CHAPTER 6

CHAPTER 6:
RECOMMENDED MITIGATION AND CONTROL MEASURES

This chapter outlines the mitigation and control measures recommended for managing and alleviating the potential environmental impacts associated with or arising from the implementation of the Project. The impact assessments have identified that there is no significant impact to be encountered during the pre-construction and post-construction stage. As such, the mitigation and control measures recommended herein are largely for the construction stage.

6.1 AIR POLLUTION CONTROL

Wet suppression and wind speed control are two common methods used to control dust at the construction site. The following are the proposed measures for control of air pollution:

i. Soil loads on construction vehicles should be kept covered during transit on public roads.

ii. Topsoil stockpiles should be kept covered or have a suitable dust palliative applied.

iii. A suitable dust palliative should be applied to unsealed roads if dust rises above unacceptable levels.

iv. All construction vehicles and machinery should be regularly serviced and maintained to ensure good working condition, thereby reducing the possibility of excessive exhaust emission.

v. Dust deposition monitoring should be conducted at the boundary to the nearest sensitive receptors during the construction stage.

vi. Air quality monitoring should be conducted in accordance with recommended sampling protocols and methodologies.

vii. Open burning is strictly prohibited.

6.2 NOISE POLLUTION CONTROL

Noise pollution may be experienced during working hours of the construction stage. As such, the proposed noise pollution control measures are:

i. Operation of heavy machineries and vehicles should be limited to daytime working hours, i.e. 0700-2200 hrs.

ii. Provision of personal protective equipment (PPE) for personnel/ workers who are handling heavy machineries.

iii. Stationary machineries and equipments such as generator set should be equipped with acoustic enclosures and silencers.

iv. All vehicles and machinery should be regularly serviced and maintained to ensure good working condition, thereby reducing the possibility of excessive noise emission.

v. Enforcing a speed limit of 40 km/hr for heavy vehicles on site.

6.3 WATER POLLUTION CONTROL

To preserve the baseline water quality of the receiving waterways, the following mitigation and control measures are recommended.

i. Although the impacts from sanitary waste discharge during the construction stage is short term, appropriate waste and sewage collection and disposal procedures and facilities (rubbish bins and toilet facilities) should be undertaken during the construction stage.

ii. Proper housekeeping should be maintained at the construction site, including the site office and workers' camp.

iii. Untreated sewage and sullage should not be discharged directly into the receiving waterways. The temporary toilet at the construction site should be designed and built in accordance to the requirement of the Sewerage Services Department. Discharges from these toilets must be treated in septic tanks with filters before being allowed to flow into receiving waters.

iv. Any sewage discharge into natural waterways should comply with the Standard A of the Environmental Quality (Sewage) Regulations 2009.

v. Erosion and Sediment Control Plan (ESCP) should be prepared and implemented to control sediment runoff from the construction site.

vi. Site clearing and earthworks should be undertaken in phases.

vii. Secondary containment with at least 110% capacity and protected from rain should be provided for storage of chemicals, fuel and lubricant.

viii. Material storage areas should be located more than 50 m from any waterways.

ix. Water quality monitoring programme should be conducted as recommended in the Environmental Management Plan (EMP).

6.4 SOIL EROSION CONTROL

6.4.1 PROPOSED MITIGATIONS FOR EROSION & SEDIMENT CONTROL PLAN

Determination of appropriate Best Management Practices (BMPs) is the key to effective surface runoff, erosion and sediment controls. It has been concluded based on the scoping of site constraints that all types of BMPs must primarily focus on effective sediment control measures. **Table 6.4.1** shows the impact and the mitigation measures used in the selection of the BMPs.

Table 6.4.1: Environmental Impacts and Mitigation Measures

Project Activities & Environmental Issues Concerned	Potential Impacts	Mitigation Measures and Recommended BMPs
Erosion, Sediment and Flood Control	i. The cleared lands after the clearing work may be left unprotected to rainfall effect and subsequently could cause direct surface runoff and soil erosion. ii. Changes of hydrology characteristics due to disturbed surface runoff leading to soil erosion and sedimentation. iii. During earthwork activities, longer period of barren surface may expose the top soil to be eroded, detached and transported into the water bodies, resulting in an increase of sediment load. iv. Earthwork phase will involve an estimated balance of cutting and filling with minimum grading activity. v. Post development erosion rate without BMP's is 106,733 tonne/ha/yr, higher than pre development stage of 266.83 tonne/ha/yr. Thus, proper mitigation is necessary to minimise the erosion rate.	i. Effective construction of BMPs in accordance to Erosion and Sediment Control Plan (ESCP) to safeguard from erosion and sedimentation. ii. The ESCP components will consist of three aspects which are drainage control, erosion control and sediment control: • Drainage control: earth drain complete with check dam, slope, temporary waterway crossing, diversion channel and drainage outlet structure. • Erosion control: after grading, place mats over bare soil adjacent to watercourse or hydro-seeding. • Sediment control: gravel access roads, channel lining, silt fence, sand bag barrier and sediment basin included with spillway. iii. With proper implementation of ESCP and vigilant supervision, the post development erosion rate is expected to be 106.733 tonne/ha/yr, which is lower than the post development erosion rate without BMPs.
Water Pollution	i. Bare land will lead to an increase in suspended solids and turbidity to the nearby water body during rainy day. ii. Biomass disposal site may contribute organic pollutants and discharge into the water body. iii. Oil and grease generated from construction machineries may be discharged into waterways.	i. Land clearing activity and earthworks schedule should avoid the rainy day/ wet season and should be carried out in phases. ii. Install BMPs and implement the ESCP to reduce the mass load of sediment reaching the nearest water body and conserve the water quality. iii. Install temporary drainage system to allow surface runoff to flow into the sediment ponds. iv. Temporary turfing or hydroseeding the bare land to assist in reducing the surface runoff velocity during storm events. v. Proper management of any solid wastes and scheduled wastes generated from the construction vehicles.

Cont.

Table 6.4.1: Environmental Impacts and Mitigation Measures (cont.)

Project Activities & Environmental Issues Concerned	Potential Impacts	Mitigation Measures and Recommended BMPs
Hydrological Impacts	i. The total surface area such as roads and drainage will increase the runoff coefficient in the area. It will increase the velocity of flow, thereby shortening the critical storm duration and therefore higher storm intensities. ii. The post development flow is higher than pre development flow if no retention pond is built.	i. Stormwater management will be via retention pond with swales and check dam providing filtration and infiltration as well as water quality improvement. ii. With stormwater management, the post development flow is lower than pre development, thus it complies with the MSMA requirement.

6.4.2 EROSION AND SEDIMENT CONTROLS – STRUCTURAL PRACTICES

Proposed erosion and sediment control measures are designed in accordance with the latest versions of the following documents:

- *Guideline for Erosion and Sediment Control in Malaysia*, published by the DID Malaysia;
- Guidelines for 'Prevention and Control of Soil Erosion and Siltation in Malaysia', Published by the DOE Malaysia; and
- *Urban Storm Water Management Manual for Malaysia 2012, Second Edition*, published by the DID Malaysia.

The proposed phasing in construction works are illustrated in **Figures 6.4.1** to **6.4.7**. The proposed BMPs application during the construction stage and subsequent permanent BMPs during the post-construction stage (and the type of BMPs for the ESCP) are listed in **Table 6.4.2** whereas **Table 6.4.3** outlines the types of BMPs in the proposed ESCP.

Figure 6.4.1: Proposed Parcels 1 to 7

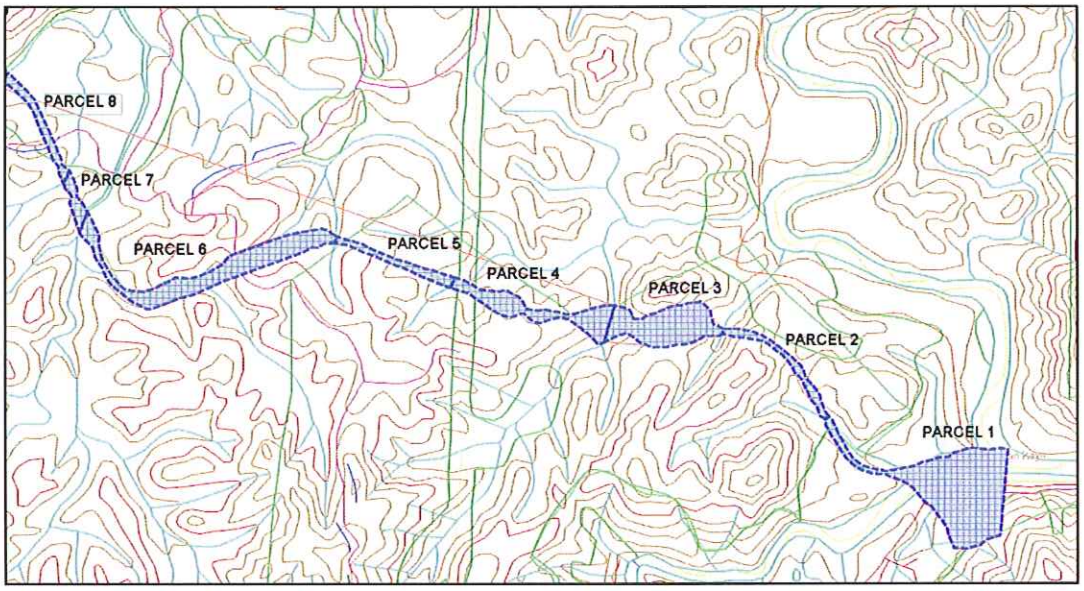


Figure 6.4.2: Proposed Phase 8 to Phase 18

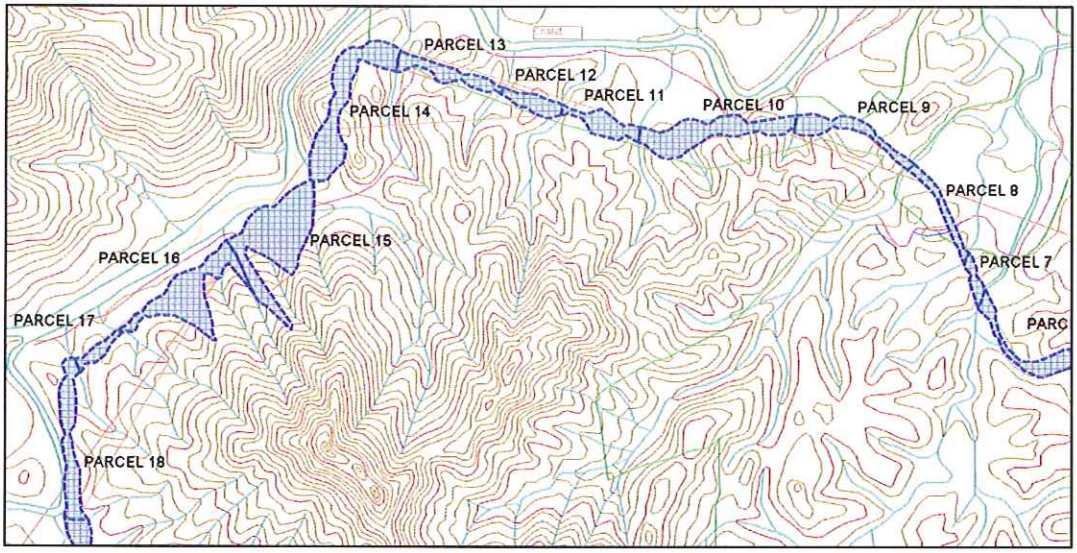


Figure 6.4.3: Proposed Phase 19 to Phase 24

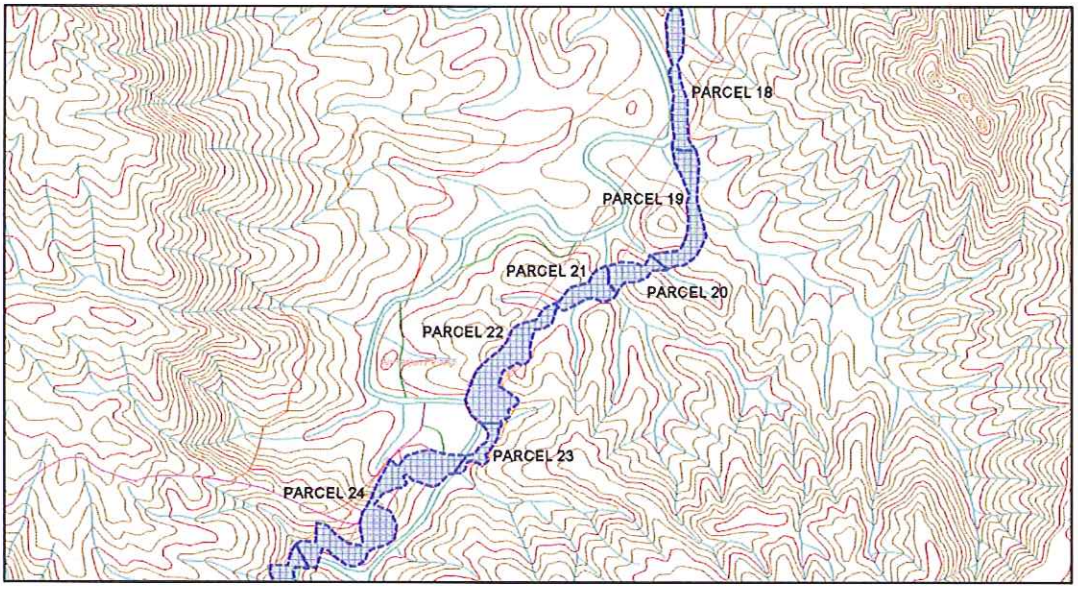


Figure 6.4.4: Proposed Phase 25 to Phase 34

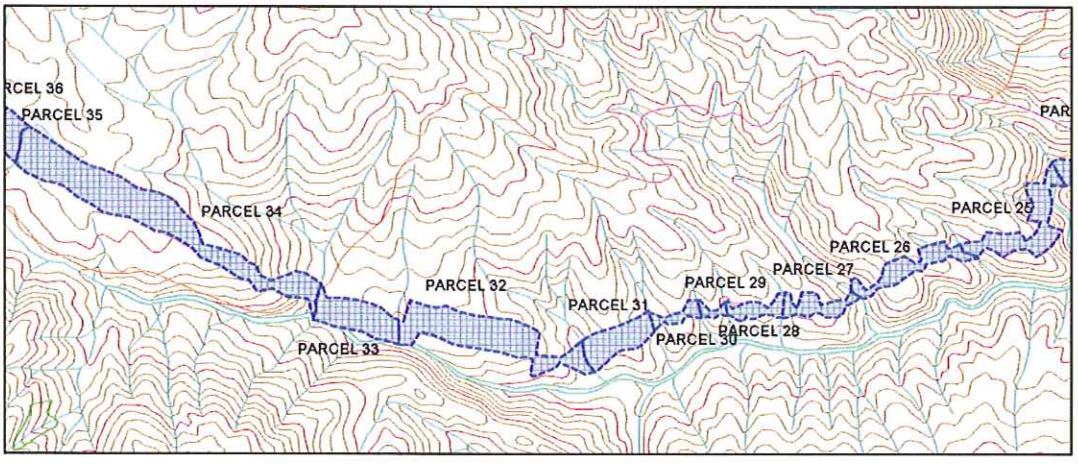


Figure 6.4.5: Proposed Phase 35 to Phase 45

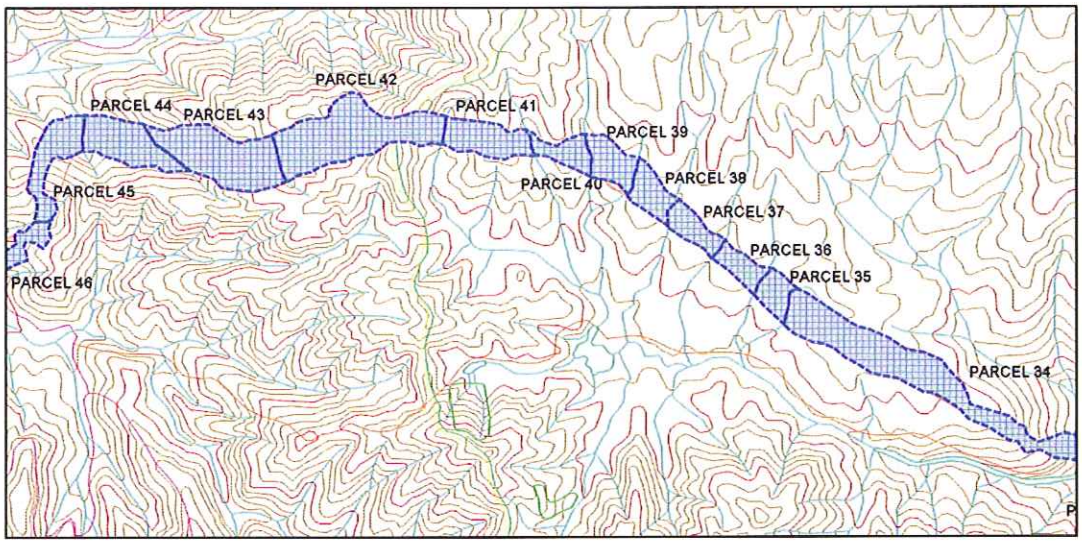


Figure 6.4.6: Proposed Phase 46 to Phase 57

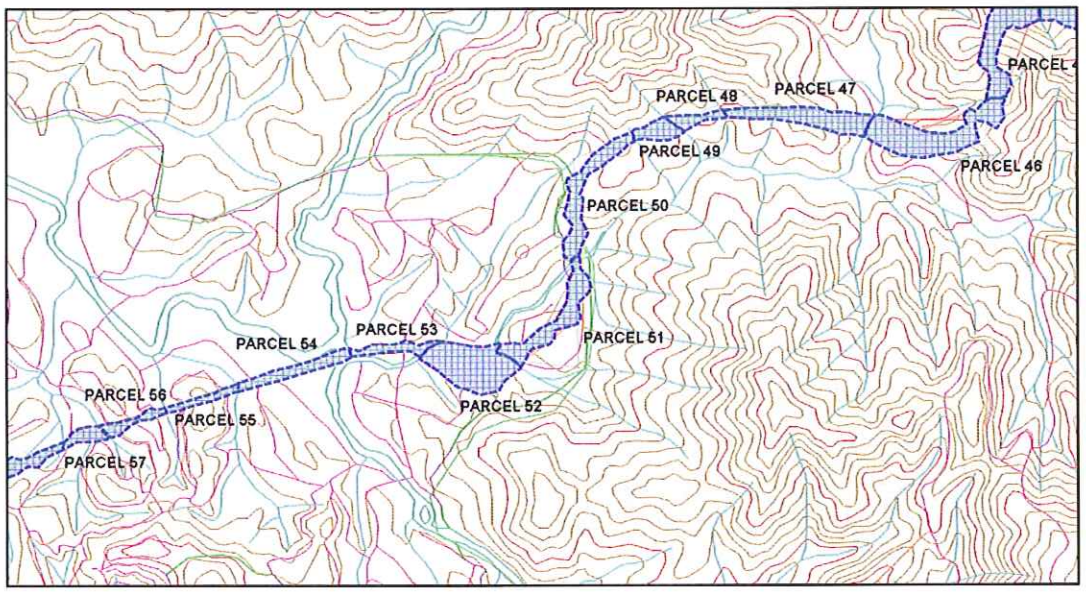


Figure 6.4.7: Proposed Phase 58 to Phase 63

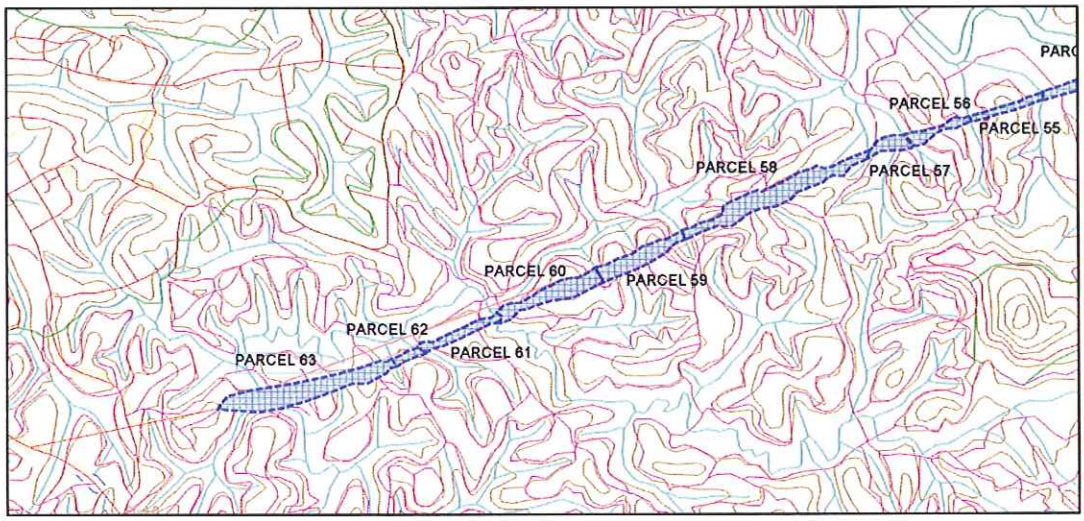


Table 6.4.2: Proposed ESCP for the Project

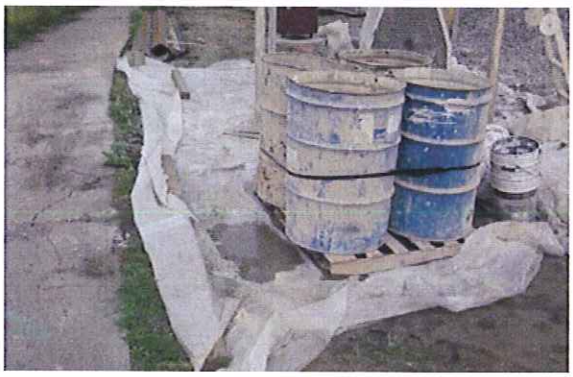
Proposed ESCP	
 Paved Temporary Road	 Silt/ sediment fence
 Sediment Pond	 Vegetative/ Green Buffer
 Culvert Crossing/ Diversion	 Tyre washing at entrance
 Covered Stockpile Area (Surplus Materials)	 Covered Stockpile Area (Materials)

Table 6.4.3: Type of BMPs in the ESCP

No.	BMPs	Numbers/ Design	Purpose	Project Application / Location
A. Drainage Control				
1.	Earth drain complete with channel lining and check dam	• 2 years ARI design storm. • Side Slope 2:1 or flatter (if applicable)	• To direct runoff into silt traps or dry sediment basins. • Check dam will reduce velocity of flow and also can trap sediment.	• Rip-rap or coir fabric placed within the bed and banks of constructed stormwater runoff conveyance channel before it flows into sediment ponds.
2.	Temporary diversion channel	• 2 years ARI design storm. • Side Slope 2:1 or flatter (if applicable	• To divert off-site runoff around the construction site, divert runoff from stabilised areas, around disturbed areas, and direct runoff into sediment traps or basins.	• To be used at low critical area as adiversion of the runoff from and within the Project site and prevent direct discharge into the existing stream.
3.	Drainage outlet structure	• 1 no. for each drainage outlet / discharge outlet to existing stream	• A physical device composed of rock, grouted rip-rap or concrete rubble which is placed at the outlet of a culvert, conduit, or channel. • To prevent scouring of the soil caused by high flow velocities, and to absorb flow energy to produce non erosive velocities.	• Proposed for use at outlets of drainage system that reroutes flows around the Project site.
B. Erosion Control				
1.	Erosion control mattress include hydroseeding	• Applicable on disturbed areas and exposed soil surfaces	• To protect exposed slope from erosion. Immediately applied after slope construction.	• Proposed for use in steep drainage ways and to assist with land clearing. Use 100% organic biodegradable mats such as coir fabric, etc.
C. Sediment Control				
1.	Temporary Silt Trap inclusive of spillway		• The basin is a temporary measure (with a design life of 12 months). • To be maintained until the site is permanently protected against erosion or a permanent detention basin or water quality control structure is constructed.	• Installed by excavating below grade or by constructing an embankment to retain water.

Cont.

Table 6.4.3: Type of BMPs in the ESCP (Cont.)

No.	BMPs	Numbers/ Design	Purpose	Project Application / Location
C. Sediment Control (cont.)				
2.	Check Dam	• Height (centre) of dam shall not exceed 1 m • For rock check dam: o *Upstream slope-* 2:1 or flatter o *Downstream slope-* 4:1 or flatter	• Check dams reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the diversion channel and earth drain. • Small barriers consisting of rock, sand bag, or earth berms are suitable material for check dams.	• Install check dams in steep terrain site to reduce velocity of surface run-off and erosion. • May be used locally as permanent erosion control to support channel stabilisation.
3.	Silt Fence	• For any point along the fence, concentrated flow shall not exceed 50 l/s and maximum water depth shall not exceed 600 mm.	• This measure does not filter runoff, but acts as a linear barrier creating upstream ponding which allows soil particles to settle out thereby reducing the amount of soil leaving a disturbed area.	• Install silt fence as perimeter sediment control around the Project site and access roads as necessary.
4.	Sand Bag Barrier	• For any point along the Project boundary and intended to block and divert flow. They are not intended to be used as filtration devices.	• As a temporary physical barrier used to exclude water from inundating areas and/or to detain sediment from stormwater runoff.	• Installed along the perimeter of the active Project site and access road as necessary.
5.	Construction Entrance and Wash Trough	• 1 no. at each entrance.	• Gravel access roads and provide construction entrance function to reduce tracking of sand or silt on to paved roadways.	• Use for ingress to all Project sites.

Cont.

Table 6.4.3: Type of BMPs in the ESCP (Cont.)

No.	BMPs	Numbers/ Design	Purpose	Project Application / Location
D. Erosion Prevention Measures				
1.	Access road construction and stabilisation	• 1 lot.	• Reduces excessive erosion and dust generation from road beds as a result of construction traffic using grade control and adjacent stabilised stormwater conveyance system.	• Installed on the access road into the active construction area and recommended to be placed at a 2% grade to drain towards the Project site.
2.	Stockpile management	• 2 nos. (1 for vehicle & equipment stockpile and 1 for materials stockpile)	• Designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, sand and other vehicles and equipments.	• Used for all stockpile, including topsoil and overburden.
3.	Vegetative preservation (Buffer Area)	• For any point along the Project boundary.	• Maintains existing soil stability, provides sediment filtration, stormwater runoff energy and energy dissipation.	• Installed at the boundaries of the active Project site to be used as perimeter control.
4.	Hydroseeding or turfing	• Project completion	• Provides final stabilisation following completion of the Project using specific and/or approved vegetation.	• At the end of grading and application of topsoil and/or following completion of disturbance in a specification area, specified approved seeding or approved vegetation, should be applied for the purposes of final stabilisation of the Project site.
E. Pollution Prevention Measures				
1.	Sanitary facilities	• Temporary toilet with septic tank	• Prevent sewage contamination from workers & personnel onto the site.	• Provide adequate portable sanitary facilities for workers. These facilities would be located on flat surfaces and in convenient locations.
2.	Solid waste management	• for the entire Project site	• Provide appropriate, labelled, and accessible containers for solid waste disposal to eliminate indiscriminate disposal or discharge of litters and/ or other wastes.	• Provide garbage containers at all work sites. • Place on flat surfaces and convenient locations for use. • Disposal facilities should be maintained in satisfactory condition for the duration of the Project.

Cont.

Table 6.4.3: Type of BMPs in the ESCP (Cont.)

No.	BMPs	Purpose	Project Application / Location
F. Project Management Measures			
1.	Covered Stockpile & Material Storage	• Protect stockpile and materials from wind and rain; and prevent accidental discharge.	• Location for stockpiling of materials will be identified for thework site and would be covered with impermeable material to protect from wind and rain. • Provide sufficient supplies of BMPs for use in emergency situations and/or heavy rains.
2.	Housekeeping	• Reduces the potential for discharge of pollutants through maintaining overall site cleanliness and orderliness; prompt response to spill cleanup and maintenance of installed erosion prevention, sediment control, and pollution prevention facilities.	• The contractor would perform activities in a manner that keeps potential pollutants from either draining or being transported off-site by managing pollutant sources and modifying construction practices to reduce the total disturbed area.
3.	Monitoring and Inspection	• Provide regular, consistent, and documented evaluation / inspection of BMPs effectiveness to prevent violation of environmental standards.	• The ESCP inspector or CESSWI or S.O. should conduct inspection of installed BMPs regularly, a minimum of once per day during in-water work activities and/ or rain event. • Monitoring activities, if necessary, would be documented in the field inspection and field notes compiled and updated regularly in the contractor prepared EMP and maintained on site.
4.	Record Keeping	• Provide visual and written documentation regarding the effectiveness and maintenance of BMPs and reporting of measured parameters necessary to confirm compliance with environmental standards and environmental protection requirements and regulations.	• Monitoring activities and data collection results would be compiled on standard inspection forms. All written and photographic information recorded during monitoring activities should be compiled and maintained.
5.	Training	• Provide environmental awareness training prior to job site entry and provide ongoing training for all personnel detailing the environmentally sensitive requirements to maintain environmental standards throughout the duration of the Project.	• Prior to entry into the work site, all staff, workers and contractors are required to attend environmental awareness training. • Additional training for new hires as well as refresher training for existing staff & workers should be provided during the Project implementation. Training should include all aspects of maintaining the environmental standards, including air, land and water quality standards.

6.4.3 PROJECT IMPLEMENTATION

A. Pre-Construction Requirements

The contractors should follow the requirements described above to minimise erosion and sedimentation during construction activities.

B. Project Requirements during the Construction Stage

A detailed ESCP should be provided as a general sequence of construction activities that are proposed from start through the end of operations. The summary of proposed ESCP and staging activities will be completed in conjunction with the following general site considerations:

- Install stabilised and appropriate BMPs.
- Install temporary stormwater management facilities as required to convey stormwater into the silt traps or sediment ponds.
- After site activities are completed and the site is stabilised, remove temporary erosion and sediment control facilities.

The control measures and best management practices (BMPs) noted below should be implemented as required to abate and control potential sediment transport in stormwater discharges from the Project site. Below are the details of the proposed ESCP for each proposed stages in construction activity for the Project.

6.4.4 METHOD STATEMENT

A. Land Clearing or Mass Grading

Land disturbing activity should be limited by divided phase line only to those grading and clearing activities within the areas identified on the preliminary plat. No land disturbing activities should be permitted outside this area. Final plat approval should be granted only after all required improvements have been installed or constructed and accepted by the S.O., including stabilisation of disturbed areas. No permit for land disturbing activities or building construction for other lot should be issued until the final plat has been approved.

B. Scheduling

Scheduling involves sequencing construction activities and the installation of erosion and sediment control measures to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff and vehicle tracking. The timing of soil-disturbing activities and the timing of the implementation of BMPs are both critical to the prevention of accelerated erosion and transport of sediment off-site. The scheduling of grading should take into account the rainy season and should minimise the length of the time that soils are left exposed, and reduce the total area of exposed soil during the rainy season. Consideration should be given to phasing the grading and construction so that critical areas (such as highly erodible soils, areas adjacent to receiving waterways, etc.) are not

disturbed until the non-rainy season, and so the entire area that is disturbed at any one time is kept to a size that can be controlled effectively.

The proposed method statement for the scheduling is as below:

- The optimum grading period is when the chance for precipitation is minimised (e.g. the non-rainy season), particularly for critical areas. If precipitation is likely during grading, minimise the length of time that soils are exposed, and the total area of exposure.
- Materials used for erosion and sediment control shall be on site at all times.
- The schedule shall clearly show how regional precipitation trends relate to soil-disturbing and restabilisation activities. The construction schedule shall be incorporated into the ESCP.
- The schedule shall also include the implementation and deployment of temporary soil stabilisation measures, temporary sediment controls, tracking controls, wind erosion controls, non-stormwater pollution controls (including waste management and materials pollution controls).
- The schedule shall also include dates for significant long-term operations or activities that may have planned non-stormwater discharges such as dewatering, cutting, drilling, boring, crushing, blasting, mortar mixing, etc.
- Develop the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, excavation, paving, pouring foundations, installing utilities, etc., to minimise the active construction area during the rainy season.
- Schedule the installation, removal, or modification of run-on controls and flow conveyance structures for the non-rainy season or when there is a low probability of precipitation to reduce the likelihood of uncontrolled flow across and from the site.
- Be prepared year-round to deploy soil stabilisation and sediment control practices. Erosion may be caused during dry seasons by unseasonable rainfall, wind, and vehicle tracking. Keep the site stabilised year-round, and retain and maintain sediment trapping devices in operational condition.
- Incorporate staged seeding and re-vegetation of graded slopes as work progresses.

C. Preservation of Existing Vegetation/ Buffer Strips

Maintaining existing vegetation or placing vegetation buffer strips can have numerous benefits for stormwater quality, erosion and sediment control, as well as landscape beautification, dust control, noise reduction, shade and watershed protection.

The proposed method statement for the preservation of existing vegetation is described below:

- Limits of clearing should be clearly marked prior to any grading or clearing activities.

- Mark areas to be preserved with temporary fencing made of orange polypropylene that is stabilised against ultraviolet light. The temporary fencing shall be at least 1 m tall and shall have openings not larger than 50 mm by 50 mm.
- Fence posts shall be either wood or metal as appropriate for the intended purpose. The post spacing and depth shall be adequate to completely support the fence in an upright position.
- Vegetated buffer strips (vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are re-designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and allowing sediment and other pollutants (e.g. total dissolved metals) to settle and partially infiltrate into underlying soils. With proper design and maintenance, filter strips can provide relatively high pollutant removal.
- The width of a buffer strip (i.e. flow path length) shall be maximised to the extent feasible with a 4.5 m suggested minimum width. Buffer strips shall be sized in accordance with site conditions and local requirements.

D. Permanent Seeding and Planting

Permanent seeding involves the establishment of a permanent, perennial vegetative cover on disturbed areas from seed. Planting of shrubs, trees, and ornamental plants should be conducted in accordance with Project landscaping specifications and local requirements.

The use of native, indigenous, or naturally-occurring grasses is recommended for biotechnical works. These 'native' grasses have evolved in a manner that will not complete with or preclude the establishment, or natural recruitment, of naturally-occurring woody vegetation. Establishment of permanent vegetation provides natural erosion and sediment control by particulates, slowing runoff velocities and enhancing infiltration. Permanent vegetation also is beneficial for long-term aesthetics and wildlife habitat.

The method statement for permanent seeding are listed below:

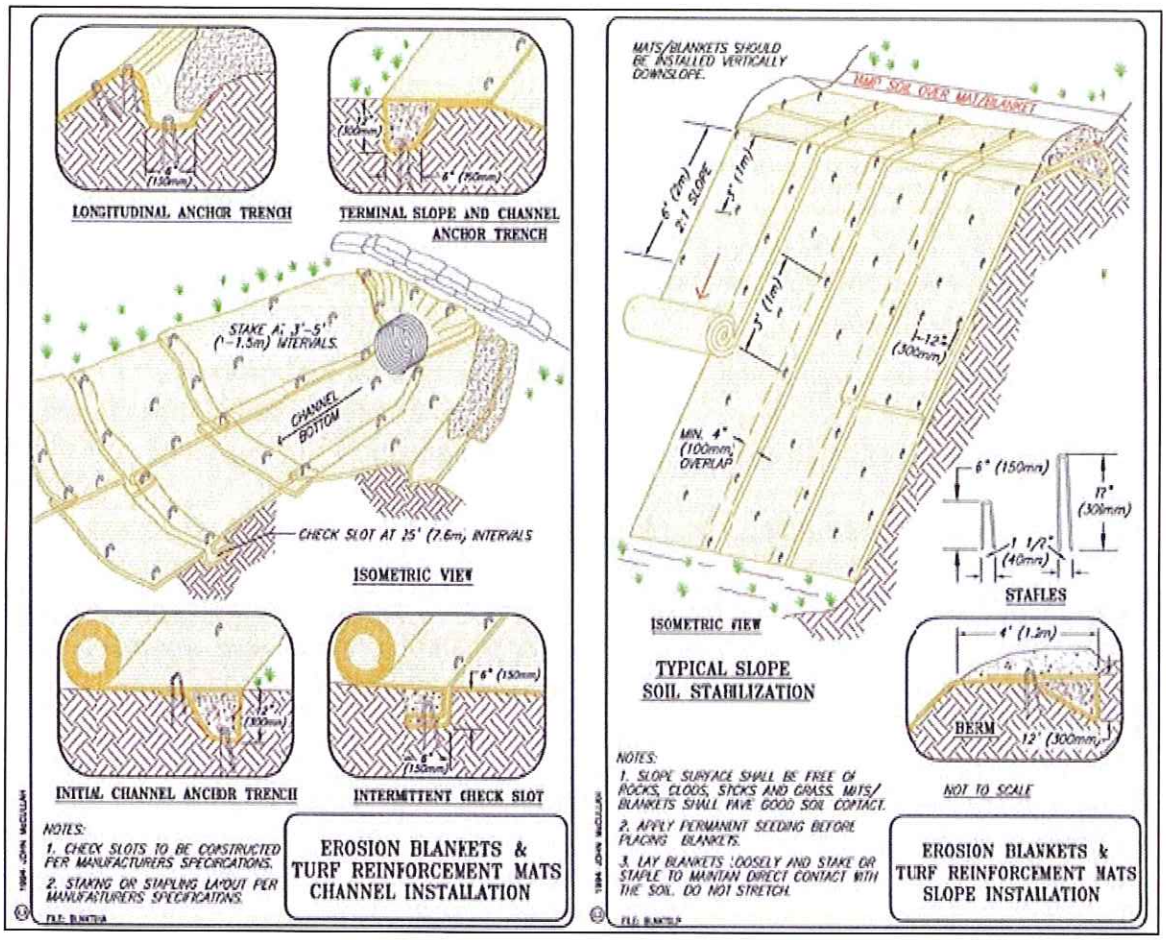
- Graded, final-graded or cleared areas where permanent vegetative cover is needed to stabilise the soil. Permanent seeding with perennial grasses is recommended when fibrous and deeply rooted vegetation is needed to provide slope and soil reinforcement.
- Slopes designated to be treated with erosion control blankets should be seeded first.
- Grass lined channels or waterways designed to be treated with turf reinforcement mats, fibre roving systems, or other channel liners will require special grass blends.

E. Erosion Control Blankets and Mats

Erosion control blankets and mats (a.k.a., rolled erosion control products - RECPs) provide erosion control by protecting the bare soil from rainfall impact, increasing infiltration and promoting vegetation growth by protecting seeds from predators and

moderating soil temperature and moisture. RECPs can be biodegradable or synthetic and can be temporary or permanent erosion control applications (**Figure 6.4.8**).

Figure 6.4.8: Erosion Blankets & Turf Reinforcement Mats Channel Installation



i. Site preparation

- Proper site preparation is essential to ensure complete contact of the protection matting with the soil.
- Site preparation should be performed in accordance with any local municipality requirements and specifications.
- Grade and shape area of installation.
- Remove all rocks, clods, vegetative or other obstructions so that the installed blankets or mats will have direct contact with the soil.
- Prepare seedbed by loosening 50.8 – 76.2 mm of topsoil above final grade.
- Incorporate amendments, such as lime and fertiliser, into soil according to soil test and the seeding plan.

ii. Materials

- Erosion control blankets are grouped into three types: biodegradable, non-biodegradable, and a combination of synthetic and biodegradable.

iii. Seeding

- Seed area before blanket installation for erosion control and re-vegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be reseeded.
- Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

iv. Anchoring

- Anchoring of RECPs is the most critical element of installation. Anchoring devices must be selected to be compatible with soil conditions.
- Where soil conditions are suitable (i.e. topsoil without substantial rocks or cobble), biodegradable stakes, staples or pins are preferred. Although biodegradable anchoring devices are preferred they must be compatible with soil conditions to ensure proper blanket installation.

v. Installation on slopes

- Dig initial anchor trench 0.3 m deep and 0.2 m wide across the channel at the lower end of the site.
- Begin at the top of the slope and anchor its blanket in a 0.2 m deep x 0.2 m wide trench. Backfill trench and ramp earth firmly.
- Unroll blanket down slope in the direction of the water flow.
- The edges of adjacent parallel rolls must be overlapped 51-76 mm and be stapled every 0.9 m.
- When blankets must be spliced, place blankets end over with 0.2m overlap. Staple through overlapped area, approximately 0.3m apart.

F. Sand Bag Barrier

Sand bag barriers are intended to block and divert flow. They are not intended to be used as filtration devices.

i. Materials

- Sand bag material: sand bag shall be polypropylene, polyethylene or polyamide woven fabric, minimum unit weight 135 g/m^2, mullen burst strength exceeding 2070 kPa in conformance with the local requirements.
- Sand bag size: each sand-filled bag shall have a length of 450 mm, width of 300 mm, thickness of 75 mm and mass of approximately 15 kg. Bag dimensions are

nominal, and may vary based on locally available materials. Alternative bag sizes shall be submitted to the engineer for approval prior to deployment.

- Fill material: all sand bag fill material shall be non-cohesive, class 1 or class 2 permeable materials free from clay and deleterious material and the fill material is subject to approval by the engineer.
- Only use sandbag barriers when diverting runoff or run-on.

ii. Installation

- Install along a level contour.
- Turn ends of sand bag row up slope to prevent flow around the ends.
- Generally, sand bag barriers shall be used in conjunction with temporary soil stabilisation controls up slope to provide effective erosion and sediment control.
- Construct sand bag barriers with a set-back of at least 1 m from the toe of a slope. Where it is determined to be not practical due to specific site conditions, the sand bag barrier may be constructed at the toe of the slope, but shall be constructed as far from the toe of the slope as practicable.

G. Vehicle Cleaning/ Wash Trough

Vehicles and equipment should be washed off site at a controlled washing facility when at all possible. Use 'dry cleaning method' such as wiping down whenever possible rather than water washing vehicles on site. If cleaning must be conducted on-site, it shall be conducted in a dedicated area with the following characteristics:

- Located away from storm drain inlets, drainage facilities, or watercourses.
- Paved with concrete or asphalt, or stabilised with an aggregate base.
- Berm to contain wash waters and to prevent run-on and runoff.
- Configured wash area with a sump to allow collection and disposal of wash water.
- Discharges wash water to a temporary sediment basin and shall not be discharged directly into storm drains or watercourses.

H. Stockpile Management

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, sand, paving materials such as Portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, asphalt binder, etc. All stockpiles should meet the following requirements:

- If feasible, locate stockpiles a minimum of 15 m away from inlets, drainage courses, or water bodies.
- Keep stockpiles organised and surrounding areas clean.

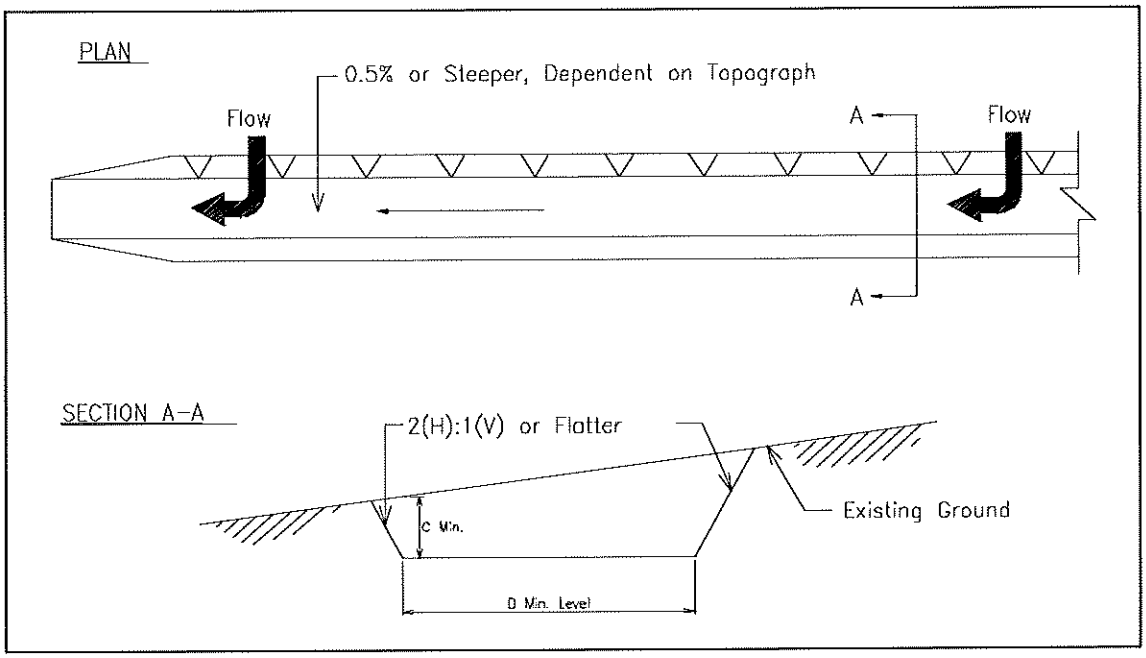
- Protect storm drain inlets, drainage courses, and receiving waters from stockpiles, using drain inlet protection and perimeter sediment controls as appropriate.
- Temporary stockpiles not removed or used by the end of one workday must be managed in accordance with this BMP and in all cases protected prior to rainfall.

I. Temporary Earth Drain

Temporary earth drains are to be constructed in order to convey the surface runoff to the retention pond. The drain is constructed along the plot border and this type of drain is also known as the perimeter drain. The size is very much depending on the catchment area itself. The bigger the catchment area, the bigger the size it would be. Trapezoidal shape drain with the side ratio of 2:1 is recommended.

Check dams will be constructed at a certain distance throughout the drainage system in order to reduce the flow velocity thus help in reducing the sidewall erosion. The side wall of the drain will be covered with grass to strengthen the side wall and to reduce the erosion. The slope for this drain is designed at 1 m drop per 750 m run and the average depth is approximately 0.5 m. **Figure 6.4.9** shows the typical design of a temporary earth drain.

Figure 6.4.9: Typical Temporary Earth Drain



J. Check Dam

Check dam (**Plate 6.4.1**) is a small temporary barrier which is also a grade control structure, or dam constructed across a swale, drainage ditch, or area of concentrated flow where the purpose is to minimise the erosion rate by reducing the velocity of stormwater in areas of concentrated flow. The purpose of a check dam is also to capture larger soil

particles and reduce sedimentation. This check dam will be installed along the drainage system at 15 m interval for scour protection.

Plate 6.4.1: Check Dam

K. Temporary Waterway Crossing

Temporary waterway crossing structure is built in order to prevent stream bank damage and to control sediment where existing waterways must be crossed during the construction stage. The size must be large enough to carry a full bank flow without appreciably altering the stream flow characteristics. It is required when construction is necessary across a small stream with flowing water (**Plate 6.4.2**). Only rock can be used for backfill within the channel limits of the stream. The structure shall be removed within 14 days after the structure is no longer needed.

Plate 6.4.2: Temporary Waterway Crossing

L. Hydroseeding

Hydroseeding process is a seeding of grasses and planting of trees, shrubs, and ground covers to provide long-term stabilisation of soil (See **Plate 6.4.3**). The appropriate method

of seeding and seed species is required to ensure successful germination and provide an effective soil stabilisation measure. The hydroseeding must adhere to the following method:

- Effective on shallow slopes typically 2H: 1V or flatter.
- Interim erosion control measures must be in place to ensure no sediment is entrained off the area and must provide at minimum temporary seeding of native or non-invasive species.
- Much caution is needed when seeding during drought/dry conditions. Subsequent applications of mechanical seeding may be required for successful vegetation establishment and soil stabilisation.
- A minimum of 150 mm of top soil should be applied to all areas subject to permanent landscaping.
- The type of vegetation, site, and seedbed preparation, planting time, fertiliser, and water requirements should be considered for each application.
- Select grasses that are tolerant of short-term temperature extremes and waterlogged soil conditions.
- Soil must be fertilised and mechanically stabilised.
- Mowing, irrigating, and fertilising are vital for promoting vigorous grass growth.

M. Outfall

RECPs can be considered for placement on top of the earth drain surface. It is used to protect the earth drain from erosion during heavy rainstorm. The grasses also act as a filter to filter out the sediment particles from the runoff thus helping to reduce the erosion problem. The Reno mattress type of outfall is shown in **Plate 6.4.4**.

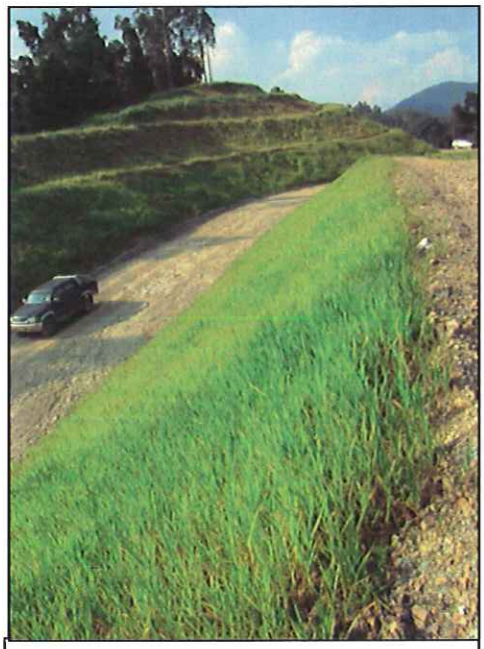


Plate 6.4.3: Hydroseeding

Plate 6.4.4: Outfall (Reno Mattress Type)

N. Sediment Pond

A sediment pond (**Figure 6.4.10**) typically consists of an impoundment, a dam, a riser pipe outlet, and an emergency spillway. The size of the structure will depend upon the location, size of the drainage area, soil type, land cover/use, rainfall amount, and any unique site conditions favourable to producing high runoff volume, velocity, or sediment. The basin is a temporary measure (with a design life of 12 months) and is to be maintained until the site is permanently protected against erosion or a permanent detention basin or water quality control structure is constructed. **Table 6.4.4** tabulates the dry sediment basin sizing guidelines.

Figure 6.4.10: Sediment Pond

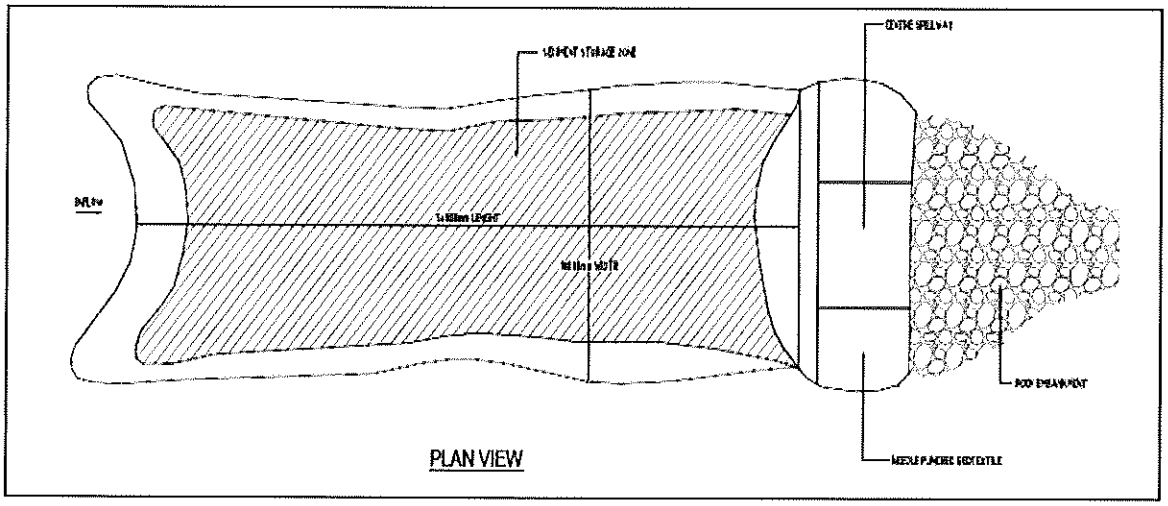


Table 6.4.4: Dry Sediment Basin Sizing Guideline

Parameter	Design Storm	Time of Concentration of Basin Catchment (minutes)				
		10	20	30	45	60
Surface Area (m^2/ha)	3-month ARI	333	250	200	158	121
	6-month ARI	n/a	500	400	300	250
Total Volume (m^3/ha)	3-month ARI	400	300	240	190	145
	6-month ARI	n/a	600	480	360	300

Source: DID (2000)

O. Silt Fence

A silt fence is a temporary linear sediment barrier of permeable fabric designed to intercept and slow the flow of sediment-laden sheet flow runoff. Silt fences allow sediment to settle from runoff before water leaves the construction site and reduce the water flow rate down slope. Silt fences are normally placed at below the toe of exposed and erodible slopes, down-slope of exposed soil areas, around temporary stockpiles, along streams

and channels and along the perimeter of a project. As of this Project, silt fences will only be installed on the down-slope of exposed soil areas to avoid sediment crossing the boundary. The common height of the fence is 0.6 m.

i. Installation

- Install silt fence along a level contour, with the last 2 m of fence turned up slope. Except for the ends, the difference in elevation between the highest and lowest point along the top of the silt fence shall not exceed one-third of the fence height.
- Generally, it should be used in conjunction with erosion source controls up slope to provide effective control.

ii. Common reasons/ circumstances for failure

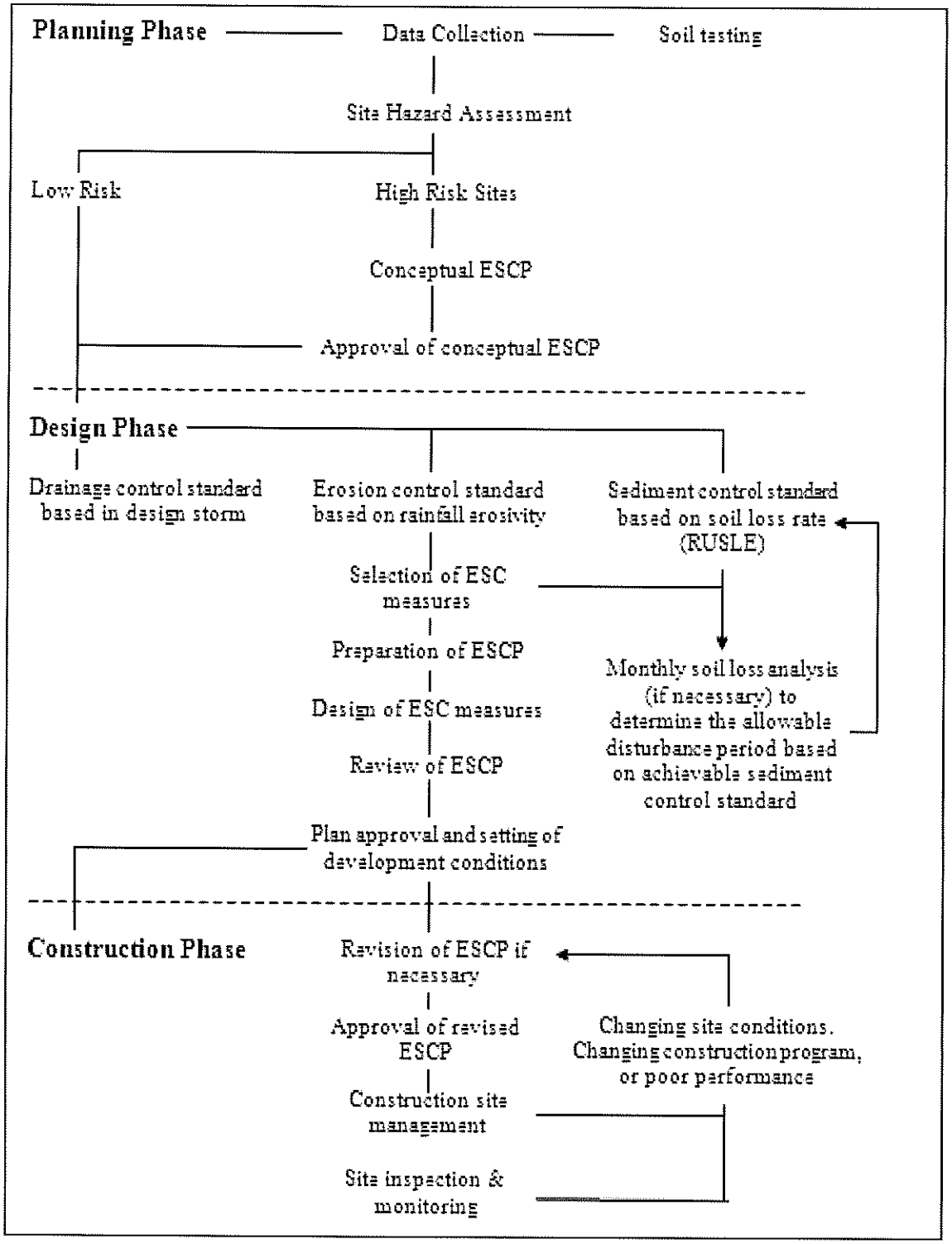
- The most common reasons for silt fence failure are due to improper installation and poor maintenance. In particular, the toe must be securely trenched into the soil and accumulated sediment should be removed when accumulation reaches 1/3 of the fence height.

6.4.5 PLANNING AND CONSTRUCTION FRAMEWORK OF ESCP

The typical ESCP development flow chart is divided into three phases: site planning, design and construction as shown in **Figure 6.4.11**. The ESCP plan will be implemented prior to the earthworks.

The control measures and best management practices (BMP) noted below should be implemented as required to abate and control potential sediment transport in stormwater discharges from the Project site. Below are the details of the proposed ESCP for each the proposed stages in construction activity for the Project.

Figure 6.4.11: Typical ESCP Development Flowchart



6.4.6 STAGES OF ESCP

i. A stabilised construction entrance should be located at each construction entrance and exit location.

ii. Laydown areas for vehicles and construction equipment will be located on stabilised portions of the site.

iii. Silt fence should be installed down gradient of earthwork activities to prevent stormwater runoff form transporting sediment to adjacent receiving waterways. Silt fence should be installed along contours to the extent practicable.

iv. Sand bag barrier, if required, should be installed before the earthwork activity starts.

v. Construct the road crossing.

vi. Construction vehicles should be washed down at specific locations prior to leaving the site.

vii. Construct sediment pond.

viii. Construct temporary earth drain.

ix. Temporary stone check dams to be placed in temporary earth drain to prevent erosion, reduce flow velocities and promote sedimentation as required. The check dams should be installed, as required, at intervals such that the crest of the downstream dam is at the elevation of the toe of the upstream dam. Regularly remove sediment deposited behind the dam.

x. Provide for temporary or permanent soil stabilisation measures in areas where soil disturbance activity has been temporarily or permanently ceased within seven days from the date the soil disturbance activity ceased. Exposed bare surfaces shall be seeded with grass or legumes or temporary mattress.

6.4.7 CONCEPTUAL ESCP

The following procedure was adopted in developing the ESCP. The proposed ESCP will efficiently control erosion and sedimentation throughout the site development process.

A. Development to Fit the Site

The development will be carried out on the existing reserve forest, utilising the existing topography thus minimising grading works. Existing vegetative buffer strips between disturbed and adjacent areas will be maintained to minimise offsite impact.

B. Limit of Clearing and Grading

The clearing and grading works will be carried out in stages and will avoid steep slopes and surface water bodies.

C. Drainage

The erosion and sedimentation can be controlled at source. The stormwater BMP's proposed will include installation of drainage system to address the site runoff in a way that will not affect the soil disturbance operations.

D. Erosion and Sediment Control Practices

Both vegetative and structural control measures will be used to control erosion and sediment from the site.

i. Vegetative Control: Temporary seeding or mulching will be used on areas that will be exposed for long periods of time prior to construction.

ii. Structural Control: Permanent stabilisation (**Plate 6.4.5**) will be performed as soon as possible after completion of grading.

Plate 6.4.5: Structural Control – Gabion Wall

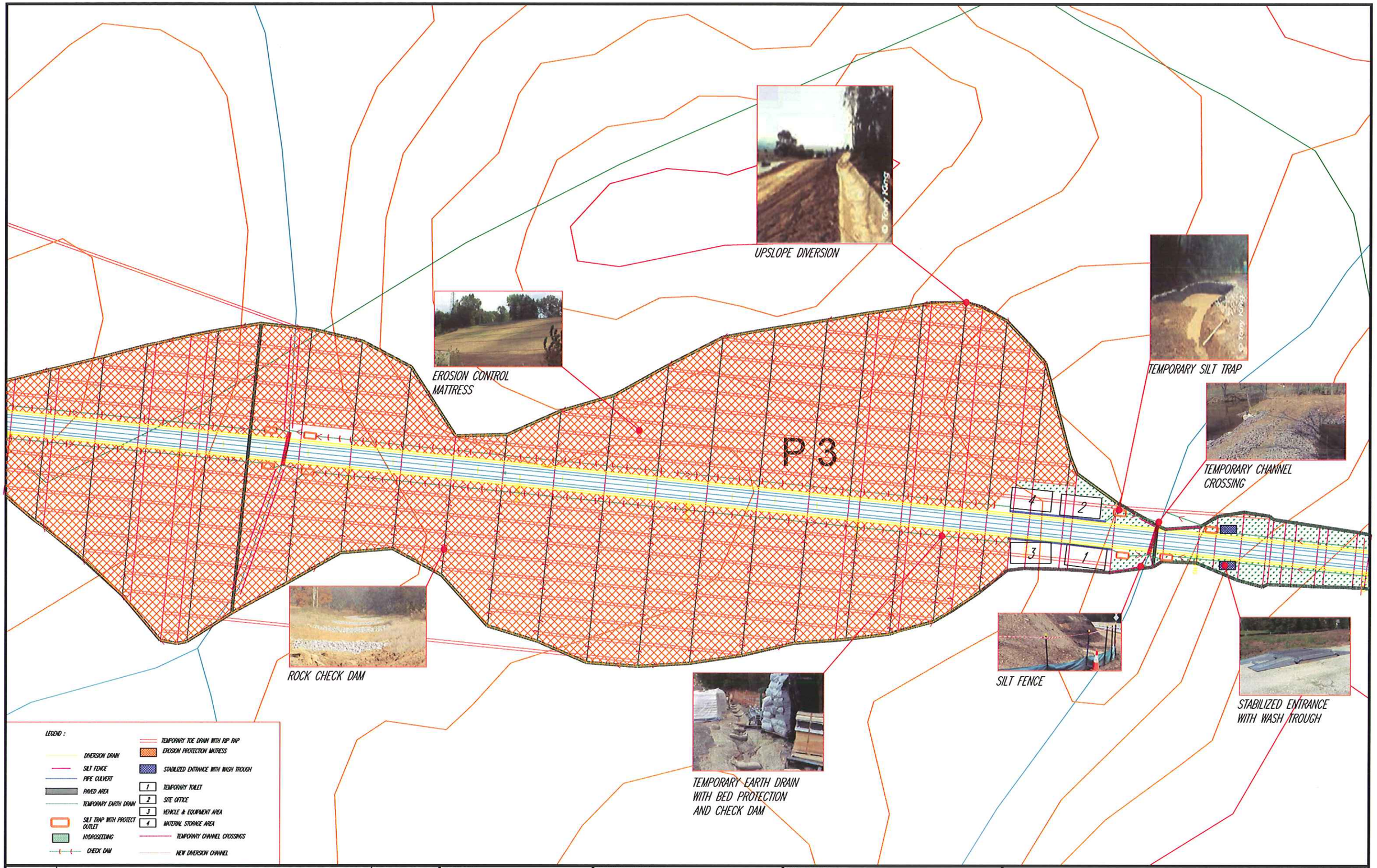
E. Plan and Map Details

Figures 6.4.12a to **6.4.12c** show the proposed conceptual ESCP for the land clearing stage, construction stage and post construction stage that could help in reducing the impact on erosion and sedimentation from the proposed Project. They consolidate the pertinent information of the erosion and sediment control plan for the Project. The plan explains the problem and their solutions with all the necessary documentation.

6.4.8 Site Inspection and Maintenance

In addition, a suitably qualified person is required to oversee the installation and maintenance of all erosion and sediment control measures on the site. The person will be required to spend a minimum of two hours on-site each fortnight and to provide a monthly inspection report. The responsible person must ensure that:

- The ESCP is being implemented properly.
- Maintenance and repairs are undertaken as required.
- Essential updating/modifications are made to the ESCP if and when necessary.



Tarikh	Butiran	Rujukan
	PINDAAN	

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PEIA FOR MEMBINA JALAN DARI SUNGAI LEMBING KE JERANTUT(REKABENTUK)

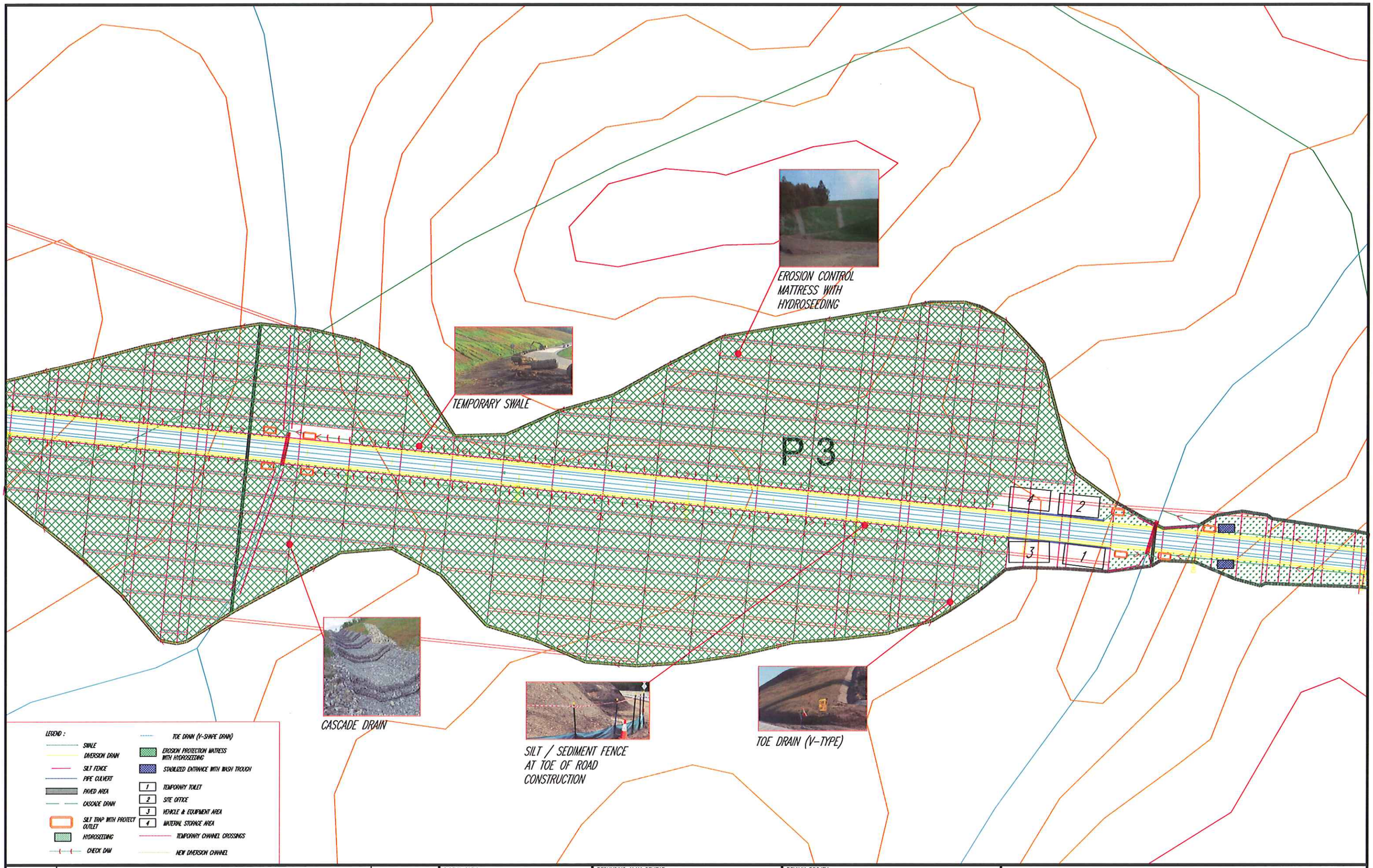
TAJUK LUKISAN :
Figure 6.4.12a: Conceptual ESCP Layout Plan During Land Clearing Stage

TARIKH: OGOS 2013

BIL LUKISAN: PEIA/SGLJ/GG/13/ESCP/01

REV.

MUKASURAT: 6-26a



Tarikh	Butiran	Rujukan
	PINDAAN	

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TAJUK LUKISAN :

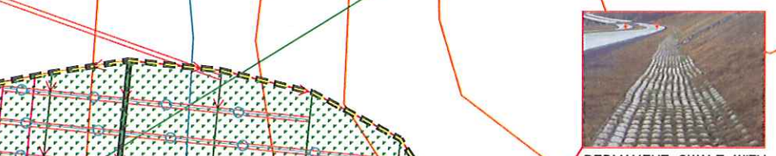
Figure 6.4.12b: Conceptual ESCP Layout Plan During the Construction Stage

TARIKH: OGOS 2013

BIL LUKISAN: PEIA/SGLJ/GG/13/ESCP/02

REV.

MUKASURAT: 6-26b



PERMANENT SWALE WITH BED PROTECTION

P 3

PERMANENT CHANNEL CROSSING

LEGEND :

- PERMANENT SWALE
- DIVERSION DRAIN
- PAVED AREA
- CASCADE DRAIN
- WETLAND / BIORENTION AREA
- HYDROSEEDING
- TOE DRAIN (V-SHAPE DRAIN)
- STABILIZED SLOPE WITH PERMANENT HYDROSEEDING
- PERMANENT CHANNEL CROSSINGS
- NEW DIVERSION CHANNEL

Tarikh	Butiran	Rujukan
	PINDAAN	

DIREKA OLEH : DA

DILUKIS OLEH : DA

DISEMAK OLEH : Ir. AZMAN ABU BAKAR

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TAJUK LUKISAN :
Figure 6.4.12c: Conceptual Permanent BMPs Layout Plan for Post Development

TARIKH: 0005 2013

BIL LUKISAN: PEIA/SGLJ/00/13/ESCP/03

REV.

MUKASURAT: 6-26c

6.4.9 MAINTENANCE AND REPAIR PROCEDURES

This section describes the procedures that will be used to ensure prompt maintenance and repair of graded surface and erosion and sediment control measures. These procedures are developed asa guidance for the contractor in implementing the ESCP. The procedures are:

- Ensure compliance with the requirements of the ESCP, the procedures, the mitigation measures proposed (as approved and or modified by the authorities).
- Verify that the limits of authorised construction work areas and locations of access roads are properly marked before clearing.
- Identify erosion / sediment control and soil stabilisation needs in all areas.
- Determine the need for and ensure that erosion controls are properly installed as necessary to prevent sediment flow into water bodies.
- Keep records of compliance with the environmental conditions.
- Identify areas that will be given special attention to ensure stabilisation and restoration after the construction stage.
- Ensure the repair of all ineffective temporary erosion control measures within 24 hours of identification.
- Identify, document and oversee corrective actions, as necessary to bring an activity back into compliance.

A. Discharge Outlet/ Energy Dissipater (Riprap Type)

- Inspect rip-rap outlet structures before, during, and after rains to see if any erosion around or below the rip-rap has taken place or if stones have been dislodged. Immediately make all needed repairs to prevent further damage.
- Clean out energy dissipation as necessary when approximately half of the void space is filled with sediment and debris.

B. Check Dam

- Inspect check dams during or after each rainfall event, and weekly throughout the rainy season. Repair damage as needed.
- Remove sediment when depth reaches one-third of the check dam height.
- Remove accumulates sediment prior to permanent seeding or soil stabilisation.
- Remove check dam and accumulated sediment when check dams are no longer needed.
- Removed sediment shall be incorporated in the Project or disposed of properly.

C. Scheduling

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule to show updated information on the deployment and implementation of construction site BMPs.

D. Permanent Seeding

- Seeded areas need to be inspected frequently to ensure the grass is growing.
- If the seeded area is damaged due to runoff, additional stormwater measures may be needed.
- Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.
- Irrigation/ watering should be used as necessary and recommended to establish vegetation in accordance with local regulations.

E. Erosion Control Mats

- All blanket and mats shall be inspected following installation and in accordance with stipulated requirements.
- Inspect installation during or after storm events to check for erosion and undermining. Any failure shall be repaired immediately.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or drainage way.

F. Silt Fence

- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric.
- Inspect silt fence during or after storm events, and weekly throughout the rainy season.
- Any required repairs shall be performed as soon as possible.
- Remove sediment when accumulation reaches 1/3 of the fence height.
- The removed sediment shall be incorporated in the Project, disposed of properly, or appropriately stabilised with vegetation.
- Remove silt fence when no longer needed and upslope area has been stabilised. Fill and compact post holes and anchorage trench, remove sediment accumulation, and grade fence alignment to blend with adjacent ground.

G. Sand Bag Barriers

- Inspect sand bag barriers during or after each rainfall event, and weekly throughout the rainy season.
- Re-shape or replace sand bags as needed.
- Repair washouts or other damages as needed.
- Inspect sand bag barriers for sediment accumulations and remove sediment when accumulation reaches 1/3 of the barrier height.
- Removed sediment shall be incorporated in the Project at locations designated by the S.O. or shall be disposed of properly.
- Remove sand bags when no longer needed. Remove sediment accumulation, and clean, re-grade, and stabilised the area.

H. Temporary Silt Trap

- Inspect during or after each rainfall event, and weekly throughout the rainy season.
- All damages caused by soil erosion or construction equipment shall be repaired before the end of each working day.
- Remove sediment when the sediment storage zone is half full. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.
- When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilised, the embankment and resulting sediment deposit shall be levelled or otherwise disposed of in accordance with the approved erosion and sediment control plan.

I. Vehicle Cleaning/ Wash Trough

- Inspect and clean work areas regularly to limit wind blown debris and pollutants transported by storm water.

J. Stockpiles

- Inspect stockpiles regularly and repair or replace covers, and perimeter controls as needed.

Erosion and sediment control facilities (e.g., silt fence, stabilised construction entrance, etc.) should be installed to minimise off-site sediment migration throughout construction until the site is stabilised. Consistent with the ESCP, temporary gravel areas or RECP cover should be provided to reduce the splash erosion impacts. Stormwater from these areas should be routed via earth drain, then to the adjacent sediment retention pond.

6.4.10 STORMWATER/ RUNOFF MANAGEMENT STRATEGIES

A Construction Stage

The following principles underpin the approach to surface runoff controls for the Project:

i. Minimise surface disturbance and restricting access to undisturbed areas.

ii. Progressive rehabilitation/ stabilisation of the Project site.

iii. Separation of runoff from disturbed and undisturbed areas where practicable.

iv. Construction of surface drains to facilitate the efficient transport of surface runoff. Drains should be constructed using trapezoidal or parabolic cross-sections.

v. Construction of silt traps to contain runoff up to specified design criterion.

vi. Use of the best available technology to mitigate the works for existing pond desludging activity and meet the discharge quality according to the DOE standards.

The above principles take into account the general recommendations for site drainage works presented in the DID's *Manual Saliran Mesra Alam (MSMA)* and a *Checklist on*

Erosion and Sediment Control Plan. In addition to these principles, development activities will generally occur in the following order:

i. Construction of temporary and permanent collection drains surrounding the Project site to convey runoff to sediment basin.

ii. Construction of check dam where required to provide for regulating concentrated flow and temporary retention of runoff from disturbance areas.

iii. Constructions of silt fences (at stockpile areas and river boundary, etc.) where required.

iv. Constructions of sediment basin (downslope of disturbance and stockpile areas).

v. General construction works will then take place once surface runoff (erosion and sediment) control measures are in place.

vi. Construction of channel / stream crossing.

vii. Construction of silt curtain at the nearest river or stream (especially at bridge crossing).

viii. Construction of bridge crossing.

The generated surface runoff should be prevented from direct discharge into the existing stream and the proposed BMPs will help to prevent the migration of sediment to watercourses. Water in the sediment basin will only be released if the suspended sediment content meets the discharge standard (e.g. 50 mg/l) in accordance with the DOE requirement. Flocculants addition may be used if required to meet the relevant discharge standard.

The temporary stormwater as well non-stormwater management systems will be installed either prior to, or in conjunction with the various phases of construction. Components of the systems will include, but are not limited to, fencing, dust control, temporary diversion of existing streams, berms to control runoff, and diversion of runoff around the Project site using earth drains and pipes or culverts.

In addition, an internal drainage system will be constructed within the Project site to control all surface runoff. The surface runoff from the Project site will flow into to the nearest channel drain before it flows into the stream or river. Initial grading of the Project and associated facilities would partially eliminate ground cover thereby increasing the Project's susceptibility to influences of surficial erosion. On-site drainage features are designed to control stormwater that falls on the Project site and the surrounding support facilities.

B Completion of Project

The Project site should be graded to collect stormwater in the conveyance system and route it into the sediment pond that will be converted into the detention pond to reduce the peak flow from the proposed development. It is proposed that the earth slope drain and temporary gravel road be maintained as a permanent ESCP as stormwater management facilities. It will reduce the impact of soil erosion and sediment production from the Project site for the future and manage the stormwater in a good manner.

Table 6.4.5 shows the lists of the proposed permanent BMPs in stormwater management to purposely reduce the impacts of soil erosion and manage the stormwater within the Project site.

Table 6.4.5: Proposed Permanent ESCP for the Project

No.	Proposed BMP
1.	Wetland or dry pond, ground stabilisation (turfing or mattress) and green buffer area, new drainage system, river or channel crossing, bridge crossing

The qualified Inspector or S.O. should perform a final inspection of the site to certify the following:

- Construction is complete and disturbed areas have been stabilised.
- Temporary erosion and sediment control facilities have been removed.
- Permanent stormwater management practices in accordance with the design have been installed and are operational.

6.4.10 CONCLUSION

The purpose of soil erosion control is to minimise soil erosion and sediment delivery, it is summarised as follows:

i. Erosion and Sediment Control Plan (ESCP) should be prepared in accordance to the *Guidelines for Erosion and Sediment Control in Malaysia* (DID, 2010).

ii. The ESCP should be prepared by a Professional Engineer (PE) who is a *Certified Professional in Erosion and Sediment Control* (CPESC).

iii. Site clearing and earthwork should be conducted in phases.

iv. Best Management Practices (BMPs) should be put in place prior to commencement of site clearing and earthwork.

v. Regular inspection and maintenance of BMPs should be conducted.

vi. Conduct sampling of suspended solids from discharge points of silt trap/ sediment retention pond.

vii. Halt earthwork during rain.

viii. Appropriate road drainage system should be provided. The depth and width of the drains should be able to accept heavy loads during heavy rain. In addition to preventing flooding of the road and ponding on the road surface, the drainage systems could protect the bearing capacity of the pavement and the subgrade material as well as avoid erosion of the side slopes. The disposal of drained water should be via outfalls to the existing watercourse. Discharge should always be in the direction of flow of the river/ stream. Protection of the bed and edges of the watercourse at the point of entry (by means of rock armour, gabions, headwalls, etc.) will help to prevent erosion by water discharging from the drain during heavy storms.

6.5 ECOLOGICAL PROTECTION AND CONSERVATION

The mitigation and control measures recommended in this section are for the protection and conservation of the biological environment that encompasses the forest, wildlife and the aquatic resources.

6.5.1 MITIGATION DURING PRE-CONSTRUCTION STAGE

A. Road Design

Road design is critical to prevent and mitigate potential impacts to local wildlife. Taking wildlife into consideration at the early stage of the Project will allow the best pragmatic options to be incorporated into the design. This will grant that preventative measures are taken proactively and not merely putting up warning signages at locations where high numbers of road kills occurred as a reactive measure. The key concerns related to impacts on wildlife for a road project are:

- Will the road act as a barrier to wildlife movement?
- Will the road result in high occurrence of road kills particularly of threatened species?
- What are the most pragmatic design options that can prevent or minimise the risk of collisions with wildlife?

The following factors increase the probability of collisions with wildlife and need to be considered during the design stage:

- Flat and straight stretches of road where Malaysian drivers may tend to speed.
- At dawn and dusk when wildlife is most active and visibility is poor.
- Stretches of the road closest to rivers which are rich in wildlife and where movement is most concentrated.
- Slow moving, small or slithering species, e.g. Pangolins, Tapirs, lizards, snakes, tortoises and small mammals may cross the road.
- Species that move in groups or herds where the last and slowest animal in the group may not be fast enough to avoid collision, e.g. wild boars.
- Arboreal species that are forced to descend to the ground and cross at grade, e.g. monkeys and squirrels.

Noting that Section 2 of the proposed road passes through the RCBFR that are very rich in wildlife; the detailed road design criteria used will thus need to cater for the diverse range of species that are found in that habitat. Adopting a conservative approach for large mammals; the road should be designed for elephants which will readily cater to all other species, e.g. Tapirs and Tigers. Elephants crossing roads at grade pose risk to motorists and for this Project, designing and constructing suitable overpasses and underpasses at strategic locations is clearly warranted and recommended.

The options for mitigation measures that can be considered at the design stage cover the following:

- Type of wildlife crossings:
  - Overpass: where wildlife cross above roads.
  - At grade: where wildlife cross roads.
  - Underpass: where wildlife cross under roads.
- Other design considerations.

Depending on the species of wildlife present, the criteria for selecting the type of road crossing is presented in **Table 6.5.1**. An assessment of suitability of crossing options for the Project is given in **Table 6.5.2** together with recommended options.

Table 6.5.1: Criteria for selecting wildlife crossings

Wildlife Category	Type of Road	Crossing Category						
		At Grade	Overpass			Underpass		
			Tunnel	Overpass	Cable	Bridge	Viaduct	Culvert
Large mammals	Expressway/ main road	X	√	√	X	√	√	X
	Small road		√	√	X	√	√	X
Small mammals & reptiles	Expressway/ main road	X	X	X	√	√	X	√
	Small road		X	X	√	√	X	√
Birds & Fish	Expressway/ main road	NA	X	X	NA	√	X	√
	NA	NA	X	X	NA	√	X	√

Note: 1. √ = Suitable
2. X = Not suitable due to size of animal, high probability of collision with wildlife or high cost.
3. Bridge of suitable height (>12 m) and with gentle slopes along the base of the bridge.
4. NA = Not Available.

Source: Adapted from JPBD (2010a).

Table 6.5.2: Road design considerations and recommendations to mitigate potential impacts on wildlife

No.	Category/ Option	Descriptions/ Comments	Suitability for the Project
A	**At Grade**		
1.	At grade	• Signages are easy & cheap to install. • No maintenance required. • Can be installed anywhere at key crossing points. • Can reconfirm wildlife crossing points after construction is completed.	• Very suitable as the road will be a rural single carriage way with low speed. • **Recommended** along: - Sections 1 & 3. - Section 2 along flat and hilly areas.
B.	**Overpass**		
1.	Tunnel	• Very expensive but will cause minimal environmental damages. • Will prevent forest fragmentation. • Suitable for: - Large mammals - Species that prefer ridge tops. e.g. Serow - Arboreal species, e.g. Gibbons. • Proved to be very effective at Genting Sempah.	• Suitable for very steep mountains and high elevations.
2.	Overpass	• Need to be >30 m wide for elephants. • None being constructed for wildlife in Malaysia. • Need to rehabilitate overpass and funnel wildlife to use it.	• Considered not suitable and not recommended.
3.	Cables	• Suitable for arboreal mammals. • Have yet to be done in Malaysia. • Considered not suitable as stretches where the terrain is steep will have the widest gaps after slope cutting . • There are risks of lightning strike, animal falling on passing vehicles and requires safety inspection.	• Considered not suitable and not recommended.
C.	**Underpass**		
1.	Bridge	• Need to be designed to accommodate crossings of large animals which naturally move along river valleys, e.g. elephants. • For elephants: a minimum of 12 m height and 12 m between spans with gentle slope at the base. • Will also cater for all other wildlife e.g. Gibbons. Monkeys, etc.	• Very suitable for all rivers. • **Recommended** for: - Crossing of rivers at: ▪ Sg. Kenau at CH.0+300. ▪ Sg. Kuantan at CH.14+050. ▪ Sg. Lepar at CH.29+500. - Crossings of all other streams with bank-to-bank width of > 3m.

Cont.

Table 6.5.2: Road design considerations and recommendations to mitigate potential impacts on wildlife (Cont.)

No.	Category/ Option	Descriptions/ Comments	Suitability for the Project
C.	**Underpass**		
2.	Viaduct	• For elephants: A minimum of 12 m height and 12 m width between spans with gentle slope at the base. • Will also cater for all other wildlife. • Rehabilitate areas underneath with suitable plant species of wildlife. • Proven to be very successful for elephants along East – West Highway.	• Suitable for stretches along steep valleys. • **Recommended** at: - Steep valleys between: ▪ CH.9+000 to CH.10+500 ▪ CH.13+000 to CH.15+500 ▪ CH.18+000 to CH.20+000 ▪ CH. 20+000 to CH. 26+000 ▪ CH.28+500 to CH.29+100 (Refer to **Figure 6.5.1**) - A long viaduct is preferable compared to a few smaller viaducts.
3.	Culvert	• Can serve as drainage and wildlife crossing. • Size: Diameter of > 150 cm is recommended, where the larger size is preferable. • Box culvert is preferred. • Culverts with the size of 150 cm can cater for medium and small sized animals, particularly small and slow moving reptiles like tortoises and terrapins.	• Very suitable for small streams. • **Recommended** for: - All small streams of < 3m width. - All seasonal streams.
D.	**Other Design Considerations**		
1.	Road Alignment	• Road alignment selection is the single most important factor that can have a major impact on wildlife. • Alignments that transect environmentally sensitive areas can result in devastating impacts if not properly controlled. • Alignments can be altered to avoid sensitive wildlife habitats like migration routes or breeding areas.	• For this Project, various alignments were considered during the Feasibility Study (Perunding Zaaba, 2002) and the proposed alignment was selected based on a range of selection criteria and assessments. • The selected alignment unavoidably cuts right through the contiguous forests of the Reman Cereh FR and the Berkelah FR which are located within the CFS core area. • Whilst the main alignment corridor has been selected, there is room to select the final alignment within this corridor that can minimise impacts on wildlife.

Cont.

Table 6.5.2: Road design considerations and recommendations to mitigate potential impacts on wildlife (Cont.)

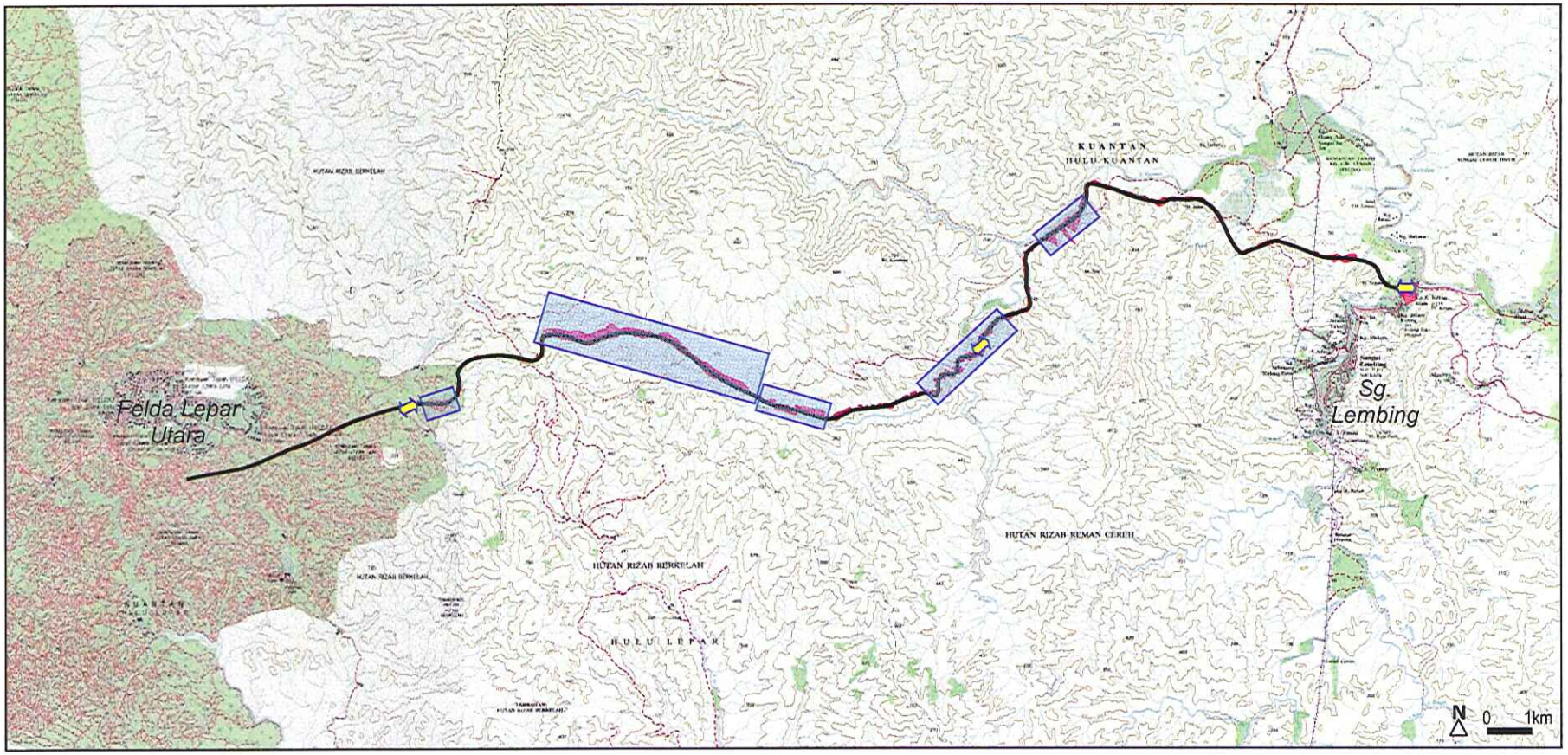
No.	Category/ Option	Descriptions/ Comments	Suitability for the Project
D.	**Other Design Considerations**		
1.	Road Alignment (cont.)	• Road alignment selection is the single most important factor that can have a major impact on wildlife. • Alignments that transect environmentally sensitive areas can result in devastating impacts if not properly controlled. • Alignments can be altered to avoid sensitive wildlife habitats like migration routes or breeding areas.	• The following should be considered: - Align the road as far from river banks as possible to provide a wider riparian reserve corridor for wildlife movement. - Minimise steep areas as best as practical which require major cuts and fill works. This will minimise forest clearing required for road construction.
2.	Road width	• The wider the road the higher the probability of collision with wildlife due to the increased width and vehicle speed.	• The proposed road is a single carriageway road which is the narrowest design.
3.	Width of works area within ROW	• Clearing the entire width of the ROW will result in unnecessary clearing of forest within the Reserve Forests; generating additional biomass waste which requires management; exposes a larger area to erosion; in addition to higher construction cost.	• Minimise site clearing to the limit of works and maximise retention of the existing forest within the ROW as best as practicable. • The site boundaries shall be clearly marked on the ground and the contractors shall be penalised for any over clearing.
4.	Design Speed	• Lower design speeds minimise the risk of collisions as both drivers and wildlife have more time to take evasive action. • Proposed design speed is low, i.e. - 40 km/h at hilly terrain. - 70 km/h at flat stretches.	• Consider reducing the speed limit at flat stretches to 60 km/h at key wildlife crossing points.
5.	Fencing	• Fencing hinders free movement of wildlife. • Poorly placed fencing may funnel wildlife to a particular crossing point that may increase the probability of being hit by vehicles or hunted by poachers. • Properly setup fencing can be used to funnel wildlife to use the crossings. • Properly designed electric fencing can be effectively used to control and or restrict movement of elephants.	• Consider this option at a later stage in the Project. • Electric fencing not deemed necessary.

Cont.

Table 6.5.2: Road design considerations and recommendations to mitigate potential impacts on wildlife (Cont.)

No.	Category/ Option	Descriptions/ Comments	Suitability for the Project
D.	**Other Design Considerations**		
6.	Slope steepness	• Steep slopes will have an impact on the movement of large mammals. Local wildlife will select favourable crossing points after the topography is altered and the road constructed.	• Design the road vertical alignment to best suit the topography so as to minimise cutting works. • Design moderate slopes in the vicinity of bridges to facilitate movements of wildlife.
7.	Riparian reserves	• River banks in tropical forests are usually very rich in wildlife and form natural conduits for wildlife movements. • The recommended river reserve is as per the DID requirements and an additional +50 m is required based on the CFS master plan.	• The alignment runs along a considerable length of Sg. Kuantan and Sg. Lepar. It is essential that adequate riparian reserves are provided to safeguard wildlife. • River and riparian reserves are to be maintained.
8.	Guard rails	• Guard rails are placed where deemed necessary for road safety. Similar to fencing, guard rails may restrict the movement of wildlife.	• Design guard rails as necessary.
9.	Pipelines	• Pipelines laid over ground may hinder the movement of wildlife.	• Consider designing underground piping or a design that will not hinder wildlife crossing.
10.	Roadside drains	• Steep and wide concrete drains may hinder the movement of wildlife.	• Design shallow sloping drains as best as practicable. • Design covered drains, if practicable.
11.	Lighting	• Lighting adversely impacts nocturnal animals and should be minimised unless required for safety purposes, i.e. at junctions at the village area or FLU4.	• Minimise lighting. • Use reflectors to enhance safety along the route.
12.	Signage	• Signages provide warning to drivers to be aware of the potential presence of wildlife as well as to reduce their speed and slow down.	• Post signages along the vicinity of the tributaries of Sg. Kuantan and Sg. Lepar where elephants may cross at grade.

Figure 6.5.1: Location of Proposed Main Bridges and Viaducts



Legend: Proposed of Main Bridge Proposed Viaduct

Note:

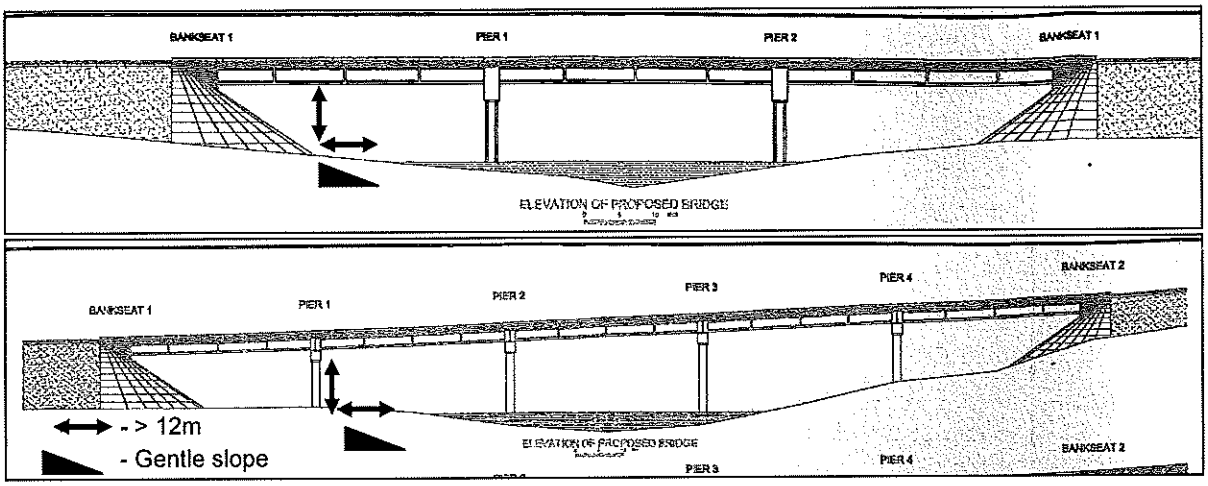
Proposed Structure:	Location:
Main bridge*	Sg. Kenau @ CH.0+300; Sg. Kuantan @ CH.14+050; Sg. Lepar @ CH.29+500.
Viaduct	CH.9+000 to CH.10+500; CH.13+000 to CH.15+500; CH.18+000 to CH.20+000; CH.20+000 to CH.26+000; CH.28+500 to CH.29+100.

** Bridges are recommended for crossing of stream >3 m width. Culverts, preferably box-type, are recommended for crossing of stream <3 m width.*

B. Bridges and Viaducts

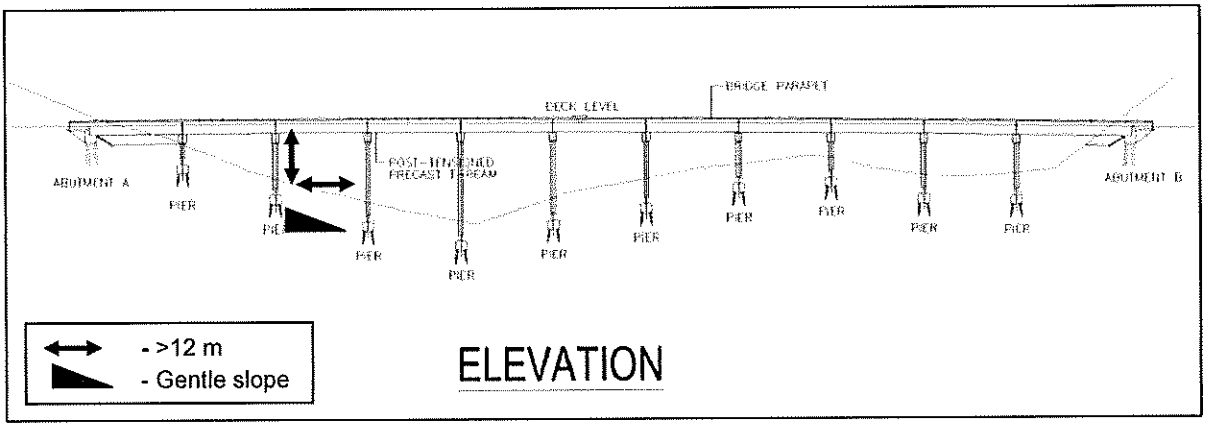
Bridges and viaducts to be installed along the road should have a minimum span of 12 m height and 12 m width between piers as recommended for elephant underpass crossings (JPBD, 2010a). The slopes at the ends of the bridges/ viaducts should be designed to have a gentle slope to facilitate the movement of wildlife. Larger bridges/ viaducts with longer and higher spans are preferable for wildlife crossings compared to many smaller bridges/ viaducts. A typical example of a bridge/ viaduct that is suitable for wildlife underpass is shown in **Figures 6.5.2a** & **6.5.2b**.

Figure 6.5.2a: Example of Typical Precast Post Tensioned Beam Option for Bridges



Note: Minimum requirements for elephant 'underpass' for bridges and viaducts – height: 12 m x width: 12 m with gentle slopes or as per original topography.

Figure 6.5.2b: Example of 'Viaduct' for Steep Valleys



Source: Adapted from JPBD (2010a).

C. Tunnels

The new road will be a barrier to gibbons that inhabit the canopy and do not usually descend to the ground where they become vulnerable to predation. As such, the proposed tunnels on steep ridges will serve as effective overpasses at these stretches. These overpasses will also be particularly effective for arboreal species and species that inhabit steep ridges like Serow; as well as Seladang, elephants, tigers and other ungulates.

The Project's Feasibility Report (Perunding Zaaba, 2002) recommended that tunnels be constructed as the 'environmentally friendly option' for the Project. The findings of this EIA concur and complement the feasibility study findings. Therefore, it is recommended that the tunnels as proposed in the feasibility study be constructed as it is the most viable environmentally friendly option to facilitate wildlife crossing.

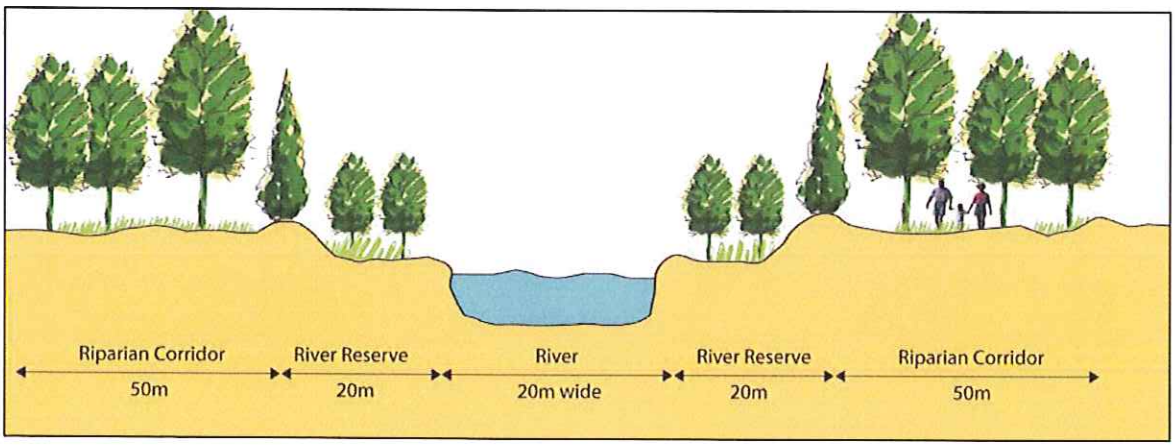
D. Riparian Buffer Zone

Rivers are natural conduits for the movement of numerous species of wildlife and at the Project site this is clearly the case for large mammals like elephants. It is imperative that suitable and adequate riparian reserve be retained along all major rivers and streams to allow continual movement of native wildlife whilst minimising the need for animals to stray onto the road.

For the proposed road, it is critical to maintain riparian reserves in compliance with the requirements specified in the CFS by JPBD. In addition to the river reserve requirements specified by the DID, an additional 50 m (minimum) riparian reserve shall be added and maintained along all major rivers and streams. The width of the riparian reserve that shall be provided and maintained for the proposed road shall comply with the requirements shown in **Figure 6.5.3** and specified in **Table 6.5.3**.

It should be noted that the detailed design of the road shall select an alignment that complies with the minimum requirement of the river and riparian reserve buffer zone. Where practicable, the alignment should be preferably as far from the river as possible.

Figure 6.5.3 Riparian Reserve within the CFS



Source: JPBD (2010a).

Table 6.5.3: River and Riparian Reserve Width

No.	River Width (m)	DID River Reserve*(m)	JPBD Riparian Reserve* within the CFS (m)	Total River + Riparian Reserve* (m)
1.	>40	50	+50	100
2.	20-40	40	+50	90
3.	10-20	20	+50	70
4.	5-10	10	+50	60
5.	<5	5	+50	55

*Note: * = on each river bank. Source: Adapted from JPBD (2010a).*

6.5.2 MITIGATION MEASURES DURING THE CONSTRUCTION STAGE

A. General

i. Hunting of wildlife; including fishing and collection of forest produces within the Forest Reserves are prohibited.

ii. Any directives or standard procedures as advised by the Department of Forestry, Pahang and PERHILITAN are to be strictly complied with.

iii. Implement awareness programmes on forest and wildlife as well as conservation. Firstly, all workers should be aware of the "value" and "importance" of conserving the forest and wildlife for future generations. Then comes the awareness of the practical measures to be implemented to minimise impacts to the forest and wildlife during the construction and post-construction phases of the Project.

iv. The Department of Forestry, Forest Research Institute Malaysia (FRIM) and PERHILITAN may be sought to conduct the forest and wildlife conservation awareness/ training programmes. The supervisors and workers should be given training or briefing on the following:

- Wildlife present in the area, particularly large mammals and snakes.
- Legislative requirements related to forest protection and prohibition on hunting, trapping, killing, disturbing nests and eggs of Totally Protected and Protected species.
- Mitigation measures for forest and wildlife protection during the construction phase.
- Precautionary measures to prevent human – wildlife encounters and the correct responses to take during human – wildlife encounters.
- Communication, reporting and emergency requirements for wildlife related issues.

v. Putting up Wildlife Posters of Totally Protected and Protected Species is an effective method of communicating legal requirements and penalties to workers on site. Suitable posters should be obtained from the PERHILITAN and displayed on site.

B. Site Clearing and Timber Salvaging

i. Demarcate and maintain Project boundary and restrict all construction activities within the boundary limit.

ii. Method Statement for site clearing should be prepared and implemented accordingly. The Method Statement should include:

- Layout plan of the work area with clear indication of the Project boundary, working areas (e.g. cut and fill areas, location of water crossings, site office and work camps) and buffer zone.
- List of machineries to be used.
- Phasing of site clearing works.
- Location and type of soil erosion and sediment control BMPs.

iii. Any field activities for salvaging any merchantable timber found within the Project area shall be conducted after written approval or permit has been obtained from the Department of Forestry, Pahang. The timber salvaging activity shall comply with any directives and prescriptions issued by the Department of Forestry.

iv. Prior to salvaging the merchantable timber, the following should be conducted:

- A 100% pre-felling inventory and marking of the trees to be felled should be conducted. The pre-felling inventory and tree marking activities are to be carried out in accordance with "*Manual Kerja Luar Sistem Pengurusan Memilih (Selective Management System), 1997*" published by the Department of Forestry Peninsular Malaysia.
- Locations of the trees to be felled and the direction of felling should be marked on working plans with a scale of 1:5,000. The working plan should also include information on:
  - Boundary of the working area;
  - Planned road and skid trail networks;
  - Permanent watercourses;
  - Areas with more than 40° slope; and
  - Locations and type of soil erosion and sediment control BMPs.
- The working plans should be approved or endorsed by the Department of Forestry Pahang prior to the construction of logging roads and tree felling.

v. The Department of Forestry Pahang shall closely oversee and monitor the activity of salvaging of merchantable timber.

vi. The design, planning and construction of logging roads shall be conducted in accordance with the "*Garis Panduan Jalan Hutan, 2010*" published by the Department of Forestry, Peninsular Malaysia.

vii. The tree felling and timber harvesting activity shall be conducted in accordance with the "*Guidelines for Reduced Impact Logging in Peninsular Malaysia, 2003*" published by the Department of Forestry, Peninsular Malaysia.

C. Human – Wildlife Encounters

When working in areas which are known to be abundant with wildlife, occasional human – wildlife encounters are bound to occur. In most cases, the wildlife will flee without causing any harm or damage. However, on certain occasions, human – wildlife encounters involving dangerous animals may result in people being attacked, mauled, trampled or bitten; or the animal being injured or killed.

To prevent human – wildlife encounters, the following 'common sense' precautions measures may be taken:

- Never approach, attempt to touch or handle wildlife.
- Do not attempt to handle snakes.
- Use safety boots or equivalent protective shoes when working.
- Make noise when working in the jungle to alert animals of your presence.
- Never attempt to feed or provide food to lure wildlife to the work area.

D. Wildlife Officer

During the construction stage of the Project, the contractor shall nominate a person to be responsible to address wildlife related issues. The designated personnel in charge of wildlife will have the following responsibilities:

- Implement the mitigation measures recommended in this PEIA Report.
- Maintain a Wildlife Record Book and document all issues related to wildlife during the Project construction stage. Records should be as accurate as possible; and details on species sighted, location, date and time, numbers (e.g. elephants), as well as the behaviour of the animals (i.e. feeding, etc).
- Records of the exact locations where large animals cross the road should be maintained as some species may use the same crossing point repeatedly. This information may provide insight to accurately place wildlife warning signage.
- Establish and maintain contact with the local Wildlife Ranger. Report important information immediately to the ranger office if the following is encountered:
  - Hunting activity in the area;
  - Road kills of animals including elephants, tigers, sun bears, tapirs;
  - Poaching of animals including tigers, siamang, sunda pangolin and other protected species;
  - Animals injured by collision with passing traffic;
  - Wildlife entering the construction area and becoming a nuisance or threatening to workers.

6.5.3 MITIGATION DURING THE POST-CONSTRUCTION STAGE

A. Wildlife Monitoring, Recording and Reporting

A project of this nature does clearly require a systematic long term structured wildlife monitoring programme. However, it is sufficient to establish a *'Wildlife Record Logbook'* and assigning a responsible person to record wildlife related information. The information recorded may allow better management of wildlife issues in the area. Thus, it is important to keep accurate records of wildlife activity. Records should be made available to the PERHILITAN upon request.

For this Project, recording elephant sightings may allow a better understanding of the movement of the local herds, road crossing points, timing and trends which may provide insights on siting of wildlife warning signage to caution road users.

Biannual reviews of wildlife issues in the area are warranted as it will provide an update on wildlife related issues in the area.

B. Wildlife Crossing Warning Signage

Standard wildlife warning signages should be put up at flat stretches of the road along Sg. Kuantan and Sg. Lepar where grade crossings are most likely. These can be adjusted or additional signage can be placed where animals crossing the road are reported. The signage should be coupled with a reduction in speed limit to 60 km/h or lower and include the following information to caution drivers:

- "Caution! Elephant/ Wildlife crossing area"
- "Do not get out of your vehicle"
- "Do not honk, or flash high beam"
- "Give way to Elephants/ Wildlife".

6.6 MANAGEMENT AND CONTROL OF SOLID AND SCHEDULED WASTES

6.6.1 MITIGATION MEASURES DURING CONSTRUCTION STAGE

During the construction stage, the following wastes management suggestions should be adhered to.

- Vegetative biomass should be disposed of at designated disposal sites.
- Suitable site should be allocated for temporary storage of vegetative biomass and earth spoils. The site should be far from waterways and provided with perimeter-bunding to ensure that direct washout into waterways is prevented.
- Standard site clearing procedures as prescribed by the authorities as well as the management procedures stated in **Section 6.5.2 B** are to be strictly adhered to in order to minimise any impact.
- Scheduled wastes generated from the Project activity i.e. servicing of transport vehicles and construction machinery, must be handled and stored in accordance to the requirements of Environmental Quality (Scheduled Wastes) Regulations 2005. Disposal must be directed to an off-site waste oil recovery facility or to Kualiti Alam Integrated Scheduled Waste Management Centre.
- Handling and storage of scheduled wastes include storing in sealed and labelled drums provided with clear markings and signage; and keeping at designated bunded area. In order to contain any leakages and spillages, the volume capacity of the bunded area must at least be equivalent to 110% of the total largest storage container.
- Proper housekeeping should be maintained on site at all times. Rubbish bins should be provided. Rubbish should be collected regularly and disposed of appropriately.
- Open burning of vegetative biomass and other wastes is strictly prohibited.

6.7 SOCIO-ECONOMY ENHANCEMENT

The following are suggestions on enhancement or facilitation for the locals in relation to the development of the Project.

i. Award the local contractors to undertake sub-contract jobs for the Project.

ii. The main contractors should offer more jobs to the local people instead of foreign labourers.

iii. Provide safety and health awareness programmes to construction workers.