Catchment	Inflow (m^3/s)	Outflow (m^3/s)	Reduction (%)
Sg Gesau	23.25	22.73	52

Hydraulic Modelling

In this study, hydraulic modeling is carried out to assess the capacity of the main channel traversing the site (tributary of Sg. Gesau) under the existing and post development of the project site. Should the existing size of the main channel is not adequate to handle the anticipated increase in flow, appropriate drainage reserve will be determined to cater for the needed enlargement of the main channel. The hydraulic modeling was carried out using the software HEC-RAS.

The objective of the hydraulic modeling is to perform hydraulic routing of flood flow in the drainage system, which uses the upstream inflow hydrograph generated from HEC-HMS. The hydraulic flow routing model is HEC-RAS. The simulated water surface profile and discharge will determine which area is prone to flooding under various scenarios (existing & future). The modeling scenarios will include existing and future conditions of the study area plus with existing and future flood mitigation facilities. The scenarios considered in this study are: i) Under existing condition; ii) Under future condition with existing channel capacity; and iii) Under future condition with flow control facilities (construction of detention ponds).

HEC-RAS can model water surface profiles along the channels and flood plain in the drainage system using fully dynamic flood routing technique based on the St. Venant equation. The model is based on gradually varied one-dimensional flow. Preliminary channel cross sections were obtained from field measurement. The estimated river cross sections will be used in the model simulation. The cross-section of the existing river that flows through the proposed development area is shown in **Figure 7.2.14**.

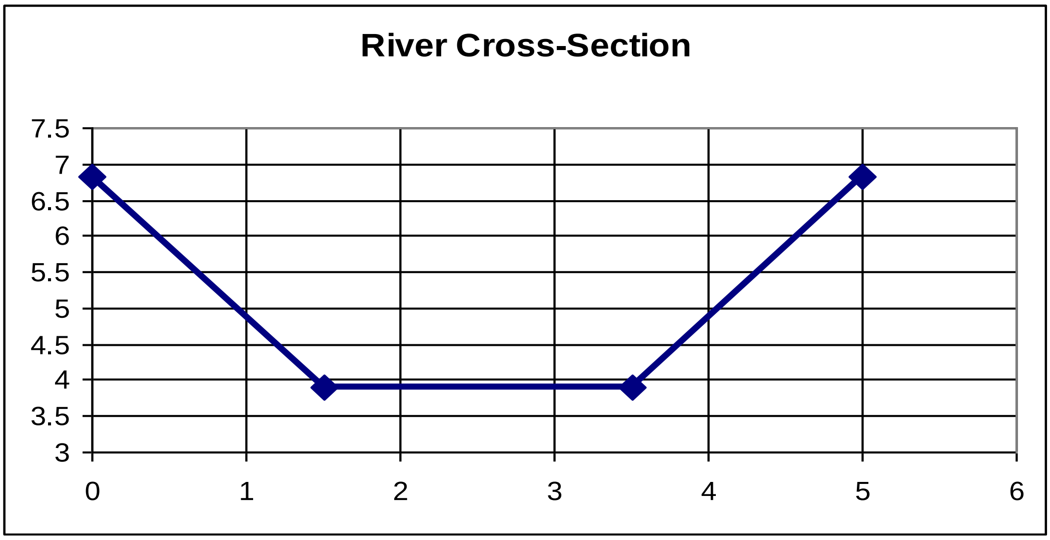


Figure 7.2.14: River Cross Section downstream of the Proposed Project Site

Storms events considered in the simulations are those with 5 and 10-year ARI's. Given that storms with 10-yr ARI are always bigger than those with 5-yr ARI, only results from 10-yr ARI are discussed. The water surface profile of Sg. Gesau (within the project area) generated by the 10-year ARI storms under the proposed forest plantation with the channel cross-sections remain unchanged. It shows that the existing capacity (38.67m3/s) is capable of conveying the 10 year peak flow (26.81 m^3/s).

HEC-RAS (Hydraulic Modelling)

The hydraulic model used in this simulation will be based on HEC-RAS model. The objective of the hydraulic modelling is to perform hydraulic routing of flood flow in the drainage system, which uses the upstream inflow hydrograph generated from HEC_HMS. HEC-RAS is one of the most widely used models, developed by the United States Army Corps of Engineers. It has been applied extensively in studying hydraulic characteristic of rivers (Pappenberger et. al. 2005 and Carson, 2006).

This model computes water surface profiles and energy grade lines in 1D, steady state, and gradually varied flow analyses (Penton and Overton, 2007). For each inundated area, the algorithm calculates the relative difference in height between the inundated area and the river. The relative difference in height means the elevation in the river must be raised for the river to connect with the floodplain (Penton and Overton, 2007).

However, the equation and the model are difficult to parameterize for the floodplain environment. HEC-RAS as a hydrodynamic river model requires high resolution DEM and closely spaced cross section data along the river. The data input requirement consists of three main parts in HEC-RAS, which are plan data, geometry data and flow data. Those requirements have to be fulfilled before running the simulation. The plan data is usually the first step in performing a simulation. The Plan will identify which geometry and flow data to be used as well as provide a description and short identifier for the simulation. If the geometry and flow data do not exist, the simulation cannot be running. It also included in the plan information are the selected flow regime and the simulation options. The options available are subcritical, supercritical, or mixed flow regime calculations. **Figure 7.2.15** shows Framework of Flood Modelling in HEC-RAS of Sg. Gesau.

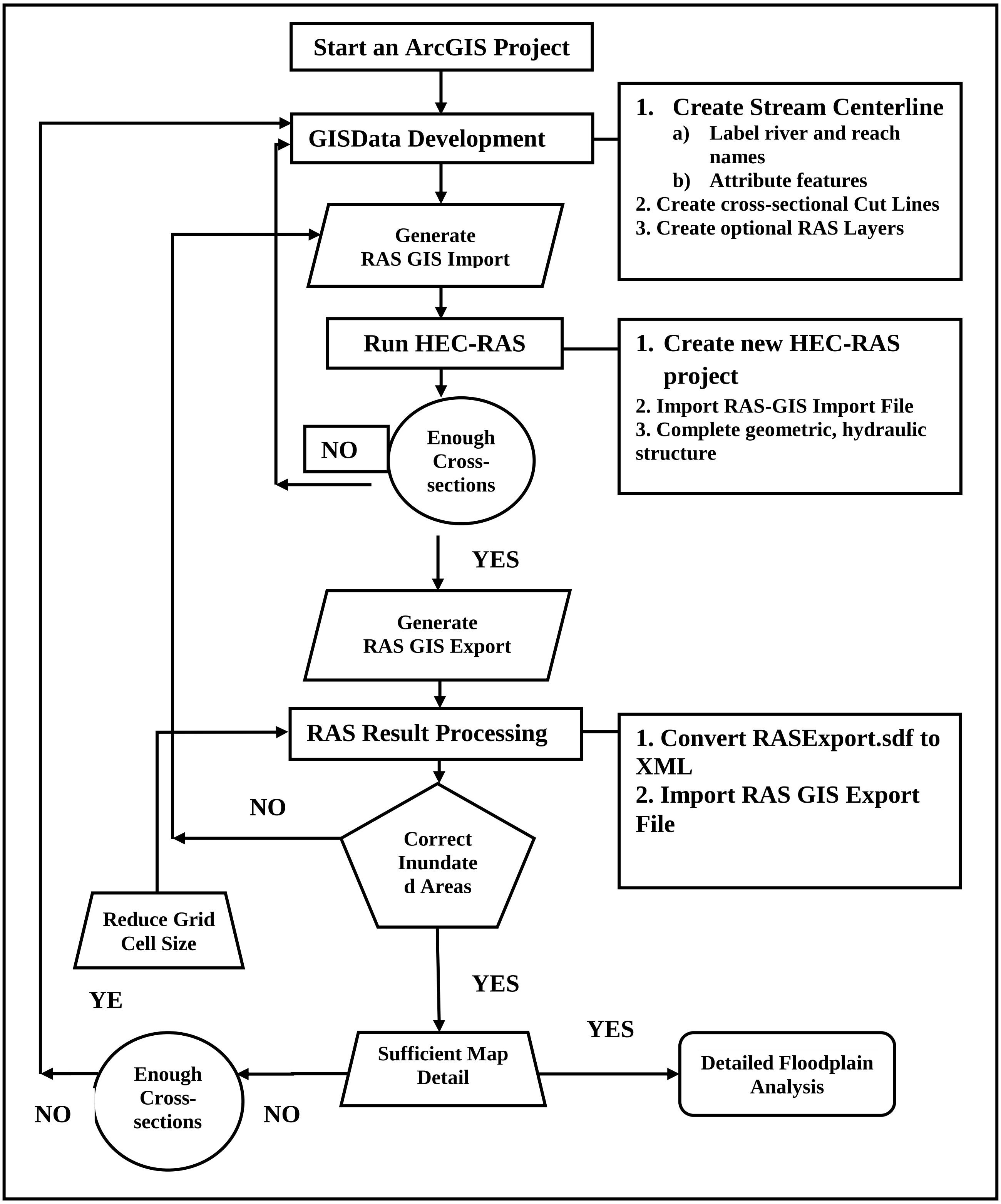


Figure 7.2.15: Framework of Flood Modelling in HEC-GEORAS, Info work (2000)

The components in HEC-RAS:

1. Geometry File: A HEC-RAS geometry file contains all of the geometric data for the river system being analyzed. The geometric data mainly consist of cross section information along with information on hydraulic structures (e.g., bridges and culverts) and roughness coefficients. Geometry files have extension from g01 to g99. The "g" indicates a geometry file, while the number corresponds to the order in which they were saved for that particular project.

2. Flow file: A HEC-RAS flow file contains boundary conditions (upstream and downstream) for hydraulic simulations. Flow files for steady flow simulations have extension .f01 to .f99. The "f" indicates a steady flow data file, while the number corresponds to the order in which they were saved for that particular project. Unsteady flow files have “u” instead of “f” in the file extension.
3. Plan file: A HEC-RAS plan file contains the list of files that are associated with the plan (e.g., geometry file and steady/unsteady flow file), and a description of all the simulation options that were set for the plan. Plan files have the extension .p01 to .p99. The "p" indicates a plan file, while the number represents the plan number.

Project file: A HEC-RAS project file contains the title of the project, the units system, and a list of all the files that are associated with the project. Project file has a .prj extension.

The modelling scenarios will include existing and future conditions of the study area plus with existing and future flood mitigation facilities. For this studies, the scenarios considered in HEC-RAS to get model water surface profiles along river and flood plain in the drainage system are as follows:-

a) Existing land survey data (2015)

Figure 7.2.16 shows the schematic arrangement of the nodes and links within the study area as represented in HEC-RAS.

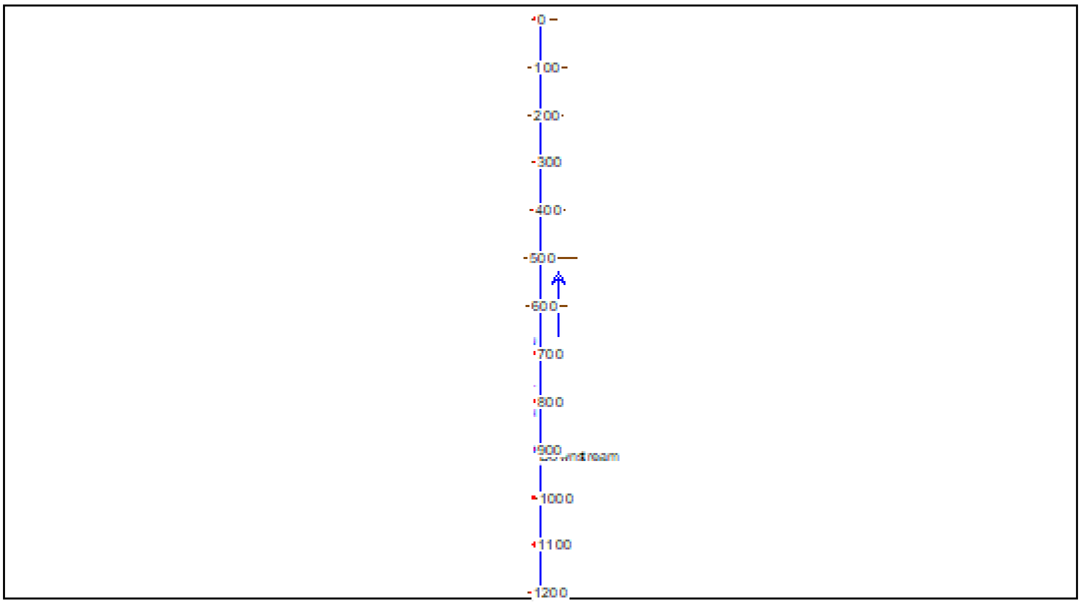


Figure 7.2.16: Schematic representation of Sg. Gesau in HEC-RAS

Hydraulic Simulation

Flow hydrograph generated by the hydrologic model were used by the Hydraulic module for the hydraulic modelling. The generated flow hydrograph will be routed through the river cross-sections.

The river cross sections were conducted and obtained where interval for the cross-sectional survey is every 50 meters for Chainage 0 (CH 0) to Chainage 1200 (CH 1200). The survey was conducted only along the main river (Sg. Gesau).

- Upstream boundary condition – Flow hydrograph
- Downstream boundary condition – Stage hydrograph

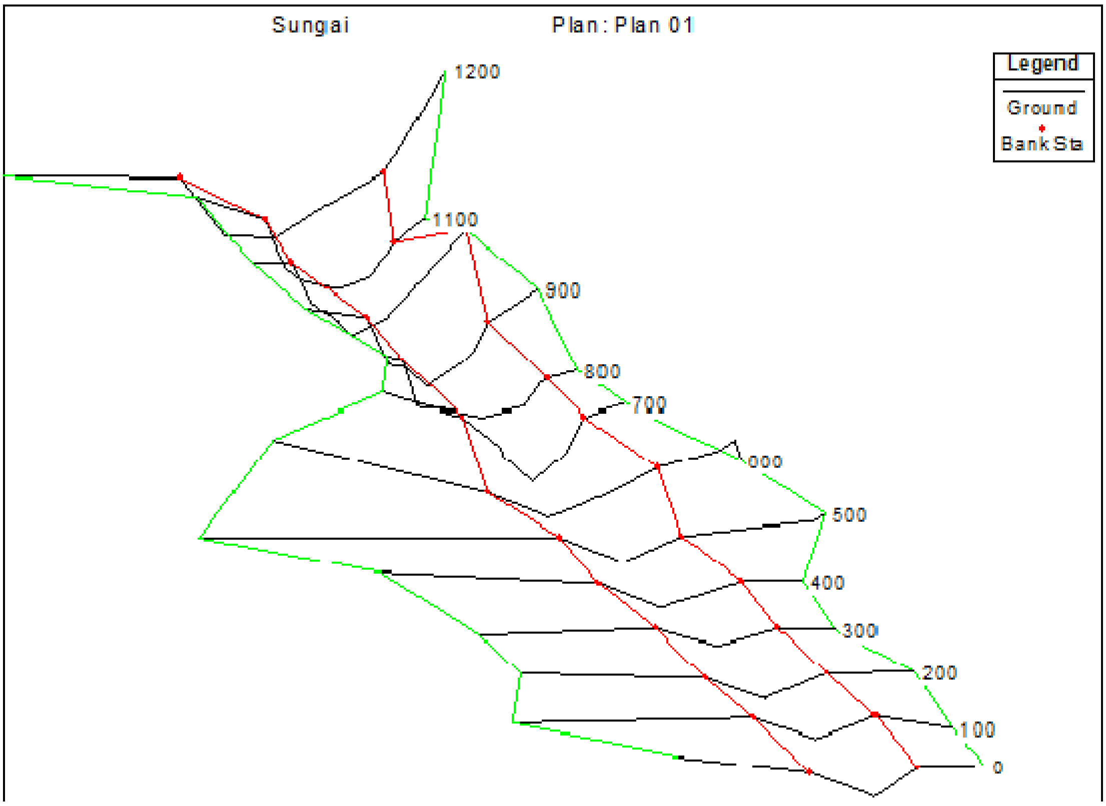


Figure 7.2.17: Perspective Plot XYZ of Sungai Gesau

The simulated result of the existing condition based on the new river cross-section survey shows that over spilling begins at most upstream section of the channel and along the main river especially at the upstream point of (CH 0 –CH 1200) based on the 100-year ARI design storm as shown in **Figure 7.2.18** and **Figure 7.2.19**. This is due to the fact that the drainage slope is mild and within certain sections of the river. This will cause back flow and results in flooding in the downstream area. Site observation confirms the findings as shown in the historical flood event. This shows that the existing section could not provide adequate conveyance capacities to convey the 100-year flood.

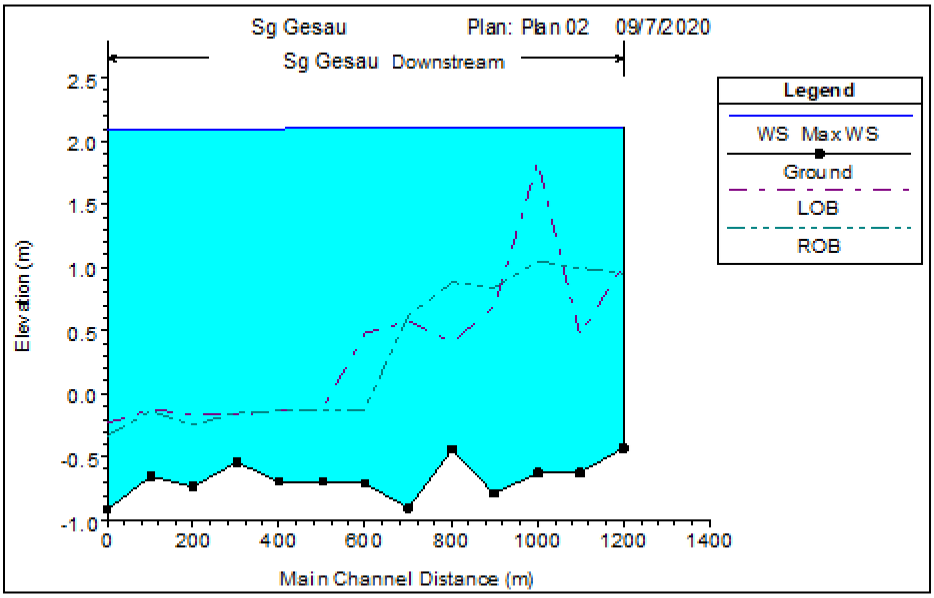


Figure 7.2.18: Water Level Based on Existing Condition – Surface Profile (100 Year ARI)

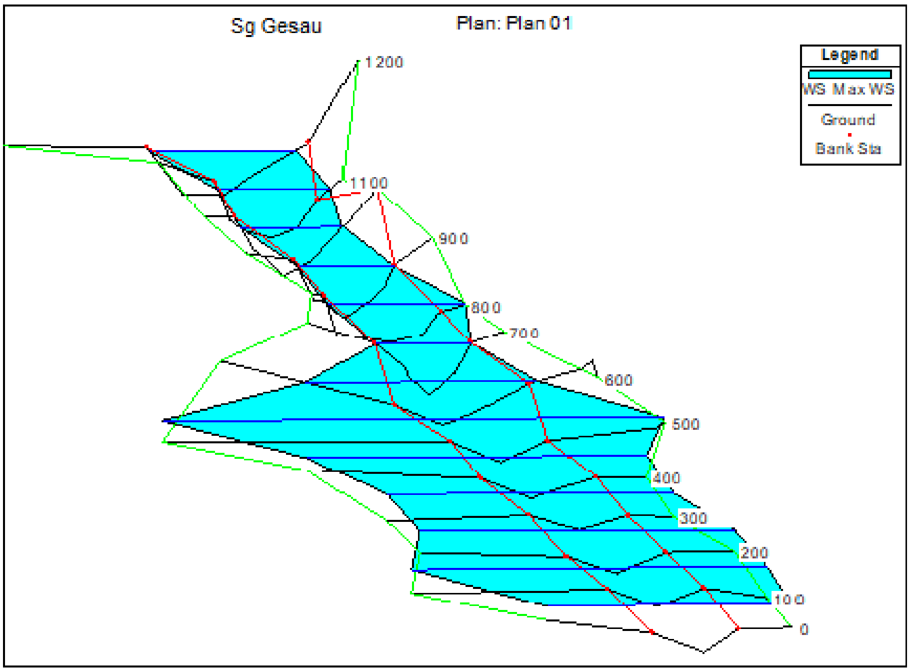


Figure 7.2.19: Water Level Based on Existing Condition – Perspective Plot (100 Year ARI)

Proposed Solution

The solution towards solving the existing problem of flash flood within the study area and the downstream area could be based on various approaches which include structural and non- structural approach. The non-structural approach includes flood plain mapping and zoning, and relocation of affected villages. The structural approach may include rapid disposal or storage approach. As proposed in the manual MSMA, storage approach is a more appropriate solution for the flash flood problem. This approach is suitable with the proposed forest plantation site.

7.2.1.5 Ambient Air Quality

Air pollution can be defined as the presence of particulate matter in the atmosphere of one or more contaminants added directly or indirectly by act of man, in such amounts that affects especially the human being. Major air pollutants from the development of forest plantation are contributes by the soil re-suspension, vehicular emission, biomass burning activity and spraying agrochemicals.

The impact of dust dispersion and air pollutants are localized, however it may give a very minimal impact. All vehicles moving in and out the project site will use the same public road used by local people. The movement of heavy vehicles will raise the re-suspension soil into the air become suspended particulate matter. High concentration of particulate matter was closely associated to local characteristics of the atmospheric circulation. The elevated concentration of particulate matter in the atmosphere will rise during the dry season and wind speed.

Sulphur oxides (SOx), nitrogen oxide (NOx), and carbon monoxide (CO) from the exhaust of transport vehicles and other machineries during the development phase may exposes to some human health risks such as asthma, default in breathing, etc.

Spraying of chemical (pesticides and insecticides) in controlling weeds, pests and diseases could introduce chemical pollutants into the air in the form of spray droplets suspended in the air and swept away by winds.

Overall, the impact of air pollutants that might be arise from forest plantation development would be a temporary short term impact on air quality if it is managed in responsible manner.

7.2.1.6 Ambient Noise

Noise pollution takes place when there is either excessive amount of noise or unpleasant sound that causes temporary disruption in the natural balance that will cause impact to human comfort, health and efficiency as well as to wildlife.

The noise generated during preparation of forest plantation will cause very minimal impacts to the surrounding area. The noise generated may contribute by the movement of vehicles, tractors and machineries use for land preparation, development of access road and transportation of invaluable woods. The noise levels of these machineries and equipment are usually between 70-85 dB (A) and more at the receptor point at the working site. Hence, during these activities the ambient noise level in the project site will be increased.

However, the project site is located deep into the woods which surrounded by forest reserve that will act as natural noise barrier to restrict the spread of noise annoyance. Operators or workers whom are handling machineries on site will more expose to the noise pollution. This reason will then damage their hearing system, sleep disorder, stress and annoyance. However, these impacts are only for short term and restricted to daytime hours only. Once the plantation area is in operation, noise pollution and noise annoyance is relatively insignificant.

To assess the potential problem of noise, the prediction of equivalent continuous equal energy level (L_{Aeq}) was carried out. Typical noise levels form representative pieces of equipment are listed in **Table 7.2.25**.

Table 7.2.25: Equipment Noise Emission Levels

Equipment	Typical Noise Level (dBA) (50 feet from source)
Backhoe	80
Compactor	82
Dozer	85
Generator	81
Paver	89
Rail Saw	90
Saw	76
Shovel	82
Truck	88

Source: Environmental Protection Agency, 1971

7.2.1.7 Flora and Fauna

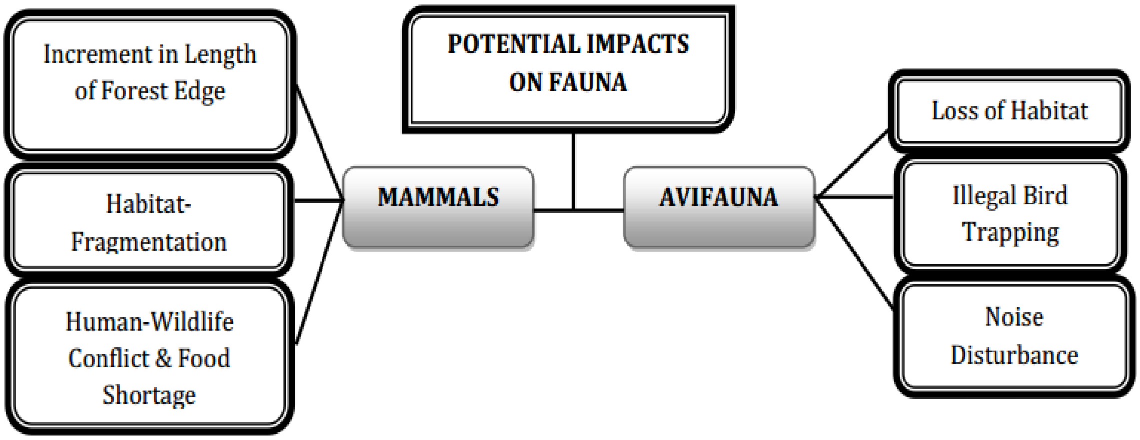
a) Flora

The project site is a secondary forest that will be conducted for timber harvesting before forest plantation take place. Forest plantation development is a program to develop the logged over forest with replanting of forest species with good management practice. The forest plantation development process will require removal of existing trees such as shrubs and leave the soil uncovered which consequently destroys wildlife habitats.

The direct impacts of vegetation removal are soil erosion, sedimentation, elevated surface runoff and water flow which affect the river water quality.

b) Fauna

Mammals and avifauna will face significant impacts during the development phase as mention below:



The potential impacts on fauna are discussed in following paragraphs.

Potential Impacts on Mammals and Herpetofauna

I. Loss of Ecosystems and Habitat

Tropical ecosystems are known as the richest and diverse in the world with Malaysia being one of the 17 mega biodiversity countries in the world. Tropical forests are perhaps the most dominant of all the ecosystems in the tropics. The proposed project is part of Slim Forest Reserve which as the name implies should be reserved with natural forests. To meet economic needs, selective and sustainable logging or less destructive eco-tourism should be applied. As reported in the existing environment chapter, the proposed project is habitat for some mega fauna such as leopard, Malayan tapir, pig-tailed macaque, and sun bear as well as home to myriad of medium and small sized fauna species. The establishment of the proposed project inevitably would lead to clearing of vegetation and habitat. It would result in loss of the rich ecosystem and habitats present at the site i.e. forest and associated habitat. The loss of habitat will lead to loss and displacement for many fauna as described below. The deforestation and opening of earth tracks also opens up other impacts such as poaching as described further below.

II. Wildlife and Fauna Loss

There were numerous totally protected and vulnerable species recorded at the site such as;

1. Leopard;
2. Malayan Tapir;
3. Sun bear;

As a result of the forest and habitat loss, fragmentation and degradation, loss in wildlife and fauna population would be another impact. During the construction stage, slow moving and many medium and small sized wildlife and fauna most probably will not able to make their escape effectively such as turtles, tortoises, lizards, amphibians, burrowing and nocturnal (active by night) species. Strictly arboreal (tree canopy dwelling) species namely monkeys and squirrels would be affected if no contiguous tree canopy is available linking to safer habitat. They would also face competition and conflict with the existing fauna as there are carrying capacities for each habitat. During the competition and conflict, some might sustain injury and even die. Though certain species are able to make their escape without much problem, they might be reluctant to leave in situations like having nests with young, hatchlings or chicks.

III. Illegal Wildlife Hunting and Collecting

Without strict regulation and monitoring, illegal wildlife hunting and collecting is another likely impact to be experienced by the fauna component. It is not only possibly done by certain labours at the site but also outsiders whom would take the opportunity. Illegal collecting is possibly could happen during the clearing works where the machine operators sometimes might find fauna trapped, exposed, in nest etc. Without strict regulation and supervision certain workers would definitely take the opportunity to collect them to be eaten, kept as pet, sell etc. Although the project developer and contractors may claim that they never let such activities to happen, in reality it is difficult to assure this on the ground on daily basis with many workers including foreign ones unless a knowledgeable and dedicate personnel is employed for this purpose.

IV. Human-Wildlife Conflict

The Department of Wildlife and National Parks Peninsular Malaysia (PERHILTAN) defines human-wildlife conflict as follow:

“Behaviours or acts of wildlife species that may cause death, injury, property destruction, damage of crops, depredation of livestock or could cause fear on public safety.”

The habitat loss experienced by fauna could cause some species to cause human-wildlife conflict especially by pig tailed macaque and wild boar which were recorded at the proposed project. Conversion of their natural ecosystem could cause these species to feed on the crops and fruits. Due to the disturbance, the workers at the site may try to harm them. Additionally, the conflict is also likely to occur within the proposed project itself and other committed plantations nearby.

V. Open Burning and Forest Fires

There is also possibility of fire to occur intentionally or accidentally from the workers and contractors at the site from burning of wastes at their *kongsi*, cigarette butts, sparks from machines etc. which may spread to the forested habitat not only within the proposed project but also to the surroundings. **Figure 7.2.20** shows examples of open burning involving projects converting forests into plantations. This would further jeopardize the wildlife and fauna surviving in already shrinking, fragmented and degrading habitats. While it is a serious offence to do open burning in Malaysia which carries penalty up to RM 500,000, it is keep on happening especially in projects converting forests into plantations. This is due to, among other, difficulty to monitor it at all times, lack of staff and resources, and the vast areas involved for the forest conversions.

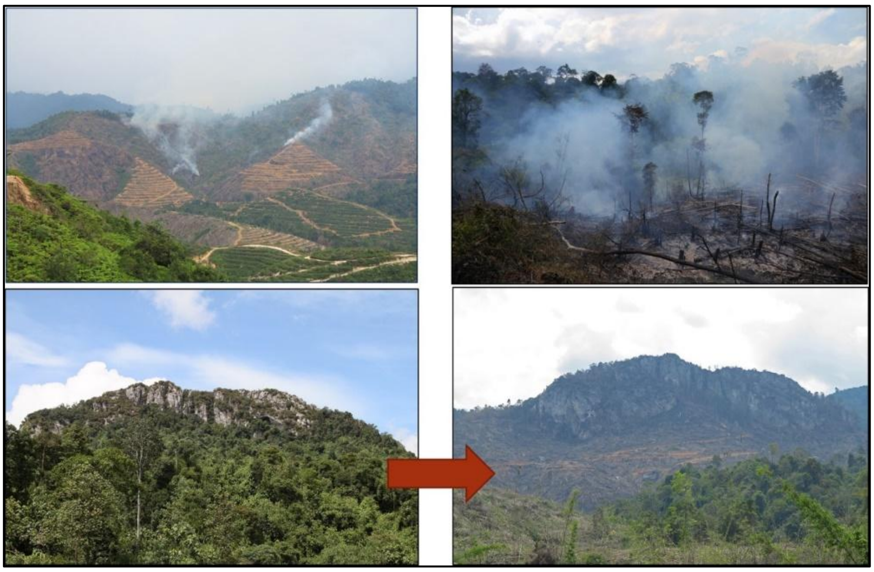


Figure 7.2.20: Examples of open burning involving projects converting forests into plantations etc. which may also destroy remaining forests and habitats in the surroundings.

<u>**Potential Impacts on Avifauna**</u>

i) Loss of Habitat

- Most birds built their nests on or in trees or nearby shrub while some on the ground. With such diverse use of trees and its surroundings by the avifauna, tree felling imposes a significant impact to their habitat and survivability.

- This is because a tree and its nearby surroundings provide not just shelter or protection against elements of nature but also provide food (fruits and insects), socializing venues (meeting, gathering, mating), and focal point (navigation, territory) also known as niche.

ii) Illegal Bird Trapping

- During land preparation, the avifauna will face the threat of illegal bird hunting or trapping which may cause species extinction.
- By having the access roads built, accessibility and visibility for the poachers to certain places in the forest area will ultimately increase.
- Most species of birds found in the study area are Totally Protected or Protected by the which means that any attempt to collect these birds from the area must have permission from the local authority i.e. Department of Wildlife and National Parks, or be faced with a fine or jail-term.

iii) Noise

- The noise will inevitably increase the existing noise levels and hence directly or indirectly cause a disturbance to the existing bird's community due to the movement of heavy vehicles during the development phase.
- Birds are known to guard their territory via calls and sounds (territorial call). Territorial song is only effective if it is heard by the other birds, and noise from heavy vehicles can be so loud that the bird song may be distorted resulting in difficulties. There also may be a chance that other individuals of the same or other species might intrude their territories which later on induce quarrels and fights. When quarrels and fights endure for a period of time, their survivability (gaining food to raise young and mating) can be dramatically reduced.

7.2.1.8 Socio-economy

During the **development phase**, there are several potential impacts that would require mitigation measures. The followings are some of the impacts identified:

a. Job Opportunities

The proposed project is expected to generate employment opportunities both for the local people and foreign workers. However, they hope the Project Proponent will prioritize and hiring locals instead of foreign workers. The type of employment such as guard, driver lorry and a few planters during development activities.

b. Human-Wildlife Conflict

Human-wildlife conflict is expected to be encountered mainly outside the proposed project site. The project proponent has to look into this matter and undertake appropriate actions such as work closely with the Department of Wildlife and National Parks (DWNP). This is to ensure that any interference of wildlife can be reduced and minimize the impacts of the workers on-site and the nearest settlement area and their crops.

c. Orang Asli Roaming Area

There are two Orang Asli villages found within 5km from the proposed project site: Kampung Orang Asli (Pos Bersih) and Kampung Orang Asli Sungai Gesau. These Orang Asli do depend, and their roaming area is most likely within the Bukit Slim Forest Reserve boundary to find forest products such as petai and rattan (seasonal). It is inconvenient for them to roam elsewhere as they are already familiar with the existing forest. Some of these Orang Asli works as rubber tappers.

d. Risk of flooding around the village

During the socio survey, the villagers mentioned that flood issues happened during monsoon season, especially in the lowland village area and the Orang Asli settlement's access road.

7.2.2 Potential Impacts during Operation

7.2.2.1 Soil Erosion

During the operations phase, the soil has been fully stabilized with existing vegetation, additional cover crops and forest trees. Hence, the impact of soil erosion during this stage would be less significant.

7.2.2.2 Waste Management

The operations phase will tend to generate wastes during field maintenance such as solid wastes, biomass wastes, sewage and scheduled wastes (agrochemical and fertilizers containers). All the mitigation measures for each type of wastes are shown in the next paragraph.

a. Solid Wastes

Solid waste will absolutely produce once the site office and base camp are in operation. Improper of handling waste management will prolong their impacts until the operation phase. Besides the serious health hazard which could lead to the spreading of disease, the aesthetic sensibility will also be offended. This is due to the hideousness of wastes piles on the roadside, on the dumping area and at the water surface. The situation has made worse by the presence of disease and always become feeding places for dogs and cats. Waste always carelessly and irresponsibly discarded in public, river bank, along the roads, and around communal bins. This scenario has become a common things which public should realize that the important to handling the waste in a proper way (Viraraghavan and Pokhrel 2005).

b. Biomass Waste

Generally, the harvest residues from hardwood and softwood from forest plantations are considered to be a major potential source of biomass. The typical forest plantation investment could generate profits in as little as 20 years for wood pellets, veneer in year 25 and timber after year 30. During operation phase, managing forest plantations involves thinning and pruning, depending on whether the trees are being grown for high-value saw logs or as lower-quality logs. The thinning process will involve the cut down of two thirds of the trees planted during the early stages of the growing cycle to make more room for the others. The felled trees are either left on the ground to rot or sometimes harvested as posts, poles or pulpwood.

Pruning session is a basic part of the efficient plantation management and collection of waste is necessary in plantation. The reasons to prune include deadwood removal, shaping (by controlling or directing growth), improving or maintaining health, reducing risk from falling branches, preparing nursery specimens for transplanting, and both harvesting and increasing the yield or quality of trees. Biomass wastes are generated from fallen leave, branches and twigs as well as seeds of forest trees. Most of these wastes are being left to rot on the plantation ground, even though some of the branches and twigs can be used for other usage.

Improper management of the biomass waste could lead to the clogged in rivers and water body. The clogged river with branches and stems will create stagnant water and disturb the water flow. When raining season or heavy rains occur, the water will overflow the river bank and cause flood. However, during drought season, the clogged water system will create water shortage at the downstream area. River system disorders will affect the importance of aquatic ecosystem. Best management practices need to be adopted in order to avoid the blockage in the natural river, water bodies as well as in the drainage.

c. Scheduled Wastes

The activities carried out during the operation phase of the project site will generate varieties of scheduled wastes. During the breakdowns and minor on-site repairs and maintenance of heavy vehicles and machineries that being used in operation phase, there will be oil and grease pollution occur due to the improper handling or accidently spillage of fuels, waste oils, and lubricants. Improper management of scheduled waste lead to the heavy downpour carries all these waste into the waterways and hence degrades the water quality. Plus, improper management of skid tank and waste oils also lead to the contamination of the water body/rivers. Oil sheen on the river may degrade the aesthetic values of the surrounding river and also may create the unsightly floating matter and subsequently will reduce the oxygenation of the water bodies.

Hence, a proper management of scheduled wastes shall be outline according to the Environment Quality (Scheduled Wastes) Regulations 2005 in order to ensure an adequate protection of human health and out environment.

7.2.2.3 Water Pollution (Sewage)

Once the site office and base camp are in operation, sewage absolutely will be produced. Sewage from toilets, kitchens, canteen and other similar facilities should be discharged into a proper sewer. All type of sewage are likely to carry pathogenic organisms that can transmit disease especially to humans; organic matter that can cause odor and nuisance problems; hold nutrients that may cause eutrophication of receiving water bodies; and can lead to eco-toxicity.

A proper sewage facilities need to be provided at an early stage/phase of the development. Thus, during the operation phase, all these facilities shall be maintained in a proper condition throughout the phase in order to have a better effluent discharge without harming the environment.

7.2.2.4 Air Quality and Noise

Air and noise pollution would not be a major concern during the operations phase. It might be a less significant impact to the environment as well. The dispersion of fugitive dusts and heavy vehicles used can be controlled and minimal when the cover crops as well as forest trees had been established.

Noise interruptions would not be significant impact when the crops have been established. Therefore, noise interruptions would not be major impact during the operational phase.

7.2.2.5 Flora and Fauna

a. Flora

During the operations phase, there would be no significant impacts on flora as the cover crops and forest trees will develop a productive forest. Through the FOA report written by W. J. Libby, 2002, forest plantations usually have less total biological diversity than do indigenous forests, and their associated biota are also different in composition from those of indigenous forests in the same area. However, most forest plantations host much greater biological diversity than do most agronomic crops. If indigenous forests are common in the region, as they should be, then the different suites of biota sustained in forest plantations add to regional biological diversity. This is a clear positive benefit of forest plantations.

The dense stands of young trees may exclude almost all other vegetation, and thus the many other organisms that would live in or on the associated flora are also absent. Thinning these dense stands and forest plantations will normally allow these associated understory plants to resume their presence. A major advantage of deploying reliable families or clones to forest plantations is that planting densities can be lower; often 1000 or fewer trees planted per hectare, to still achieve similar or even better final-harvest stands. Lower planting density not only reduces planting and later thinning costs. It also leaves much more open niche among the planted trees, where a rich associated biota develops soon after planting and persists through much or all of the rotation.

b. Fauna (Mammals)

During the operations phase, the availability of food (forest seeds and young trees) would attract wild animals especially the wild boar and monkeys to enter the area searching for food.

c. Avifauna

The development phase would result in loss of fauna and avifauna which tend to migrate to new breeding places. The outcome can be considered as permanent hardly back to normal condition once even after the plantation reach its completion stage (operation phase). The forested area nearby which is still with natural habitat condition is capable in accommodation the migrated avifauna that was displaced out from their original habitat during the implementation of the activity.

Bird's diversity is often higher at the edges of such habitats, where it is close to other, more floristically diverse habitat than at the core of the plantation. Typical species found near the forest plantation usually include, Oriental Magpie Robin, White-throated Kingfisher, Yellow-vented Bulbul, Spotted Dove and Mynas.

7.2.2.6 Socio-Economics

The following are some of the potential impacts during operations stage:

a. Human Wildlife Conflicts

There would be an encroachment of wildlife on and off to the plantation area even though mitigation measures have been taken to minimize their occurrence. The project proponent and the Department of Wildlife and National Parks have to work together to ensure that the conflict is minimized.

b. Employment Opportunities

The plantation is expected to employ at least 8 professionals in the management of the estate and more than 10 full- time workers.

7.3 PROJECT ABANDONMENT AND REHABILITATION

Project abandonment can occur at any stage of the Project development or operation, which may due to the down turn of the nation's economy, social acceptability of the project in the community, or unforeseen management and technical problems. During project abandonment, it may happen an incident especially the intrusions of poachers and wildlife encroachment.