

Esso Highlands Limited



Papua New Guinea LNG Project

**Environmental and Social Management Plan
Appendix 9: Erosion and Sediment Control
Management Plan**

PGGP-EH-SPENV-000018-011

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1.0 OBJECTIVES

Esso Highlands Limited (Company) has developed this Erosion and Sediment Control Management Plan as part of its Environmental and Social Management Plan (ESMP).

The objectives of the Erosion and Sediment Control Management Plan are to:

1. Maintain stable landforms to reduce erosion and enhance reinstatement
2. Maintain integrity of assets (through stable landforms)
3. Reduce adverse impacts on stream water quality, and associated beneficial values, and in-stream sedimentation.

The Erosion and Sediment Control Management Plan should be read in conjunction with other Company plans:

- Ecological Management Plan
- Waste Management Plan
- Water Management Plan
- Reinstatement Plan.

2.0 LEGAL REQUIREMENTS

Legal and other requirements applicable to this plan are identified in **Attachment 1**.

3.0 SURVEYS

Company shall undertake a sedimentation and geomorphologic characterisation study of the Omati River in order to collect data of the portion of the riverbed in which the proposed LNG Project gas pipeline will be laid so that any future changes can be compared to pre-construction conditions.

4.0 MANAGEMENT AND MONITORING

Table 1 presents a summary of the potential impacts related to erosion and sediment mobilisation, together with mitigation and management measures to avoid or reduce these impacts.

Contractor shall develop an Erosion and Sediment Control Management Plan, which will as a minimum incorporate the measures described in Table 1 but shall not be limited to these measures.

Due to differing scopes of work and work locations, not all management and mitigation measures in the Erosion and Sediment Control Management Plan are applicable to all Contractors. Company's Environmental and Social Mitigation Register defines which management and mitigation measures are applicable to each Contract scope of work.

Mitigation and management commitments contained in the PNG LNG Project Environmental Impact Statement (EIS) are identified by a code commencing with an 'M' in the 'Mitigation Item Reference Number' column. Some mitigation measures have been reworded to provide further clarity or more detailed information regarding required measures. In these instances, the code is displayed in italics, and these reworded measures supersede what is in the EIS.

Other mitigation and management commitments required by Company are identified with a code commencing with an 'A'.

Monitoring to be undertaken as part of the Erosion and Sediment Control Management Plan is described in Table 1.

Contractor shall develop site-specific procedures for the monitoring program, to be agreed by Company.

Table 1: Management and Monitoring

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective[†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
Destabilised landforms	Soil erosion resulting in reduced water quality and reinstatement success (Objective 1, 2, 3)	Assess and establish erosion and sediment control requirements (particularly in relation to site preparation earthworks, road construction across watercourses, watercourse diversions, site drainage), detailing specific erosion and sediment controls to be implemented (e.g., diversion drains, sediment ponds and fabric silt curtains). The controls should limit the mobilization and dispersion of sediment into freshwater and estuarine environments.	M23	Assess areas of continuing erosion every 3 months by road and/or foot patrol.	Ongoing	Contractor
		Conduct fine-scale routing of the RoWs, wellpads, facility platforms and access ways to avoid erosion-prone areas, such as weak soils, tributary headwalls along ridges and over-steepened slopes in gorges, and reduce the number of watercourse crossings, where practicable.	M141	Verification	Ongoing	Contractor
		Where a watercourse crossing is considered too large and fast-flowing for the use of conventional open-cut trenching methods, horizontal directional drilling may be used to install the pipeline.	M142	Verification	N/A	Contractor
		Horizontal direction drilling sites on either side of a watercourse will be re-contoured, graded and rehabilitated after pipe installations are completed to reduce soil erosion and fugitive sediment.	M143	Verification	N/A	Contractor
		Mitigate impacts from sidecasting in steep terrain areas, for example by using fine particle size organic matting or lattice framework or similar in karst areas to trap organic matter across sidecast where practicable and implementing sediment control measures downstream of sidecast material where practicable. (Refer to the 'Erosion and Sediment Control Plan' for	M156	Verification	N/A	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		measures relating to sediment control).				
		Undertake terrain evaluation and mapping to identify past instabilities (e.g., landslides).	M157	Verification	N/A	Contractor
		Consider the hydraulics of the watercourse in the design and construction of bridges, abutments and in-river bridge supports (where needed) and consider stability and flow disruptions.	M154	Verification	N/A	Contractor
		Design the modified and new wharfs at Kopi Shore Base to take account of channel characteristics of the lower Kikori River that may affect the long-term stability of the river frontage.	M161	Verification	N/A	Contractor
		Reduce time between clearing and grading/capping of sites as far as practical to limit exposure of the site soils and subsoils to rainfall-based erosion and scour.	A64	Verification	Ongoing	Contractor
		Restrict site clearing and incidental site disturbance as far as practical by demarcating areas that require clearing and by confining traffic to designated tracks and laydown areas as far as practicable.	A65	Verification	Ongoing	Contractor
		Where practicable, utilize land-clearing techniques that preserve the rootstock of removed vegetation in the ground.	M74	Verification	Ongoing	Contractor
		Where practicable, reduce disturbance of natural drainage channels during grading; avoid blocking channels with graded material.	A66	Verification	Ongoing	Contractor
		Reinstate disturbed batter slopes (if present) as soon as is practicable.	A67	Verification	Ongoing	Contractor
		Where appropriate, undertake active works to re-establish vegetation in areas that may be slow or difficult to regenerate naturally, difficult to stabilise or	M119	Verification	Ongoing	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		prone to erosion (see Reinstatement Plan).				
		<p>Implement industry good practice erosion and sediment control measures at watercourse crossings, as necessary.</p> <p>Monitor and maintain erosion control structures until adequate slope stabilization, sediment control and subsidence control has been achieved.</p> <p>Monitor erosion at reclaimed watercourse crossings remediate as necessary.</p> <p>Design culverts to accommodate design flows and mitigate sedimentation and debris.</p> <p>Avoid stockpiling spoil and/or topsoil materials close to waterways (i.e., maintaining a minimum of 10 m from waterline), where practicable.</p> <p>Install diversion drains to intercept uncontaminated surface runoff around facilities and away from construction areas, where necessary.</p> <p>Install sediment control structures to intercept sediment-laden surface runoff to reduce sediment delivery to watercourses.</p> <p>Prohibit deposition of sidecasting material directly into waterways where practicable.</p> <p>Implement sediment control measures downstream of sidecast material where safe and practicable.</p> <p>Monitor and maintain sediment control structures until adequate slope stabilization, sediment control and subsidence control has been achieved.</p> <p>Control sediment runoff from stockpiles and cleared areas around watercourses, where practicable.</p> <p>Grade ROW and access way alignments adjacent to</p>	M155	Monitor erosion control structures	Weekly and following storm events.	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		streams away from watercourses.				
		Inspect condition and stability of banks at completed pipeline watercourse crossings after storms.	A68	Verification	After storm events	Contractor
		Keep pipeline RoWs and access way alignment approaches to watercourses as close to right angles as possible to limit disturbances to the banks of watercourses, where practicable.	M140	Verification	Ongoing	Contractor
		Limit the clearing of riparian vegetation to the width required to safely accommodate RoW, access ways and watercourse crossings. Also, reduce number of watercourse crossings to limit riparian soil erosion and sediment delivery to watercourses.	M64, M4	Verification	Ongoing	Contractor
		Trim riparian trees using chainsaws rather than by whole tree removal, where practicable.	A69	Verification	Ongoing	Contractor
		Remove trees, debris or soil inadvertently deposited below the high water mark of watercourses where safe to do so and, where practicable, in a manner that reduces disturbance of the bed and banks. Use material for reinstatement (see Reinstatement Plan).	M138	Verification	Ongoing	Contractor
		Where practical, stabilise cleared banks to facilitate reinstatement.	M139	Verification	Ongoing	Contractor
		Control potential scouring at road culvert outlets by installing energy dissipation devices, such as rock mattresses or gabions, where required.	A70	Verification	Ongoing	Contractor
		(LNG Plant Site) Limit ground disturbance and vegetation clearing (for facility sites, camps, lay down areas) to the areas requiring development within the perimeter fence (plus working buffer zone).	M5	Verification	Ongoing	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		Reduce the period surfaces are exposed, and reinstate areas no longer required for construction or support services. Provide particular attention to areas prone to erosion.	M7	Verification	Ongoing	Contractor
		Where practicable, disturbed areas will be returned to former landforms and vegetation of exposed areas will occur as soon as practicable once construction activities are completed in any particular location. Areas prone to erosion will receive particular attention.	M18	Verification	Ongoing	Contractor
Loss or degradation of topsoil from cleared areas	Reduced reinstatement success (Objective 1, 2)	Where practicable, soil, mulch and discarded vegetation debris (including natural seed stock) will be spread on reclaimed or rehabilitated disturbed land surfaces to facilitate natural revegetation.	M121	Verification	Ongoing	Contractor
		Where practicable, topsoil will be conserved in designated topsoil stockpile areas at facility construction sites for later reuse.	M122	Verification	Ongoing	Contractor
		Salvage topsoil for rehabilitation of slopes, where practicable.	M123	Verification	Ongoing	Contractor
		Where salvaged, reduce damage to topsoil and mulch with sterile medium to protect seed resource.	M124	Verification	Ongoing	Contractor
Runoff from cleared/disturbed areas causing increased suspended solids/turbidity and in-channel sedimentation	Reduced water quality with consequent reduction in: • Availability of aquatic resources.	Validation monitoring of sedimentation will be undertaken during construction and will be similar in scope to that undertaken for the EIS characterization or expanded as required.	M207	Verification	Prior to clearance	Contractor
		Assess erosion and sediment control measures required for each work site and detail specific sediment and erosion controls to be implemented.	A71	Verification	Prior to clearance	Contractor
		Provide protection for stream headwaters in the Baia	M85	Verification	N/A	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
	<ul style="list-style-type: none"> Suitability of water for drinking. (Objective 3)	River area and elsewhere in the upstream project area above 1,800 m to reduce erosion material entering the watercourse.				
		The LNG Project gas pipeline will be buried in the bed of the Omati River to protect the pipeline and limit potential causes of interruptions to natural bed sediment transport processes.	M194	Verification	N/A	Contractor
		Undertake sedimentation and geomorphologic characterisation studies of the Omati River to collect data of the portion of the riverbed in which the proposed LNG Project gas pipeline will be laid so that any future changes can be compared to pre-construction conditions.	M186	Verification	N/A	Company
		Limit the clearing of riparian vegetation to the width required to safely accommodate RoW, access ways and watercourse crossings. Also, reduce number of watercourse crossings to limit riparian soil erosion and sediment delivery to watercourses.	M64	Verification	N/A	Contractor
		Where practicable, conduct construction works at water crossings during periods of low water flow	A72	Verification	N/A	Contractor
		River/stream crossings are to be limited in areas of high, unstable banks.	M158	Verification	Ongoing	Contractor
		Maintain minimum of 10 m vegetation buffer zone from watercourses wherever practicable.	A73	Verification	Prior to clearance	Contractor
		Limit the duration of in-stream construction activities at watercourse crossings to shortest time practicable.	M153	Verification	Ongoing	Contractor
		Avoid placement of fill material in watercourses.	A74	Verification	Ongoing	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective [†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		Develop a water quality monitoring plan for the Hides Gas Conditioning Plant (see Water Management Plan).	M164	Verification	Water Management Plan	Contractor
		(Lake Kutubu Catchment) Conduct post-construction inspections along the upgraded RoW and roadway within the catchment of Lake Kutubu including: <ul style="list-style-type: none"> • Check for problematic erosion areas and implement remedial works as appropriate. • Inspect ditches and culverts and remove accumulated debris, where required. Review feedback from water quality monitoring for advance warning of deteriorated water quality due to increased suspended sediment loading (refer Water Management Plan).	M152	Verification	Ongoing	Contractor
		(LNG Plant) Protect pools within the ephemeral streams of the Vaihua River catchment using temporary sediment control measures downslope of active construction areas (perimeter fence and roads).	A75	Verification	Ongoing	Contractor
		(LNG Plant) Use silt curtains and other industry good practice management controls as appropriate when working in mangroves, particularly near the seaward extent.	M24	Verification	Ongoing	Contractor
		(LNG Plant) Reduce sediment release resulting from construction of the jetty.	M204	Verification	Ongoing	Contractor
		(LNG Plant) Silt curtains and/or other industry good practice management controls will be used to restrict the spread of sediment released during construction of the combined LNG Jetty/Materials Offloading Facility earthen causeway, particularly when working in mangroves, or adjacent to the reef and seagrass areas.	M216	Verification	N/A	Contractor

Table 1: Management and Monitoring						
Source of Impact	Potential Impact and Relevant Management Plan Objective[†]	Mitigation and Management (Design Feature/Specific Measure)	Mitigation Item Reference Number	Monitoring	Monitoring Frequency	Responsibility
		(LNG Plant) Measures to reduce sediment release resulting from construction of the earthen causeway will include setting a lower limit of particle size for material used for LNG Jetty/Materials Offloading Facility causeway construction and/or use of a geotextile lining or similar industry good practise to reduce the release of fine sediment into the water column.	<i>M215</i>	Verification	N/A	Contractor

[†] See Section 1.

5.0 ROLES AND RESPONSIBILITIES

Contractor shall ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of the Erosion and Sediment Control Management Plan.

Contractor's Erosion and Sediment Control Management Plan shall describe the resources allocated to and responsible for the execution of each task and requirement contained therein, and shall describe how roles and responsibilities are communicated to relevant personnel.

Company shall ensure sufficient resources are allocated on an ongoing basis to achieve effective implementation of Company's responsibilities in the Erosion and Sediment Control Management Plan.

6.0 TRAINING, AWARENESS & COMPETENCY

Contractor shall ensure that all personnel responsible for the execution of the tasks and requirements contained within the Erosion and Sediment Control Management Plan are competent on the basis of education, training and experience.

Contractor's Erosion and Sediment Control Management Plan shall describe the training and awareness requirements necessary for its effective implementation.

Contractor's training activity associated with the Erosion and Sediment Control Management Plan shall be appropriately documented by means of a training needs assessment, training matrix/plan and records of training undertaken.

Company shall ensure that all Company personnel responsible for the execution of Company's tasks and requirements in the Erosion and Sediment Control Management Plan are competent on the basis of education, training and experience.

Company's training activity associated with the Erosion and Sediment Control Management Plan shall be appropriately documented by means of a training needs assessment, training matrix/plan and records of training undertaken.

7.0 PERFORMANCE INDICATORS

Table 2 outlines indicators for measuring and verifying performance in relation to Erosion and Sediment Control management.

Table 2: Performance Indicators

ID #	Performance Indicator	Measurement	Internal Assessment Frequency	Relevant Management Plan Objective [†]
1	Landform stability	Occurrence of sediment control structures and mass failings	Monthly & after significant storm events	1, 2
2	Maintenance of water quality and flow regimes	Turbidity levels, stream/river flow dynamics and affect on down-stream user consumption patterns	Monthly	3
Performance Indicators to be further developed and agreed between Contractor and Company				

[†] See Section 1.

8.0 REPORTING AND NOTIFICATION

Contractor's monthly report to Company shall include:

- Number and results of verification inspections prescribed in Table 1, including but not limited to landform stability inspections, sediment control structure and stockpile inspections and control measures implemented to manage failing sediment control structures and stockpiles
- Performance Indicators as applicable in the reporting period.

Attachment 1: Legal and Other Requirements

LEGAL AND OTHER REQUIREMENTS

Contractor shall comply with applicable Papua New Guinea Laws and Regulations, applicable International Finance Institution (IFI) requirements and International Treaties and Conventions (where applicable).

Papua New Guinea Laws and Regulations

The Environment Act 2000 contains numerous provisions that promote environmental protection, regulate environmental impacts associated with development activities, and safeguard the life supporting capacity of air, water land and ecosystems. While none are related to sediment and erosion control *per se*, the following are indirectly relevant insofar as unsuccessful outcomes relating to sediment control and erosion are likely to have an immediate and adverse affect on surface water quality:

- Environment Act (2000): hosts the Environment (Water Quality Criteria) Regulation (2002) and specifically Schedule 1: Water Criteria for Aquatic Life Protection
- Public Health (Drinking Water) Regulation (1984):
 - Schedule 1 Standards for Raw Water
 - Schedule 2 Standards for Drinking Water

International Financial Institution Requirements

The following International Finance Corporation (IFC) Guidelines apply to sediment and erosion control. Contractor shall meet the intent of these guidelines:

- IFC *EHS General Guidelines*: Section 4.0

Recommended soil erosion and water system management approaches include:

- *Sediment mobilization and transport*: Reducing or preventing erosion by:
 - Scheduling to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical
 - Contouring and minimizing length and steepness of slopes
 - Mulching to stabilize exposed areas
 - Re-vegetating areas promptly
 - Designing channels and ditches for post-construction flows
 - Lining steep channel and slopes (e.g. use jute matting)
- *Clean runoff management*:
 - Segregating or diverting clean water runoff to prevent it mixing with water containing a high solids content, to minimize the volume of water to be treated prior to release
- *Road design*:
 - Limiting access road gradients to reduce runoff-induced erosion
 - Providing adequate road drainage based on road width, surface material, compaction, and maintenance
- *Disturbance to water bodies*
 - Depending on the potential for adverse impacts, installing free-spanning structures (e.g., single span bridges) for road watercourse crossings
 - Restricting the duration and timing of in-stream activities to lower low periods, and avoiding periods critical to biological cycles of valued flora and fauna (e.g., migration, spawning, etc.)
 - For in-stream works, using isolation techniques such as berming or diversion during construction to limit the exposure of disturbed sediments to moving water

- Consider using trenchless technology for pipeline crossings (e.g., suspended crossings) or installation by directional drilling
- *Structural (slope) stability*
 - Providing effective short term measures for slope stabilization, sediment control and subsidence control until long term measures for the operational phase can be implemented
 - Providing adequate drainage systems to minimize and control infiltration
- IFC *EHS Guidelines for Onshore Oil and Gas Development*: Section 1.1, Terrestrial Impacts and Project Footprint”
- IFC Performance Standard 3: *Pollution Prevention and Abatement*, Pollution Prevention, Resource Conservation and Energy Efficiency:

“The Client will avoid the release of pollutants, or, when avoidance is not feasible, minimize or control the intensity or load of their release. This applies to the release of pollutants due to routine, non-routine or accidental circumstances with the potential for local, regional and transboundary impacts.”