CHAPTER III
PREDICTION AND EVALUATION OF SIGNIFICANT IMPACTS

Prediction and evaluation of impact are conducted toward the results of the hypothetical significant impacts identification from the proposed Tangguh LNG Expansion Project in the Bintuni Bay and Fakfak Regencies, West Papua studied in the ANDAL Terms of Reference document that has been approved by Ministry of the Environment (Decree of the Deputy Minister for Environmental Governance, Ministry of the Environment No. 30 Year 2013).

Evaluation of significant impacts are conducted in reference to the Regulation of the Minister of the Environment No. 16 Year 2012 and uses impact evaluation methods generally used for projects associated with international financing institutions (IFC, World Bank and ADB) as well as guidelines for the evaluation of significant impacts usually applied in BP projects (BP Guidelines for Impact Assessment - GRP 3.6-0001).

The impact evaluation follows the steps shown in **Figure III-1** in order to determine impact significance to determine whether a hypothetical significant impact that has been identified through the scoping process in the Terms of Reference is an "insignificant impact" or a "significant impact."

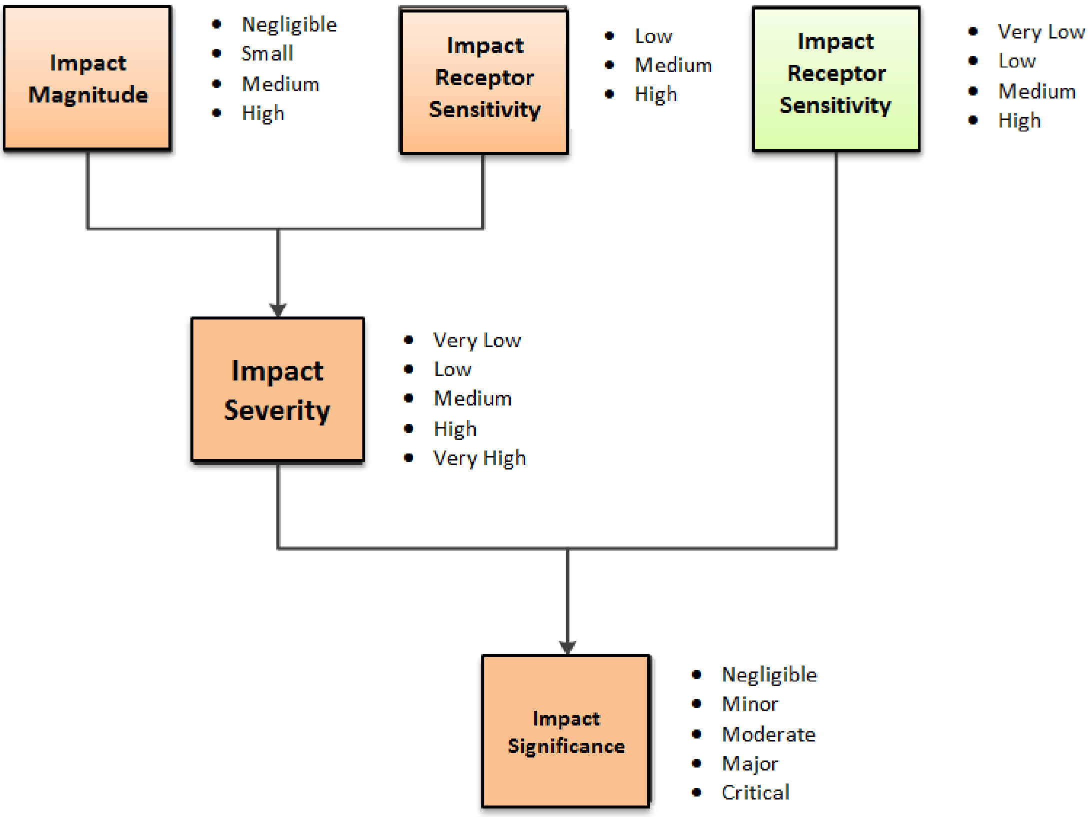


Figure III-1 Impact Evaluation Steps to Determine Impact Significance

A brief description of definitions and criteria used in evaluating each hypothetical significant impact is shown on **Table III-1.**

Table III-1 Impact Criterias and Definitions

Impact Criteria	Definition
	Impact Nature
Negative Impact	An impact which the changes caused to the environmental baseline become worse than its original state.
Positive Impact	An impact which the changes caused to the environmental baseline better than its original state.
	Impact Type
Direct Impact (Primary)*	The impact of direct interaction between the proposed project activities with the environmental components receiving the impact (e.g. the loss of wildlife habitats due to forest clearing)
SecondaryImpact (Secondary, Tertiary and so on)*	An impact on environmental components as a derivative impact from primary impact in the form of a secondary, tertiary impact and so on (e.g.: changes in wildlife diversity due to loss of habitats)
Indirect Impact	Impacts due to other activities, where these activities arise due to the existence of the project (example: the rise of service industries around the project area)
Cumulative Impact*	Impacts of an activity occur along with impacts from other activities affecting the receptor (human or wildlife) or resources (physical-chemical, biological, socio-economic-cultural components) at the same time and place
Residual Impact	Impacts that remain after the proposed management activities have been carried out on the activitycausesing impacts.
	Impact Duration

Impact Criteria	Definition
Temporary	The impact is predicted to occur for the short term and it could be intermittent and / or occasional.
Short Term	An impact that is predicted to last for limited time (e.g. during the construction phase only) and will cease on completion of the activities, or as a result of mitigation, or reinstatement measures, or natural recovery.
Long Term	An impact that is predicted to last in a long period of time (such as: increased noise, increased NOx, SOx concentration during the operation phase) and will cease on completion of the project operations. This definition includes intermittent or repetitive impacts (although not continuous) that occur in a long period of time.
Permanent	An impact that is predicted to occur once during the project expansion and cause permanent changes on affected receptors* (humans or animals) or resource* (environmental components of physical-chemical, biological, socio-economic-cultural) – (e.g. artefact destruction, loss of sensitive habitats, and others) that endures beyond the project life time.
Impact Extent	
Local	An impact that is predicted to take place on local scale (i.e. restricted to the project site or within the project area or within the study area covered by the ANDAL)
Regional	An impact that is predicted to take place on a larger scale than the local scale (i.e.: occurs outside the project area boundary or a regional impact)
Global	An impact that is predicted to take place on a global scale scale (i.e.the impact could extend beyond country/national boundaries or such impacts to be international concerns)
Impact Magnitude	
Negligible Small Medium High	Impact magnitude (**negligible, small, medium or large**) is determined by taking into account all dimensions of the impact prediction, consisting of the following: • The impact nature or the nature of the change (what is affected and how); • The impact extent; • The impact duration and reversibility; and • Impact intensity As much as possible, all dimensions determining the magnitude of the impact (especially the intensity of the impact, the extent of the impact, and duration of the impact) are expressed quantitatively. The dimensions of impact intensity and extent are obtained from modeling results; while the duration of the impact is obtained from the description of the planned activities.
Impact Receptor Sensitivity	
Low Medium	A factor that is considered in determining the sensitivity of the impact receptor (**low, medium or high**) is whether the receptor of the impact is the geophysical-chemical environment, the biological environment or humans:
High	• If the impact receptor is the geophysical-chemical environment (e.g. water bodies) then the quality, level of importance and sensitivity to the changes will be taken into consideration. • If the impact receptor is the biological environment, the significance level (i.e. the local, regional or global significance level) and sensitivity to the impact is taken into consideration.
	• If the impact receptor is humans, the sensitivity level of the communities (social groups) will be taken into consideration including the capacity to adapt and manage the effects of the impact. • Other factors are considered in the evaluation of the sensitivity of environmental components as receptors of the impact namely the legal protection status, government policies, economic value and stakeholder

Impact Criteria	Definition
	opinion.
Impact Severity	
Slight	The the impact severity (**very low, low, medium, high or very high**) is determined by comparing the impact magnitude and the impact receptor sensitivity as shown in the following matrix:
Low	Matrix to Determine Impact Severity Level
Medium	
High	
Very High	

		Receptor Sensitivity		
		Low	**Medium**	**High**
Impact Magnitude	**Negligible**	Very Low	Low	Low
	Small	Very Low	Medium	Medium
	Medium	Low	High	High
	Large	Medium	High	Very High

Impact Criteria	Definition
Impact Likelihood	
Very Low	The probability of an event to occur is very low, however it may occur at any time during normal operating conditions; Example: ever heard that the incident has occurred in the industry.
Low	An event may occur at any time during normal operating conditions; Example: the event has occurred previously at the company
Medium	An event is likely to occur under normal operating conditions; Example: the event has occurred several times a year at the company
High	An event will occur under normal operating conditions (unavoidable / inevitable); Example: the event occurs repeatedly in a single year at a location within the company
Impact Significance	
Negligible	Impact significance is determined by looking at the interaction between the impact severity level and the impact likelihood as shown in the following matrix:
Minor	Impact Significance Matrix
Moderate	
Major	
Critical	

		Peluang Kejadian Dampak			
		Sangat Kecil	**Kecil**	**Sedang**	**Tinggi**
Keravanan Dampak	**Sangat Rendah**	Diabaikan	Diabaikan	Diabaikan	Diabaikan
	Rendah	Diabaikan	Diabaikan	Diabaikan - Minor	Minor
	Sedang	Minor	Minor	Minor - Moderat	Moderat
	Tinggi	Minor - Moderat	Moderat	Mayor	Mayor
	Sangat Tinggi	Moderat-Mayor	Mayor	Mayor	Kritis

* Can be determined from a flow chart of significant hypothetical impacts
** Receptor : Human beings and other living things (wildlife) that may be affected by project activities
***Resources : Physical-chemical, biological, and socio-economic-cultural elements, that do not include humans and other living things (receptors), that may be affected by project activities

In some cases, the impact prediction on social, economic, cultural and public health cannot be measured quantitatively, then some criteria and definitions of impact that is typically used in the evaluation of the impact of the hypothetical critical socio-economic-cultural and public health set out in **Table III-2**. The rest of criteria and definition of impact is the same as listed on the **Table III-1**.

Table III-2 Criteria and Definitions Specifically Used in Evaluating Impacts on Social, Economic, Cultural and Public Health Aspects

Impact Criteria	Definition
	Impact Duration
Temporary	Takes place for a period of 0 -1 years
Short Term	Takes place for a period of 1-5 years
Long Term	Takes place for a period of 5-30 years
Permanent	Takes place for a period of more than 30 years and is irreversible
	Impact Extent
Local	The impact takes place at the project site, as far as a few acres, and at the villages near the project site
Regional	The effects of the impact reaches the District and Provincial levels
Global	The effects of the impact reaches the national level and becomes an international concern
	Impact Magnitude
Negligible Low Medium High	Impact magnitude (**negligible, small, medium, large**) is determined from a combination of several aspects below: 1. The impact nature; 2. The impact size and intensity; 3. The impact extent 4. The impact duration
	Impact Intensity
Low	The impact occurs less than once a month (once every two months, and so on)
Medium	The impact occurs once a month
High	The impact occurs twice a week
Very High	The impact occurs every day
	Receptor Sensitivity
Low Medium High	Indicators for social, economic, cultural, educational and public health aspects are presented in **Appendix V**

To determine the impact magnitude on social, economic, cultural and public health aspects, the first step is to determine the "impact size " by combining the "impact intensity" and the "impact extent " as shown in **Table III-3.** Subsequently the "impact magnitude" on social, economic, cultural and public health aspects is determined by combining the "impact size" obtained from **Table III-3** with the " impact duration " as shown in **Table III-4.**

Table III-3 Determining the Size of the Impact on Social-Economic-Cultural and Public Health Aspects

		Impact Intensity			
		Low	**Medium**	**High**	**Very High**
Impact Extent	**Local**	Negligible	Low	Medium	Medium
	Regional	Low	Medium	Medium	High

	Global	Medium	Medium	High	High

Table III-4 Determining the Magnitude of the Impact on Social-Economic-Cultural and Public Health Aspects

		Impact Size			
		Negligible	Low	Medium	High
Impact Duration	Temporary	Negligible	Low	Low	Medium
	Short Term	Low	Medium	Medium	Medium
	Long Term	Low	Medium	High	High
	Permanent	Medium	Medium	High	High

The whole series of impact evaluations are done to obtain the significance of each hypothetical significant impact being evaluated. The definition of impact significance is presented in **Table III-5** which is a relative ranking of the significance of the impact.

Table III-5 Impact Significance Definitions

Impact Significance	Definition
Negligible Impact	**Insignificant**: The magnitude of the change is almost similar to natural variations
Minor Impact	**Insignificant**: Impact is detected but is not significant
Moderate Impact	**Significant**; impact can be mitigated. The impact should be mitigated where practiable
Major Impact	**Significant**; amenable to mitigation; impact must be mitigated
Critical Impact	Intolerable; impact is not amenable to mitigation; alternatives must be identified to negate the source of the impact

Holistic evaluation of all hypothetical significant impacts on the environmental components/parameters for each type of activity as the source of impact which is obtained from predictions and evaluations of the hypothetical significant impacts is performed using a flow chart of impact. The flow chart is used to determine the correlation (cause-affect) between the source of the impact and the significant impacts on the environmental components/parameters, and between the environmental components / parameters affected by the significant impact, so that every type of activity as a source of impact and the types of impact as key variables which must be managed and monitored through technological, social and institutional approaches can be identified.

After a re-verification or thorough review of the hypothetical significant impacts is conducted through the scoping process in the Terms of Reference as well as based on data collected in the preparation of the ANDAL document, there are several changes (added, eliminated or incorporated) to the environmental parameters that have been considered as hypothetical significant impacts in the Terms of Reference to be environmental parameters in the ANDAL as listed in the following table:

Table III-6 Amendment in the KA ANDAL for the Composition of the ANDAL Document

No	Proposed Activity / Environmental Component	Proposed Activity / Parameter		Description
		ANDAL TOR	Amendment	
Proposed Activity				
1.	Gas Field Appraisal and Exploration Program	In the ANDAL TOR it is part of the Gas Exploitation Activity in the Pre-Construction phase	In this ANDAL document, it is a separate activity from Gas Exploitation Activity (Sub Chapter 1.2.5 - Description of the Proposed Project Activities)	The program is carried out prior to the commencement of gas exploitation activities. According to the impact identification and scoping result in the ANDAL TOR that has been approved by Ministry of the Environment (Book II Appendix I.1 Integrated Activities of The Tangguh LNG Expansion Project), the proposed activity is not a significant impact, but will be managed
Environmental Components				
1.	Air Quality	Light Sightings	Light Emissions	-
2.	Demography	• Migration (mobility) • Population structure • Population growth	Migration (mobility), population structure, population growth (combined)	The demographic parameter is a combination of several population parameters, namely migration changes (mobility), population structure and population growth. Combining these parameters was done considering the data that was analyzed for the three parameters is the same with the analysis results. Thus, the three parameters are discussed as a whole.
3.	Socio-Cultural	The Presence of the Indigenous People	This is part of the demographic impact and impact of acculturation and assimilation	In the analysis of the social impacts, the impact receptor is the local residents without ctaking into account ethnic group and place of origin. Impact on the Indigenous People* is included in the study on demographic parameters and assimilation - acculturation. A study on the indigenous people is specifically written in the Tangguh LNG Social Management which is part of the RKL document and serves as a reference for social programs.
4.		• Assimilation and acculturation • Changes in social norms and values	Assimilation and acculturation combined with changes in social norms and values	Parameters of social norms and values combined with assimilation and acculturation parameters and taking into account the social processes that occur in the villages of the Bintuni Bay occurring simultaneously. Thus, the study on social norms and values is always closely connected to the study on assimilation and acculturation.

No	Proposed Activity / Environmental Component	Proposed Activity / Parameter		Description
		ANDAL TOR	Amendment	
5.		Vulnerable groups	The discussion on vulnerable groups is part of the discussion on socio-economic conditions	Because the location of remote villages and the socio-economic conditions of the people are almost evenly distributed, vulnerable groups (the disabled, elderly and extremely poor) are not discussed separately. Taking into account the communal nature of the communities in the villages, an impact will be felt by everyone whether they are in the vulnerable group or not. Regarding positive impacts, if Tangguh obtains benefits, the residents of the Bintuni Bay already have a mechanism for sharing the benefits.
6.	Education	Access to education	Changes in access to education and public services	Access to education is one of the essential matters that is studied in the ANDAL. However, in addition to education there are also other public services that are needed by the community. Therefore, with the access to public services added to educational access, there is a broader management of the impact.
7.	Socio-Economic	None	A decrease in the income of fishermen	Changes in the income of the people is defined as changes in income to the people in general regardless of occupation. In this context, disturbance to fishing activity only affects the income of fishermen in the area of the activity.

3.1 GAS EXPLOITATION ACTIVITIES

3.1.1 Geophysical-Chemical

3.1.1.1 Noise

- **Environmental Baseline**

  In defining the baseline for noise levels under seawater of the Bintuni Bay, an assessment for noise level was conducted using a comparative study of literature, as shown in **Table III-7**. **Table III-7** shows that the underwater average noise level ranges from 80 dB re 1µPa to 108 dB re 1µPa with a frequency of 8 Hz - 100 Hz. According to studies by Soares *et al.* (2011), high levels of underwater noise is caused by winds, currents and the sounds generated by marine biota.

Table III-7 Reference of Underwater Noise Levels

Source	Location	Noise Level (dB re 1μPa)	Frequency (Hz)
Huang *et al.* (2001)	East China Sea 29	88	102
SVT (2011)	Legendre Island West Seas	101 – 108	40 – 96
	Dixon Island West Seas	99.3 – 114.6	40 – 96
Wilkinshaw (2005)	Norwegian Sea	80	15

Because of no underwater noise levels of the Bintuni Bay available, as a comparison, thus data from the waters of the Dixon Island West Seas is used where the shoreline is similar with the Bintuni Bay shoreline (see **Figure III-2**). Therefore, in analysing the underwater noise levels of the Bintuni Bay, the underwater noise levels of the West Seas of the Dixon Island i.e., 99.3 dB re 1μPa to 114.6 dB re 1μPa at a frequency of 40 Hz - 96 Hz is used to estimate the underwater noise level at Bintuni Bay.

- **Impact Prediction and Evaluation**

  The main receptors of the noise level increase due to production well drilling activity is marine mammals, discussed in Section 3.1.2.1 on Changes in Nekton Diversity (Including Marine Mammals).

3.1.1.2 Sea Water Quality

a. Increase in Total Suspended Solids (TSS)

- **Environmental Baseline**

  According to an environmental baseline survey conducted in July-August 2012 during the dry season and March-April 2013 during the wet season at offshore locations of the Bintuni Bay, TSS concentrations during the dry season ranged from 2 to 19 mg/L and 3 to 30 mg/L during the wet season, which means they still meet the seawater TSS quality standards for marine biota (80 mg/L) in accordance with the Decree of the Minister of the Environment No. 51 Year 2004.

- **Impact Prediction**

  The increase in concentrations of TSS is a result of drilling mud and drill cuttings discharge into the sea from production wells drilling. Drilling mud and drill cuttings that are discharged into the sea are as follows:

  - Water-based mud (WBM) from the final depths and/or WBM that no longer can be used;
  - Drill cuttings from drilling with WBM;
  - Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).

This impact evaluation takes into consideration all the wells to be drilled during the Tangguh LNG Expansion Project that are included in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during initial development, and up to 9 platforms and up to 60 wells to be drilled as part of future development at the Bintuni Bay at different time and location (assuming there will be only one drilling platform in the same time).

Source: http://wikimapia.org

Figure III-2 Location of the West Seas of the Dixon Island, Australia

The initial stage of drilling program will be conducted for 8 years. Several exploration and appraisal wells may also be drilled during this period. Well drilling is performed in stages at each offshore platform. Each platform consists of several wells. The drilling of each well takes place over a period of 3-6 months.

The prediction of impact on TSS that will arise due to the drilling activity are supported by modeling using the Generalized Environmental Modeling System for Surface Waters (GEMSS ®). To predict the dispersion over a greater distance (over 200 m) the suite of hydrodynamic GEMSS (GEMSS-HDM) is applied. The modeling is conducted for the ROA, TTB, WDA, and UBA platforms to represent the overall drilling activity of up to 11 platforms. The depth of the sea at the ROA site is 36 m, 28 m at TTB, 62 m at WDA and 22 m at UBA.

The estimated type and content of the material to be disposed of, the physical properties of the drilling mud and drill cuttings and the duration of discharge is specified in **Table III-8**.

Table III-8 Characteristics of Discharged Materials

Day	Mud (bbls)	Cuttings (bbls)
1	1,500	624.5
2	1,500	624.5
3	1,500	624.5
4	1,500	624.5
5-7	0	0
8	1,500	624.5
9	1,500	624.5
10	1,500	624.5
11-13	0	0
14	1,500	624.5
15	1,500	624.5
16-18	0	0
19	1,500	624.5
20-22	0	0
Total (bbls)	**15,000**	**6,245**

Note: *SBM mud will not be discharged into the sea

Particle size distribution of the drilling mud and drill cuttings is shown in **Table III-9** based on the same values of previous drillings (2007-2009).

Table III-9 Drill Cuttings and Mud Particle Distribution and Size

Drill Cuttings		WBM	
Particle Size (μm)	Volume Fraction (%)	Particle Size (μm)	Volume Fraction (%)
52	2	1	2.2
170	9	1,5	3
450	15	3	8.6
910	18	5	20.2
2,600	16	7,5	9.1
4,400	15	15	20.8
15,000	25	30	19.5
		35	2
		75	11.4
		150	3.3

The total amount of discharge is approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings, with a 26.5 days drilling duration used in the modeling. The density of the drill cuttings is 2,650 kg/m^3 and the density of the drilling mud (WBM) is 1,510 kg/m^3. Modeling is done up to four days after the drilling is completed to determine the extent of the impact (*fate*).

Drilling in ROA

TSS distribution modeling results during drilling in ROA during the dry season is shown in **Figure III-3** and during the wet season in **Figure III-4**.

The maximum increase of TSS concentrations during the wet season and dry season is 3.0 mg/L. The TSS value is reduced to 0.5 mg/L at a radius of 250 m from the disposal site. Sediment thickness is up to 10.1 mm during the wet season and 11.4 mm during the dry season at the disposal site, and will drop to 3 mm at a radius of 250 m from the disposal site.

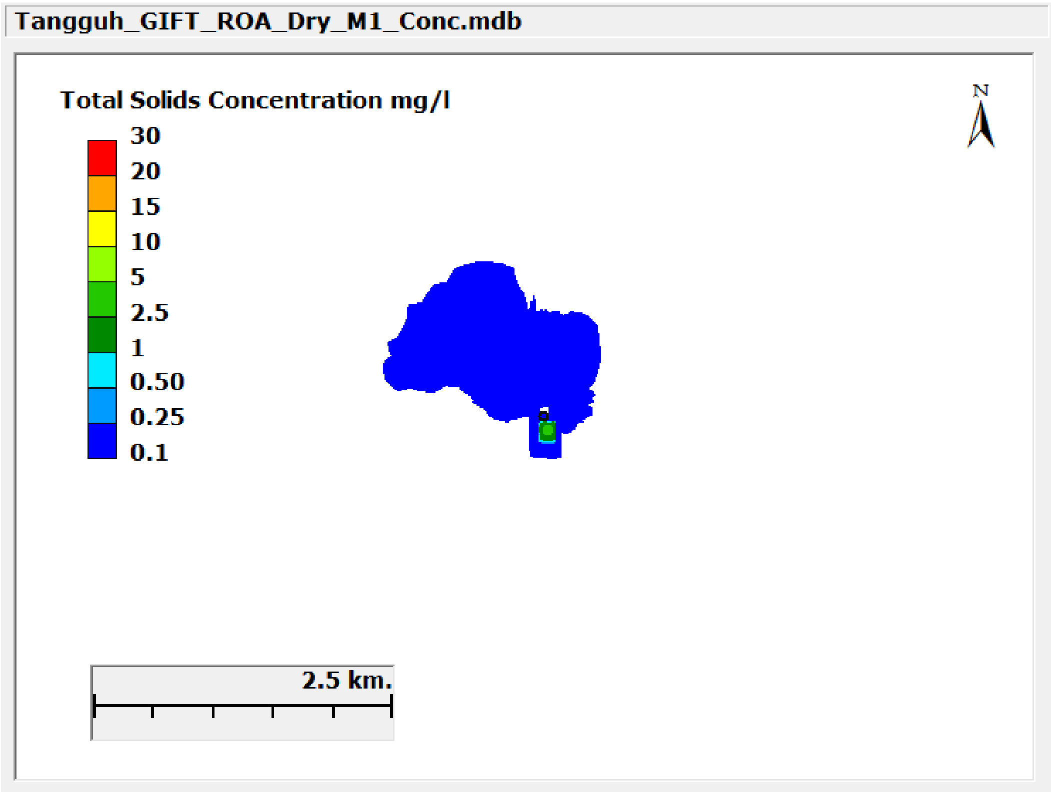


Figure III-3 Maximum Increase in TSS Concentration During Drilling in ROA During the Dry Season

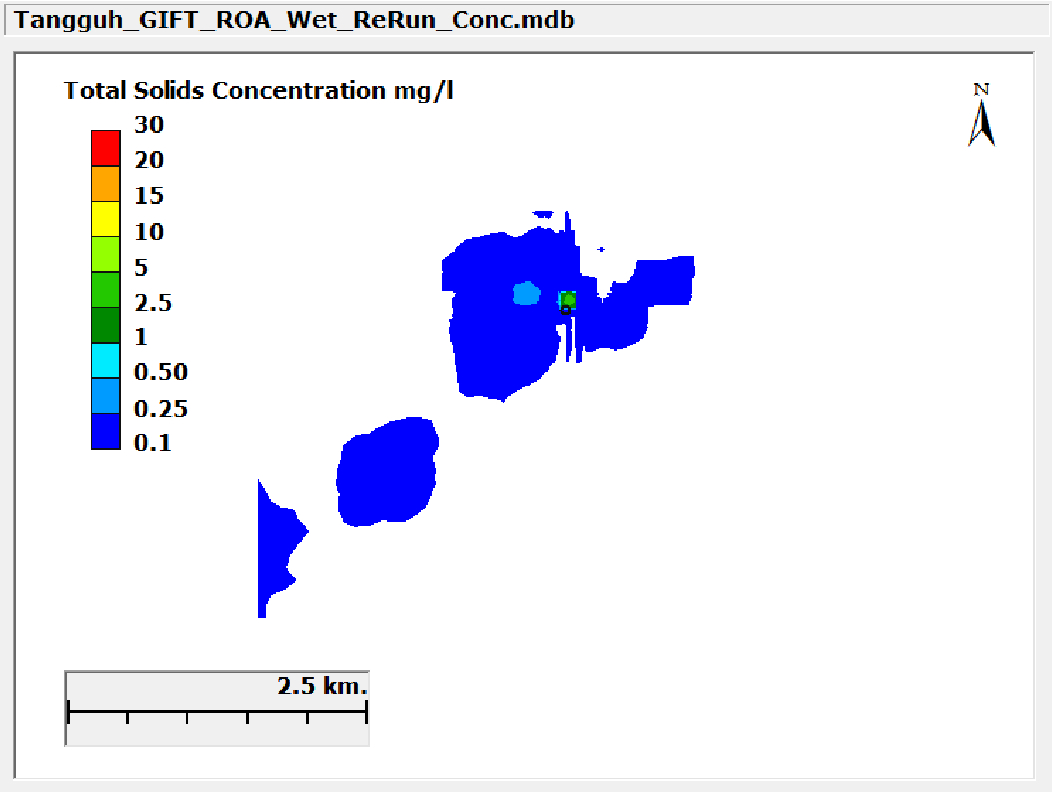


Figure III-4 **Maximum Increase in TSS Concentration During Drilling in ROA During the Dry Season**

Drilling in TTB

TSS distribution modeling results during drilling in TTB during the dry season is shown in **Figure III-5** and during the wet season in **Figure III-6**.

The maximum increase in TSS concentrations during the wet season is 2.0 mg/L, and 7.2 mg/L in the dry season. The TSS value is decreased to 0.25 mg/L at a radius of 250 m from the disposal site during the wet season. Sediment thickness is up to 15 mm during the wet season and 149 mm during the dry season at the disposal site, and will drop to 3 mm at a radius of 150 m from the disposal site.

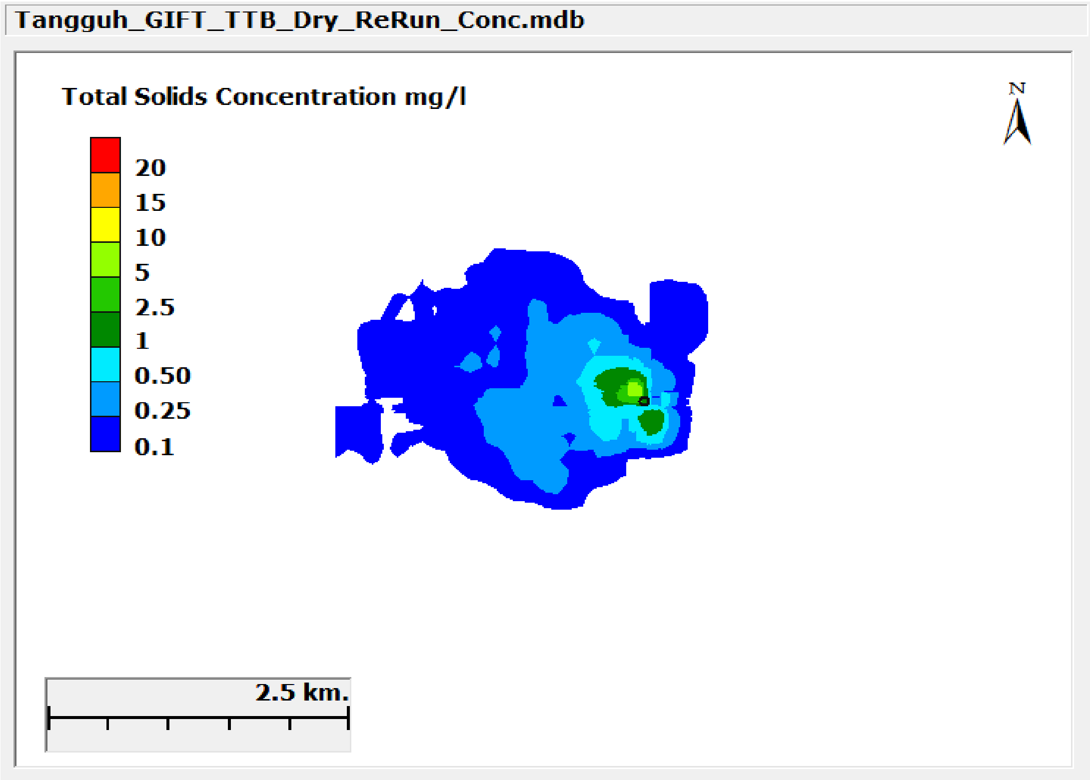


Figure III-5 Maximum Increase in TSS Concentration During Drilling in TTB During the Dry Season

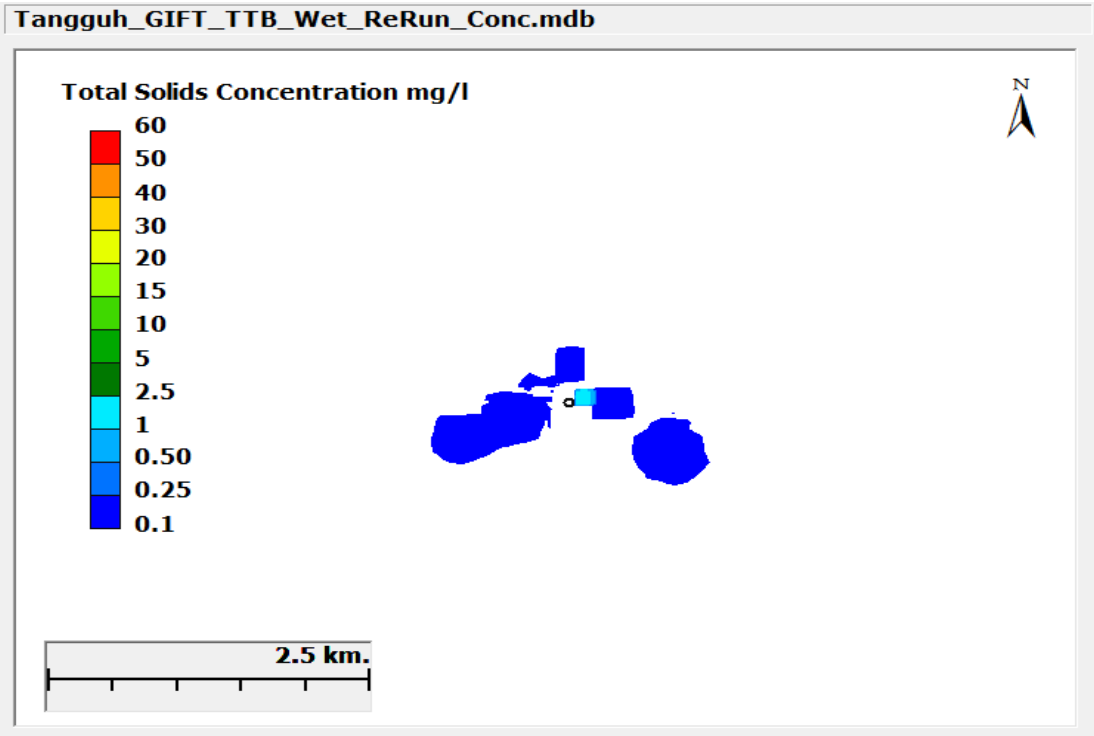


Figure III-6 Maximum Increase in TSS Concentrations During Drilling in TTB During the Wet Season

Drilling in WDA

TSS distribution modeling results during drilling in WDA during the dry season is shown in **Figure III-7** and during the wet season in **Figure III-8**.

The maximum increase in TSS concentrations during the wet season is 6.8 mg/L, and 5.9 mg/L during the dry season. The TSS value is decreased to 0.25 mg/L at a radius of 1.5 km from the disposal site during the wet season. Sediment thickness is up to 7.8 mm during the wet season and 6.3 mm during the dry season at the disposal site, and will drop to 3 mm at a radius of 150 m from the disposal site.

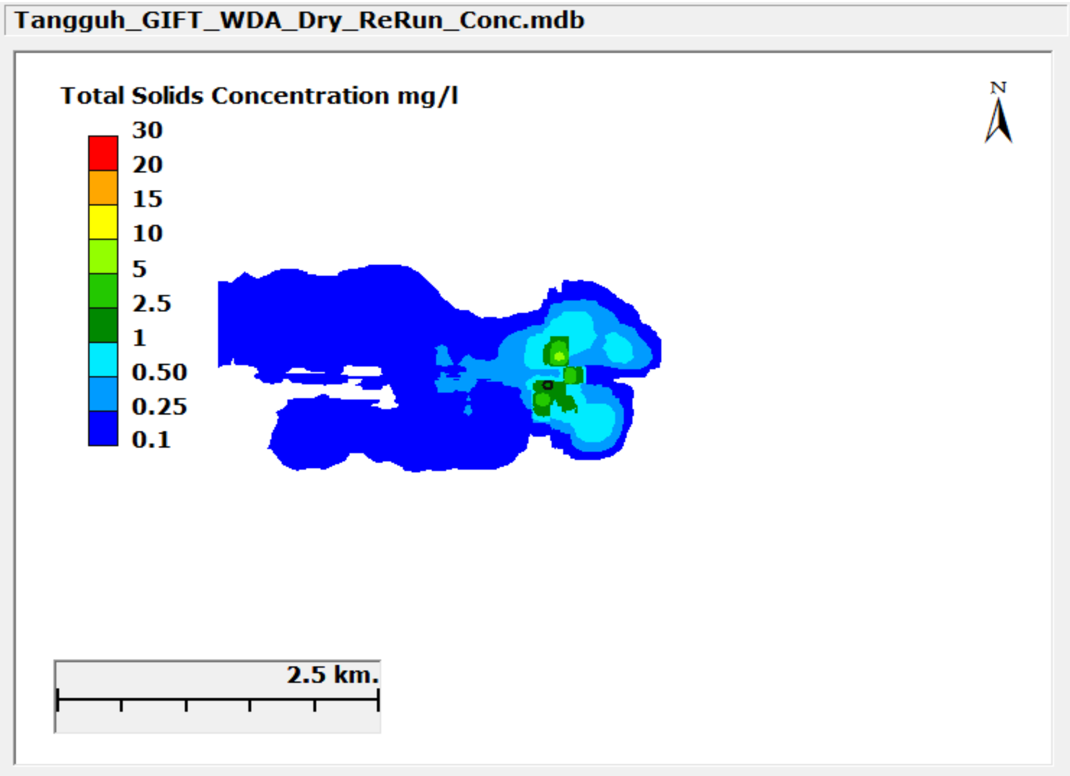


Figure III-7 Maximum Increase in TSS Concentration During Drilling in WDA During the Dry Season

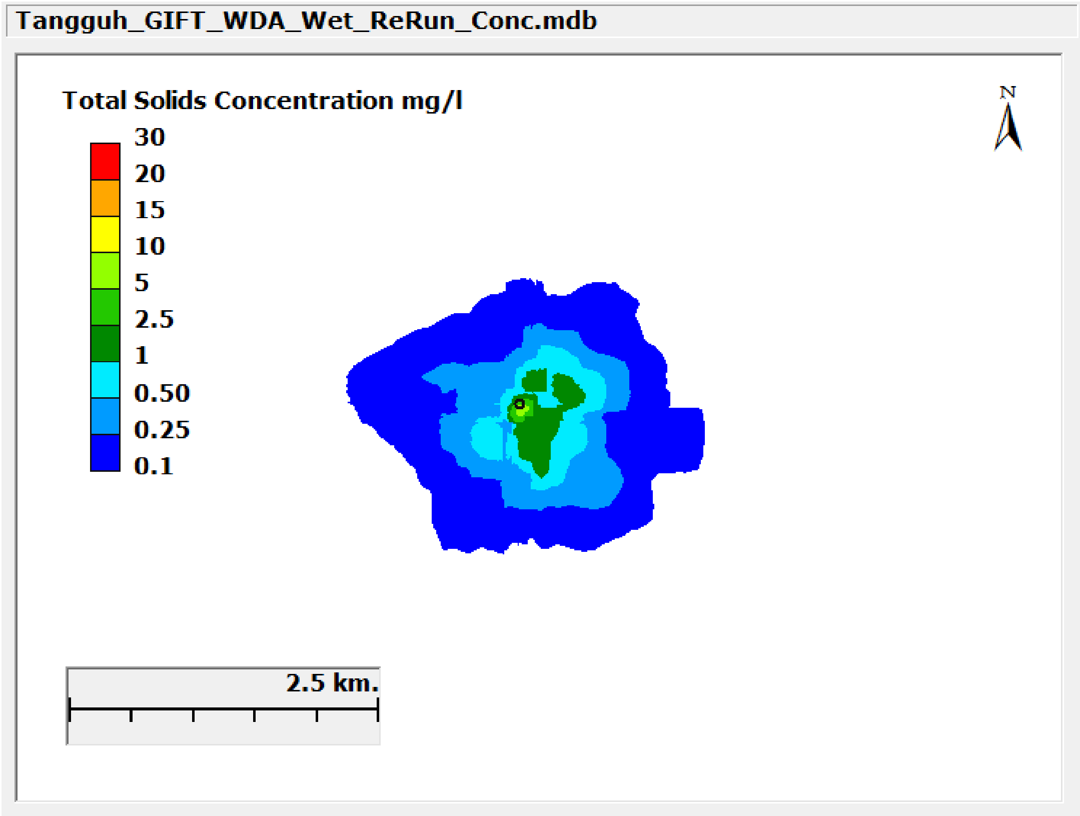


Figure III-8 **Maximum Increase in TSS Concentration During Drilling in WDA During the Wet season**

Drilling in UBA

TSS distribution modeling results during drilling in UBA during the dry season is shown in **Figure III-9** and during the wet season in **Figure III-10**.

The maximum increase in TSS concentrations during the wet season is 21.1 mg/L, and 7.0 mg/L in the dry season. The TSS value is decreased to 5 mg/L at a radius of 500 m and 1 mg/L at a radius of 1 km from the disposal site during the wet season. Sediment thickness is up to 21.2 mm during the wet season and 17.2 mm during the dry season at the disposal site, and will drop to 3 mm at a radius of 150 m from the disposal site.

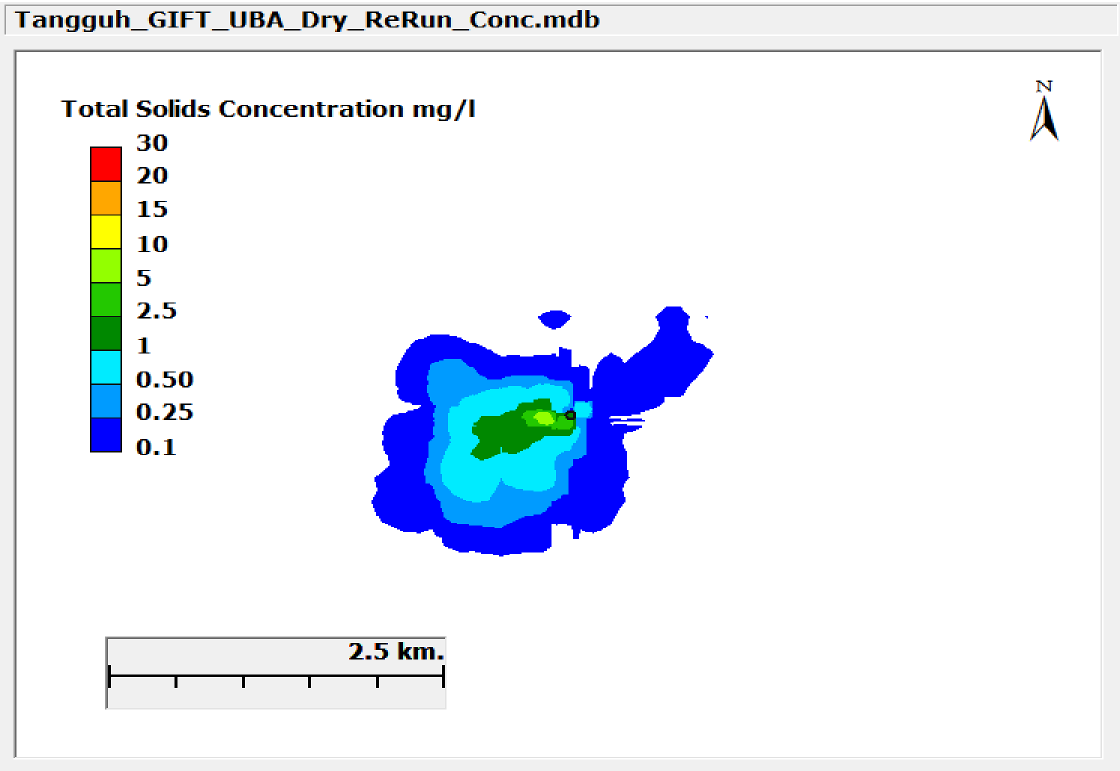


Figure III-9 Maximum Increase in TSS Concentration During Drilling in UBA During the Dry Season

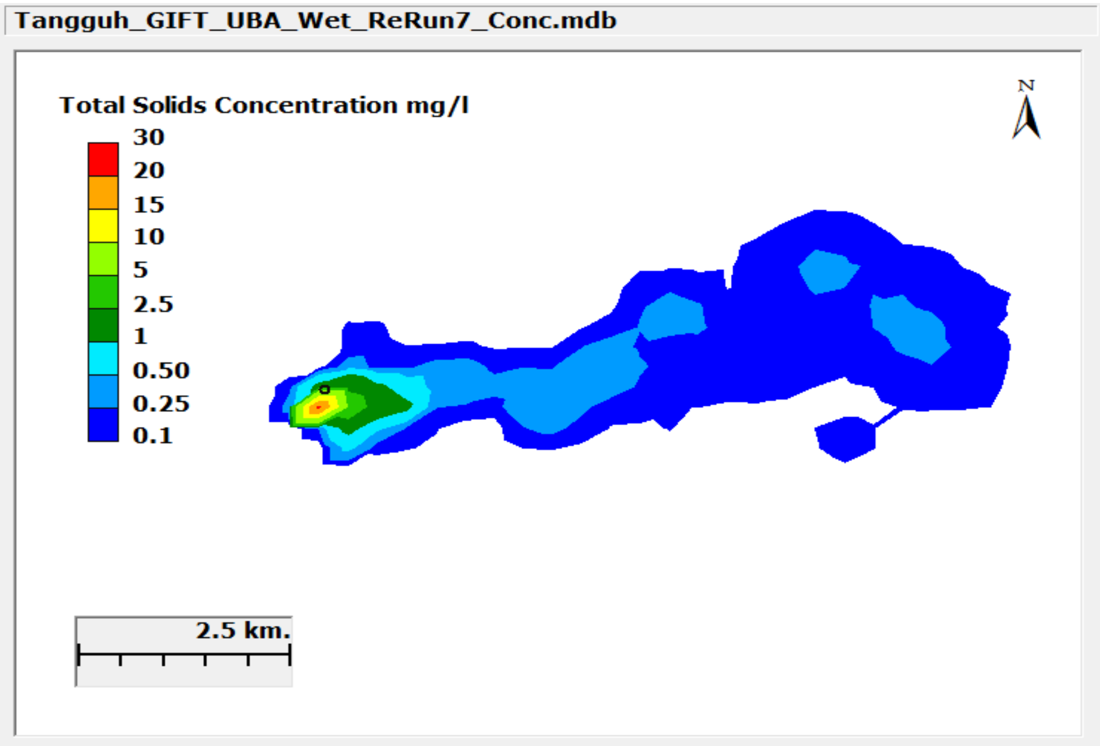


Figure III-10 Maximum Increase in TSS Concentration During Drilling in UBA During the Wet Season

Conclusion

A summary of TSS modeling results around the disposal site can be seen in **Table III-10**. Values shown in the **Table III-10** are the maximum incremental that occur shortly after disposal activity and dissipates quickly in line with the increase in distance from the disposal site. At a distance of 500 m, the increase in TSS concentrations is significantly reduced, and sedimentation is not visible.

Table III-10 Summary of TSS Modeling Results Around the Disposal Site

Scenario	Location	Maximum Increase of TSS (mg/L)	Maximum Sediment Thickness (mm)
ROA Dry Season	Disposal site	3.0	11.4
	Radius 500 m	0.1	0
ROA Wet season	Disposal site	3.0	10.1
	Radius 500 m	0.1	0
TTB Dry Season	Disposal site	7.2	14.9
	Radius 500 m	0.5	0
TTB Wet season	Disposal site	2.0	15
	Radius 500 m	0.1	0
WDA Dry Season	Disposal site	5.9	6.3
	Radius 500 m	0.5	0
WDA Wet season	Disposal site	6.8	7.8
	Radius 500 m	1	0
UBA Dry Season	Disposal site	7.0	17.2
	Radius 500 m	1	0
UBA Wet season	Disposal site	21.1	21.2
	Radius 500 m	5	0

- **Impact Evaluation**

According to modeling results, the discharge of drilling mud and drill cuttings from one well can cause an increase in the concentration in TSS with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the disposal site. Therefore, the concentration of TSS around the disposal site during the dry season ranges from 9.2 to 26.2 mg / L and ranges from 24.1 to 51.1 mg/L during the wet season, which means that it still meets the TSS sea water quality standards for biota (80 mg/L) in accordance with Minister of the Environment Decree No. 51 Year 2004.

Table III-11 Impact Evaluation –Alternative of the Drilling Mud and Drill Cuttings Management (Overboard Discharge) on Increase in TSS Concentrations

<table>
<tr><td rowspan="1">Impact Description</td><td colspan="5">Increase inTSS concentrations due to the overboard discharge of drilling mud and drill cuttings of production well drilling.

The proposed disposal of drilling mud and cuttings is as follows:
- Water-based mud (WBM) from the final depths and / or WBM that no longer can be used;
- Drill cuttings from drilling with WBM;
- Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).

The evaluation of this impact takes into consideration all the production wells to be drilled during the Tangguh LNG Expansion Project that are included in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during the initial development, and up to 9 platforms and 60 production wells drilled as part of future developments in the Bintuni Bay at different time and location (assuming there will be only one drilling platform at a time).

The initial stage of drilling program will be conducted over 8 years. Several exploration and appraisal wells also is likely be drilled during this period.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">The disposal of drilling mud and drill cuttings will increase the concentration of TSS in the sea water around the disposal site in the Bintuni Bay. The increase in TSS is temporary until sedimentation occurs.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Disposal of drilling mud and drill cuttings will directly increase the concentration of TSS in the waters around the disposal site in the Bintuni Bay.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">Each well drilling period usually takes approximately 3 to 6 months. Discharge of drilling mud and drill cuttings is conducted only during the effective drilling time up to a period of 30 days from the total drilling period for one well.

There will be 5 to 10 wells drilled for every platform with an estimated period of 1 to 2 years required for the drilling of these wells.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">According to modeling results, the discharge of drilling mud and drill cuttings from one well can cause a temporary increase in the concentration of TSS with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the disposal site, but generally decreases rapidly to 5 mg/L at a distance of 500 m (UBA scenario). Modelings performed for this AMDAL study are based on normal drilling activity.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">The environmental baseline for TSS concentrations during the dry season at Bintuni Bay offshore locations range from 2 to 19 mg/L and during the wet season ranges from 3 to 30 mg/L.

According to modeling results, the discharge of drilling mud and cuttings from one well can cause a temporary increase in the concentration of TSS with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the disposal site. If the increase in TSS concentration is added to the TSS concentration based on an environmental baseline survey, the TSS concentration at the disposal site during the dry season ranges from 9.2 to 26.2 mg/L and during the wet season ranges from 24.1 to 51.1 mg/L, which means that it meets the TSS sea water quality standards for biota (80 mg/L) in accordance with Minister of the Environment Decree No. 51 of 2004.

At the time of the discharge after drilling activity, TSS rapidly settles, there will be no cumulative distribution of TSS in the wells that have been drilled.</td></tr>
</table>

	Although the ambient water quality criteria for TSS will not be exceeded in each well, considering the overall number of wells to be drilled during the 15 year period of the drilling program, precautionary measures are carried out and the magnitude of the impact is considered 'low'.'				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The Bintuni Bay is a sensitive area considering that the bay is a habitat for marine mammals, reptiles and turtles, sustains local fisheries, and it is also surrounded by mangroves. The receptor of the impact of the increase in TSS concentrations due to the discharge of drilling mud and drill cuttings are plankton (passive organisms) and nekton (active organisms). Plankton in the Bintuni Bay has a high adaptability to the natural fluctuations of TSS. This is shown from the fairly high range of TSS values observed in the Bintuni Bay. Meanwhile, nekton and reptiles may avoid from the drilling mud and cuttings disposal site. Considering that the Bintuni Bay is environmentally sensitive and the ability of the marine biota to avoid the affected areas, the impact receptor sensitivity (plankton and nekton) is considered 'medium'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The severity of an impact can be determined from the magnitude of the impact and the impact receptor sensitivity. Since the magnitude of the impact is 'small' and the impact receptor sensitivity is 'medium', the impact severity is 'medium'.				
Impact Likelihood	**Very low**	**Low**	**Medium**	**High**	
	Considering the total number of wells to be drilled during the entire drilling program, the impact likelihood is categorized as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The combination of a 'medium' impact severity and 'medium' impact likelihood, categorizes the impact significance as 'minor-moderate' and is a significant impact.				

The evaluation result for impact significance indicates the impact of the overboard discharge of drilling mud management has a 'minor-moderate' significance. Therefore the impact is categorized as a '**significant impact**'.

b. Increase in Concentration of Oil and Grease

- **Environmental Baseline**

According to results of the environmental baseline survey conducted in August-September 2012 during the dry season and during April-May 2013 during the wet season in the Bintuni Bay, an oil layer as well as oil and grease parameters were not detected at all offshore sampling locations, during both the wet and dry seasons.

- **Impact Prediction**

Evaluation of this impact takes into consideration all the wells to be drilled during the Tangguh LNG Expansion Project that are included in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during the initial development, and up to 9 platforms and 60 wells drilled as part of future developments at the Bintuni Bay at differing times and locations (assuming there will be only one drilling platform at a time).

Increase in concentrations of oil and grease can occur from the discharge of drill cuttings from the drilling of wells using synthetic based mud (SBM) into the sea. Discharge will be performed only if it fulfills the following criteria: the oil content in the drill cutting is ≤ 6.9% (≤ 69,000 ppm). The residual mud from the synthetic-based mud (SBM) will not be discharged overboard. If oil-based mud (OBM) is used, the drilling mud and drill cuttings will not be discharged overboard.

The impact may occur up to 30 days from the effective drilling period of 3-6 months for each well and 1 to 2 years as a whole considering there will be 5 to 10 wells that will be drilled for each platform.

- **Impact Evaluation**

Environmental baseline data shows that oil and grease in the Bintuni Bay is not detected. Based on the Regulation of the Minister of Energy and Mineral Resources No. 045 Year 2006, the allowed oil content in drill cuttings from drilling activity that may be discharged into the sea is a maximum of 10%. However, according to international guidelines, the oil content in the drill cuttings of synthetic-based mud (SBM), that may be discharged into the sea is a maximum of 6.9%. Therefore, the increased concentrations of oil and fat from the discharge of drill cuttings should be low. However, considering the total number of wells to be drilled during the drilling program, as a precautionary measure, the magnitude of the impact is considered 'medium'.

Table III-12 Impact Evaluation - Alternative of the Drilling Mud and Cuttings Management (Overboard Discharge) on Increase in Oil and Grease Concentrations

Impact Description	*Increase in concentrations of oil and grease due to drilling mud and drill cuttings discharge from well drilling using synthetic based mud (SBM).* *The analysis of this impact was conducted with the provision that the discharge meets the following criteria: the oil content of the drill cuttings is ≤6,9% (≤ 69,000 ppm). The residual* synthetic-based mud *(SBM) will not be discharged overboard. If* oil-based mud *(OBM) is used, the drilling mud and drill cuttings will not be discharged overboard.*				
Impact Nature	**Negative**	**Positive**			
	The discharge of drill cuttings with SBM can temporarily raise the concentrations of oil and grease of the seawater around the disposal site in the Bintuni Bay.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The overboard discharge of drill cuttings from production well drilling activity using SBM can increase the concentrations of oil and grease in the waters around the disposal site. This impact is a 'direct impact'.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact may occur within 30 days from the effective drilling period of 3-6 months for each well and 1 to 2 years as a whole considering there will be 5 to 10 wells that will be drilled for each platform. *The evaluation of this impact takes into consideration all the wells to be drilled during the Tangguh LNG Expansion Project that are included in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during the initial development, and up to 9 platforms and 60 wells drilled as part of future developments at the Bintuni Bay at different time and location (assuming there will be only one drilling platform at a time).*				
	The initial drilling program will be conducted for 8 years. Several exploration and appraisal wells may also be drilled during this period.				

Impact Extent	**Local**	**Regional**	**Global**		
	This impact is a local impact due the slightly increase in concentrations of oil and fat and it is only temporarily dispersed around the disposal site of the drill cuttings.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Environmental baseline data shows that parameters for oil and grease in the Bintuni Bay were not detected. According to the Regulation of the Minister of Energy and Mineral Resources No. 045 Year 2006, the allowed oil content in drill cuttings from drilling activity that can be discharged overboard is a maximum of 10%. *However, according to international guidelines, the oil content in the drill cuttings of synthetic-based mud (SBM), that can be discharged overboard is a maximum of 6.9%. Therefore, the increase in concentrations of oil and grease from the discharge of drill cuttings should be **low**. However, considering the total number of wells to be drilled during the drilling program, as a precautionary measure, the magnitude of the impact is considered '**medium**'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The Bintuni Bay is a sensitive area considering that the bay is a habitat for marine mammals, reptiles and turtles, sustains local fisheries, and it is also surrounded by mangroves. *The receptor impact of the increase in concentrations of oil and grease due to the discharge of drilling mud and drill cuttings at offshore locations are plankton (passive organisms) and nekton (active organisms). The increase in concentration of oil and grease is considered low, therefore plankton will not be affected while nekton and reptiles may avoid the drilling mud and drill cuttings disposal site. Therefore, the impact receptor sensitivity (plankton and nekton) is considered 'low'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The combination of a 'medium' impact magnitude and 'low' impact receptor sensitivity generates a 'low' impact severity.				
Impact Likelihood	**Very low**	**Low**	**Medium**	**High**	
	*Considering the total number of wells to be drilled during the entire drilling program, the impact likelihood is categorized as **'medium'**.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	*The combination of a 'medium' impact severity and 'medium' impact likelihood, categorizes the impact significance as **'negligible-minor'** and is an insignificant impact.*				

Based on the evaluation above, it can be concluded that the significance of the impact from the alternative of drilling mud and drill cuttings management (overboard discharge) on increase in oil and grease concentrations is categorized as 'negligible-minor'. Therefore the impact is categorized as' insignificant'.

3.1.2 Biology

Marine Biota

3.1.2.1 Changes in Nekton Diversity (Including Marine Mammals)

- **Environmental Baseline**

  The predicted impact on all types of nekton is focused on marine mammals because this type of marine biota is sensitive towards disturbances from human activities.

Several studies and monitoring activities of marine mammals at the Bintuni Bay conducted by the Tangguh LNG from 2005 to 2013, recorded the sightings of at least five species of marine mammals, which they are the part of the Cetacea ordo consisting of four species of dolphins and one whale species, namely:

a. Indo-Pacific Humpback Dolphins (*Sousa chinensis*);

b. Spinner Dolphins (*Stenella longirostris*);

c. Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*);

d. Bottlenose Dolphins (*Tursiops truncatus*); and

e. Bryde's Whales (*Balaenoptera brydei*).

Marine mammals are divided into three Ordos, namely *Cetacea, Sirenia,* and *Carnivora*. In tropical waters, especially the waters of the Bintuni Bay, so far, only marine mammals from the Cetacea Ordo have been found which are divided into two groups, namely *Odontocetes* and *Mysticete*. All dolphin species found in the waters of the Bintuni Bay are from the *Odontocetes* group, while the Bryde's whales found are part of the *Mysticete* group.

Based on the frequency of encounters and the types found, *Sousa chinensis* is the species oftenly found, while the species that is most rarely found is the Bryde's whale. As for other species of dolphins such as the Stenella longirostris, Tursiops aduncus and Tursiops truncates, the percentage of sightings is similar.

- **Impact Prediction**

Source of Impact

Impact on changes in nekton diversity (including marine mammals) are due to three activities during the construction phase, namely (1) the transportation and installation of offshore platforms, (2) production wells drilling and (3) overboard discharge of drilling mud and drill cuttings.

Potential Impact

<u>1. Transportation and Installation of Offshore Platforms</u>

The transportation and installation of offshore platforms are scheduled to start in mid 2017 and end in 2018. The estimated total time required for the installation of the platforms is between 3-6 months per platform. Underwater noise impact particularly occurs during the installation of the jacket and deck platform that will take place approximately 6 to 8.

In marine waters, especially where vision becomes a limiting factor, sounds and the sense of hearing becomes a vital factor in the survival of marine mammals. Sounds and hearing are used to maintain unity of the group in social interactions, for echolocation to identify and obtain food, to detect sounds from approaching predators, and also to avoid potentially dangerous situations such as getting hit by an object in the sea (J. Gordon *et al.*, 2004).

Most marine mammals generate and receive sounds. Underwater vocalizations include *Clicking*, vibrational sounds (*Trills*), singing (*Warbles*), whistling (*Whistles*), and vocalizations that resemble the sound of bells (J.Gordon *et al.*, 2004). The *Odontocetes* group is known to communicate at a medium frequency (from 1 kHz to over 20 kHz) with several species performing echolocation at high frequencies (from 20-150 kHz). In contrast, the *Mysticetes* group uses an echolocation system at a low frequency (<10 Hz - <10 kHz) (**Figure III-11**).

Activity from vessels is one of the contributors of underwater noise, especially low-frequency noise, however higher frequency noises can also be generated depending on the size of vessel and the propulsion system used. It is estimated that approximately 85% of the noise of shipping activity is caused by the propulsion system generated by the rotation of the propellers (Barlow & Gentry 2004 in Genesis 2011). The noise generated may mask the sounds of marine mammals.

As shown in **Figure III-11** most of the noise radiated from commercial vessels is below 1 kHz, however noise from smaller vessels with a powerful propulsion system is capable of generating ambient noise at frequencies over 1 kHz (Kipple 2002 in Genesis 2011). These conditions could interfere with marine mammals that emit and receive sounds at a low frequency.

Masking at higher frequencies (1-25 kHz) can occur when vessels are near the group of marine mammals. During these conditions, the *Odontocetes* group, which also operates at the same frequency may experience sound masking due to the noise from the vessels.

Masking can also affect the behavior of marine mammals. Ranging from small effects such as a shift in orientation towards a sound source, to greater effects such as long-term behavioral changes in foraging, navigation and reproductive activities.

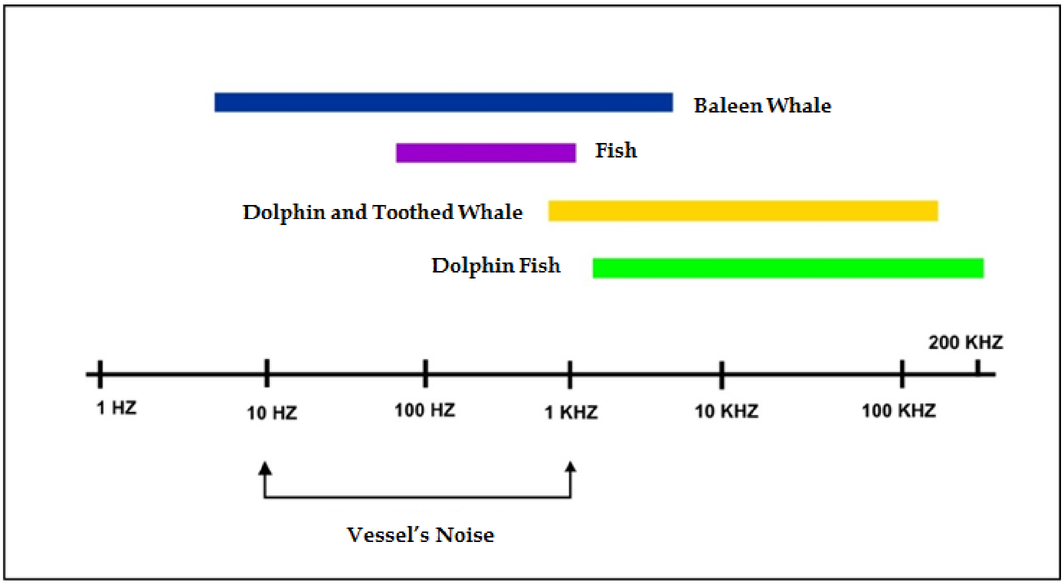


Figure III-11 Frequency Relationships Between Marine Mammal Sounds and Sounds from Shipping (Source: B. Southall, NMFS/NOAA)

In response to vessels, marine mammals may modify or cease producing sounds that they use to communicate, forage, avoid predators, or gain awareness of their environment (Au & Green 2000, Van Parijs & Corkeron 2001). For instance, bottlenose dolphins (Tursiops truncates) have been observed to reduce their calling rates when vessels are approaching.

2. Production Wells Drilling

The evaluation of this impact takes into consideration the Initial Development and Future Developments as part of the scope of the Tangguh LNG Expansion project in this AMDAL study. Initial Developments include the development of two platforms, with up to 13 production wells, 4 infill wells, and 3 option DCRI wells. Future Developments include the development of up to 9 platforms and the drilling of up to 60 wells. This activity will be carried out at different times and locations (with the scenario that there will be only one drilling platform at a time). The initial drilling program is scheduled to begin in mid 2015 and is expected to take approximately 8 years. During this time frame, drilling is not performed continuously at the same location, but for only a period of 3-6 months for each well and a total of 1-2 years for each platform.

Several exploration and delineation/appraisal wells may also be drilled during this period.

Underwater noise from drilling activity is generally generated from the transmission of vibrations from drilling machinery and equipment such as the use of generators, pumps, compressors, drilling machines and the drilling platform itself (Genesis, 2011). The level of the noise generated depends on the specifications of the equipment and the type of platform/drilling platform used in the drilling activity. No studies have been made related to noise generated from the drilling platform using a jack-up system like the one used in Tangguh LNG, however it is estimated that the noise generated will be the same as the noise generated from the drilling platform in **Table III-13**, with a recorded noise of 162 dB (rms) re 1 µPa @ 1m at a frequency of 0.01-10 kHz.

Table III-13 Measurements of Underwater Noise Levels from Several Drilling Platform Types When There is no Drilling Activity

Type of Source	Activity	Hydrophone Depth (m)	Sound Power Measurement (LW)	Bandwidth Measurement kHz	Characteristics	Reference
Converted Freighter	Logging	17	125 dB (rms) re 1µPa@200m	0.02-1	Continuous increasing tones to 1.850 Hz	(Greene 1987)
	Drilling	27	134 dB (rms) re 1µPa@200m	0.02-1	Continuous strong tones at 277 Hz	
Drill Ships - West Novion length 250 m	Drilling	50, 100 & 200	195 dB (rms) re 1µPa@1m	0.001-139	Continuous low frequency at a bandwidth of 100–400 Hz	(Nedwell and Edwards 2004)
Semi-submersible	Active no drilling	110	117 dB (rms) re 1µPa@125m	0.01-10	Continuous low frequency	(McCauley 1998)
	Drilling	110	115 dB (rms) re 1µPa@405m	0.01-10	Tones generated from Drill Strings at a low frequency bandwidth of <70 Hz	
Platform	Drilling, Production and Water Injection		162 dB (rms) re 1µPa@1m	0,01-10	Broadband Noise	(Hannay, *et al*. 2004)

Source : Genesis, 2011

Low noise frequency during drilling activity as shown in the table above is expected to have an impact of noise masking of marine mammals from the Mysticetes group such as the Bryde's Whale found in the Bintuni Bay. For mammals from the Odontocetes group such as dolphins, this acoustic disturbance is considered minor because they operate at a moderate to high frequency of > 1 kHz.

Although studies and observations that have been done show that the Bryde's whale has been seen only at the mouth of the bay, it is possible that the impact of noise masking due to drilling may still exist. The more to the west nearing the mouth of the bay, acoustic disturbances towards marine mammals, especially the Bryde's whale becomes more significant. The drilling site closest to the mouth of the bay is the UBA platform located to the northeast of Kokas.

3. Discharge of Drilling Mud and Drill Cuttings

Drilling of exploitation wells are scheduled to begin in mid 2015 until 2023. During this time frame, drilling is not performed continuously at the same location, but for only a period of 3-6 months for each well and a total of 1-2 years for each platform. Discharge of drilling mud and drill cuttings is performed only during the effective drilling time to a period of 30 days after the total drilling period for one well.

The current plan is drilling of all depth stages (except for the reservoir zone) of production wells using Water Based Mud (WBM), with plans to use Synthetic-Based Mud (SBM) or Oil Based Mud (OBM) for the last phase (reservoir stage). The use of SBM or OBM at an interval of 17.5 "(other than the reservoir zone) is currently being assessed and will depend on the condition of the wellbore.

Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings produced from each well will be discharged into the sea. Drilling mud and cuttings that is discharged into the sea comprises the following:

- *Water-based mud (WBM)* from the final depths and / or WBM that no longer can be used;

- Drill cuttings from drilling with WBM;

- Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).

Discharge of drilling mud and drill cuttings is not expected to cause a significant direct impact on marine mammals, however may potentially cause indirect impacts associated with the availability of food for marine mammals at the disposal site (temporary). Discharge of drilling mud and drill cuttings may cause temporary changes of the water quality at the disposal site, particularly physical changes such as turbidity. The availability of food for marine mammals such as fish, shrimp, etc. may be reduced depending on how far the decline in water quality is as a result of the discharge of the drilling material.

According to modeling results, the discharge of drilling mud and drill cuttings from one well can cause an increase in the concentration of TSS with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the disposal site, but generally decreases to 5 mg/L at a distance of 500 m. Therefore, the potential for the availability of fish, shrimp and other biota as food for marine mammals to be reduced as a result of decreased water quality is small.

As described in **Chapter I Description of the Proposed Activities,** in addition to the option of the discharge of drilling mud and drill cuttings, the Tangguh LNG Expansion Project also considers implementing the option of drilling mud and drill cuttings reinjection (DCRI) in injection wells that will be constructed at each platform or into the annulus of the production wells being drilled. Impact on nekton including marine mammals only occurs for the option of discharge of drilling mud and drill cuttings into the waters of the Bintuni Bay.

- **Impact Evaluation**

All of the three activities mentioned above are expected to have an impact on marine mammals, either directly or indirectly, such as increased noise underwater, the potential for collisions with vessels, and indirect disturbances to the availability of food that can affect the existence of the marine mammals. Physiological changes which include changes in behavior may occur due to underwater acoustic disturbances.

The possibility of mammals colliding with vessels may occur, although to date, throughout the existence of Tangguh LNG, there have been no records of such incidents due to the activities of Tangguh LNG. Some types of marine mammals will move away from the area disturbed by the vessel movement, however some types of marine mammals, especially the Sousa chinensis dolphins will move closer in groups to the movement of the vessel (Erftemeijer, et al. 1989). For current operations, the Tangguh LNG has implemented procedures for the protection of marine mammals, such as the setting of the route and speed of the vessels. This procedure will continue to be applied to the activities of the Tangguh LNG Expansion Project.

Based on the above description, the impact of the transportation and installation of offshore platforms on nekton diversity (including marine mammals) is categorized as 'minor', while the impact of production well drilling, discharge of drilling mud and drill cuttings on nekton diversity (including marine mammals) is categorized as 'moderate'.

Table III-14A Impact Evaluation – Transportation and Installation of Offshore Platforms on Changes in Nekton Diversity (including Marine Mammals)

<table>
<tr><td rowspan="1">Impact Description</td><td colspan="5">Changes in nekton diversity (including marine mammals) due the activities of transportation and installation of offshore platforms.

Offshore platforms will be fabricated and assembled outside the Tangguh LNG project site and the study area. Once fabrication is completed, the platform will be transported by vessel and installed at the proposed location of the production well drilling in the waters of the Bintuni Bay. For the impact evaluation in this AMDAL study, the impacts from the transport of the platform which will be examined are the impacts generated upon entering the Berau/Bintuni Bay up to the platform installation location.

The source of the potential impacts from the transportation and installation of offshore platforms is the waves generated from vessel movement, underwater noise disturbance from vessels and potential collisions of marine mammals with the vessels. This impact is caused mainly by the transport of platforms (approximately 1 week) and the platform jacket and deck installation process that will last approximately 6-8 weeks</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Marine mammals (dolphins and whales) are sensitive to direct disturbances from the movement of vessels in the form of waves generated and the possibility of collisions in addition to the acoustic energy generated by the activity of the transport vessels and disturbances during the installation of the platform jackets and deck that can disrupt the communication and navigation systems of marine mammals, causing them to avoid the area.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">The impact is mainly caused by the transportation of offshore platforms, ranging from the movement of vessels which generate waves and cause possible collisions with marine mammals. Furthermore, the acoustic energy generated by vessels and noise disturbances during the installation of the platform jackets and deck can disrupt the communication and navigation systems of marine mammals.

For the evaluation of the impact in this AMDAL study, the impacts from the transportation of offshore platforms for each platform is evaluated starting from when the vessel carrying the platform that has been assembled enters the Berau/Bintuni Bay until it reaches the platform installation location. The length of time for this transport is estimated to be ± 1 week. For the installation of the offshore platform, the impact of underwater noise primarily occurs during the installation of the platform jackets and deck which is expected to take approximately 6 to 8 weeks.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">Therefore, the impacts associated with the transportation and installation of the platforms are temporary. However, the impacts will reoccur for every platform installation at different locations and times (2 platforms will be constructed during the Initial Development and up to 9 offshore gas platforms will be constructed during Future Development). During the Initial Development and Future Development, the transportation and installation activities for each installation will take place at different time and location (with the scenario that there will only be one offshore platform installation at a time), so that the duration of the impact is 'short term'.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Disturbances to nekton (including marine mammals) may occur within the project area in the vicinity of the platform. There will be no impacts on areas outside the study area.</td></tr>
</table>

<table>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Transportation and installation of the platforms will be supported by approximately 14 vessels consisting of barge transportation, tugboats, support vessels, derrick barges, crew boats, survey vessels, anchor handling tug vessels, and construction barges. It is estimated that 85% of vessel noise is resulted by propeller cavitations (Barlow & Genty 2004 in Genesis, 2011).

A shown in Figure III-11 most of the sound energy radiated from commercial vessels is below 1 kHz, although smaller vessels with a stronger propeller rotation are able to produce a frequency higher than 1 kHz (Kipple, 2002 in Genesis, 2011). Based on environmental baseline studies, it has been described that the marine mammals that are often found in the Bintuni Bay is Sousa chinensis in addition to Stenella longirostris, Tursiops aduncus and Tursiops truncates which are from the Odontecetes group (dolphins and toothed whales) which produce and receive sounds at a frequency of 1 kHz to almost 200 kHz.

Noise generated from the transportation and installation of offshore platforms may mask the sounds of marine mammal activity temporarily. Furthermore, given that the extent of the impact is 'local', and the impact duration is categorized as 'short term', the magnitude of the impact from the transportation and installation of offshore platforms is categorized as 'low'</td></tr>
<tr><td rowspan="2">Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td colspan="2"></td></tr>
<tr><td colspan="5">The impact receptor is nekton (including marine mammals) that are sensitive to acoustic energy however nektons have a high swimming ability and are able to avoid (Au & Gree 20000, Van Parijs & Corkeron 2001). Therefore, the receptor sensitivity is categorized as 'medium'.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Slight</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">With a 'small' impact magnitude and a 'medium' impact receptor sensitivity, the impact severity is categorized as 'medium'.</td></tr>
<tr><td rowspan="2">Impact Likelihood</td><td>Very low</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">The possibility of disturbances to marine mammals resulting from the transportation and installation of offshore platforms is low. Based on current sightings of dolphins that are commonly seen swimming with the vessels or even swimming around the platform.</td></tr>
<tr><td rowspan="2">Impact Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">Based on the above considerations that indicate an impact severity of 'medium' and 'small' impact likelihood, the significance of the impact is categorized as' minor 'and is an insignificant impact.</td></tr>
</table>

Table III-14B Impact Evaluation – Production Wells Drilling and the Overboard Discharge Alternative of Drilling Mud and Drill Cuttings on Changes in Nekton Diversity (including Marine Mammals)

<table>
<tr><td>Impact Description</td><td>Changes in nekton diversity (including marine mammals) as a result of production well drilling and discharge alternatives of drilling mud (WBM) and drill cuttings (WBM and SBM).

<u>Production Wells Drilling</u>
The evaluation of this impact takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL.</td></tr>
</table>

	Initial Development includes the development of two offshore platforms with up to 13 production wells, 4 infill wells and 3 DCRI option wells, while Future Development includes the development of up to 9 offshore platforms and drilling of up to 60 wells. This activity will be carried out at different time and location (assuming there will be only one drilling platform at a time). The Initial Drilling Program will be conducted for 8 years. *Several exploration and delineation/appraisal wells may also be drilled during this period. The potential source of the impact is noise generated from drilling activity.* *<u>Overboard Discharge of Drilling Mud and Drill Cuttings</u>* *In this section, the discharge of drilling mud and drill cuttings consists of the following:* - *Water-based mud (WBM) from the final depth and /or WBM that no longer can be used;* - *Drill cuttings from drilling with WBM;* - *Drill cuttings from drilling with* synthetic-based mud (SBM) *with oil content ≤ 6.9% (≤ 69,000 ppm).* *Overboard discharge has the potential to have an impact on nekton diversity, including a reduced availability of fish, shrimp and other biota which make up the food of marine mammals.*				
Impact Nature	**Negative**	**Positive**			
	Marine mammals (dolphins and whales) are sensitive to noise generated from drilling activity that can disrupt the communication and navigation systems of the marine mammals, causing them to stay away from the area. *Overboard discharge of drilling mud and cuttings will reduce the availability of fish and shrimp which make up the food of marine mammals.*				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	<u>Direct Impact:</u> the overboard discharge of drilling mud (WBM) and drill cuttings (WBM & SBM) will cause a temporary increase in TSS in the vicinity of the discharge point which may further reduce the availability of fish and shrimp which make up the food of marine mammals. *<u>Secondary Impact</u>: the increase in underwater noise from production wells drilling (the impact of increase in underwater noise is described in **Table III-13**)*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	During drilling, the impact will occur up to 30 days from the effective drilling time of 3 to 6 months for each well and 1 to 2 years overall. Likewise for the discharge of drilling mud and drill cuttings which will be performed in conjunction with the drilling activity. Although there will be 5 to 10 wells to be drilled for each platform, the production well drilling activity will be carried out at different time and location (with the assumption that there will only be one drilling platform at a time). *The impact is estimated to last up to 30 days of the effective drilling time.* *Therefore, the impact duration is categorized as 'short term.'*				
Extent of Impact	**Local**	**Regional**	**Global**		
	Disturbances to nekton (including marine mammals) may occur within the project area around the drilling site. There will be no impact on areas outside the study area.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Drilling will be supported by approximately 10 vessels (LCT, support vessels, tugboats, and crew boats). The operation of these ships may also generate waves and underwater noise that may affect marine mammals in the area. *There are no studies yet regarding noise generated from drilling platforms using a jack-up system like that used in the Tangguh LNG Expansion Project, however the estimated noise generated will be similar to the noise generated from the drilling platform as shown in **Table III-13**, where the recorded sound pressure level is 162 dB (rms) re 1 µPa @ 1m at a frequency of 0.01-10 kHz (Genesis, 2011).* *According to modeling results, the discharge of drilling mud and drill cuttings from one well can cause an increase in the concentration of TSS with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the discharge point, but generally decreases rapidly to 5 mg/L at a distance of 500 m. Therefore, the potential for the availability of fish, shrimp and other biota as food for marine mammals to be reduced as a result of decreased water quality is small.*				

	The Bintuni Bay is the habitat of several protected species of marine mammals such as the Sousa chinensis *and* Stenella longirostris *that are sensitive to noise. Noise can cause dolphins and marine mammals behavioral changes, and interfere with navigation and communication. Direct and indirect disturbances will cause the dolphins and marine mammals to avoid the areas with high noise levels such as at the drilling platform.* *However, according to the marine mammal monitoring program that is currently being implemented in Tangguh LNG areas as part of the previous VRA and VRB drillings, the TEAP well exploration drilling as well as other marine mammal monitoring studies and programs in the Bintuni Bay, indicate that marine mammals are often found close to VRA and VRB as well as the drilling platform during well drilling. This indicates that drilling activity does not cause significant disturbances to marine mammals.* *Given that the extent of the impact is 'local', and the impact duration that is categorized as 'short term' and marine mammals that may become familiar with the increased underwater noise, the magnitude of the impact caused by these two activities is categorized as 'medium.'*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact receptor is nekton (including marine mammals) that are sensitive to acoustic energy however nektons have a high swimming ability and are able to avoid the area. Therefore, the receptor sensitivity is categorized as 'medium.'				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	With an impact magnitude of 'medium' and an impact receptor sensitivity of 'medium', the impact severity is categorized as 'high.'				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	The possibility of disturbances to marine mammals resulting from the production well drilling and overboard discharge of drilling mud and drill cuttings is low based on current sightings of dolphins that are commonly seen swimming around the platform during well drilling.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Based on the considerations above that indicate an impact severity of 'high' and a 'low' impact likelihood , the impact significance is categorized as 'moderate' and is a significant impact.				

3.1.2.2 Changes in Nekton Diversity (including Marine Mammals) due to the Existence of Offshore Platforms

- **Environmental Baseline**

In this section the prediction of impacts on all types of nekton is focused on fish.

According to data obtained from field surveys conducted during February - May, 2013, fish catch using fishing gear such as gill nets, bottom trawls and pelagic trawls totaled 2,013. The number of species found were 82 species belonging to 33 families and 10 ordo with most belonging to the *Perciformes* ordo. These conditions can be understood taxonomically because the ordo is composed of many families found in the waters of the world.

- **Impact Prediction**

The existence of offshore platforms is expected to have a positive impact on the diversity of nekton because the jackets can be turned into FADs (*Fish Aggregating Devices*). The platform jackets will be colonized by epibiota which will provide a place to live as well as a source of food for fish. This phenomenon has been studied by Black *et al.*, 1994 in the Australian waters.

At each offshore platform a 'safety exclusion zone' will be implemented for safety purposes and to ensure the production operations are not disrupted. This restricted area also gives an opportunity for aquatic biota, including nekton to thrive so that not only is their diversity increased but also their abundance.

- **Impact Evaluation**

The existence of offshore platforms during the Tangguh LNG operations for the long term and a high impact likelihood categorizes the positive impact resulting in the presence of offshore platforms as 'Moderate'.

Table III-15 Impact Evaluation – Changes in Nekton Diversity on Fish Due to the Existence of Offshore Platforms

Impact Description	*The Existence of Offshore Platforms on Changes to Nekton Diversity* *The platform jackets that can function as FADs so that they can become a habitat for nekton. Another interesting aspect that attracts nekton to the platforms is the illumination especially during night time.*				
Impact Nature	**Negative**	**Positive**			
	Positive Impact: Offshore platforms are illuminated and have a FAD effect that attracts nekton and become a new habitat.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The existence of platforms has a direct impact on the presence of nekton.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will take place for the duration of the operational phase, so it is categorized as a 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The existence of the platform has an impact on nekton within the project area.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	According to data obtained from field surveys conducted during February - May, 2013, fish catch using fishing gear such as gill nets, bottom trawls and pelagic trawls totaled 2,013. The number of species found were 82 species belonging to 33 families and 10 ordo with most belonging to the Perciformes ordo. These conditions can be understood taxonomically because the ordo is composed of many families found in the waters of the world. *There will be 4 to 6 jackets that will function as FADs. The light from the platform at night will attract nekton to approach the platform area. The jackets can serve as breeding and feeding grounds for several species of fish that will indirectly enrich the fish population in the surrounding area and increase the catch of fishermen. Therefore, the impact magnitude is 'low'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Nekton are sensitive to illumination and attracted to FADs.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Because the impact magnitude is 'small' and the impact receptor sensitivity is 'high', the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	FADs as new habitats and illumination that attracts nekton is likely to occur. Therefore, the likelihood of the impact is categorized as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the impact severity is 'medium' and impact likelihood is 'high', then the impact significance is categorized as 'moderate' and is a significant impact.				

3.1.2.3 Decrease in Benthos Abundance

- **Environmental Baseline**

According to environmental baseline data of benthos during the dry season (2012), the abundance of benthos found at each observation station in the Bintuni Bay highly varies with a range of 0 to 735 ind/m^2. During the dry season, at several locations such as OS-02, OS-05, OS-13 and OS-14, benthos is not found. These conditions differ during the wet season where there is a lower abundance and smaller range, i.e. 8 to 260 ind/m^2.

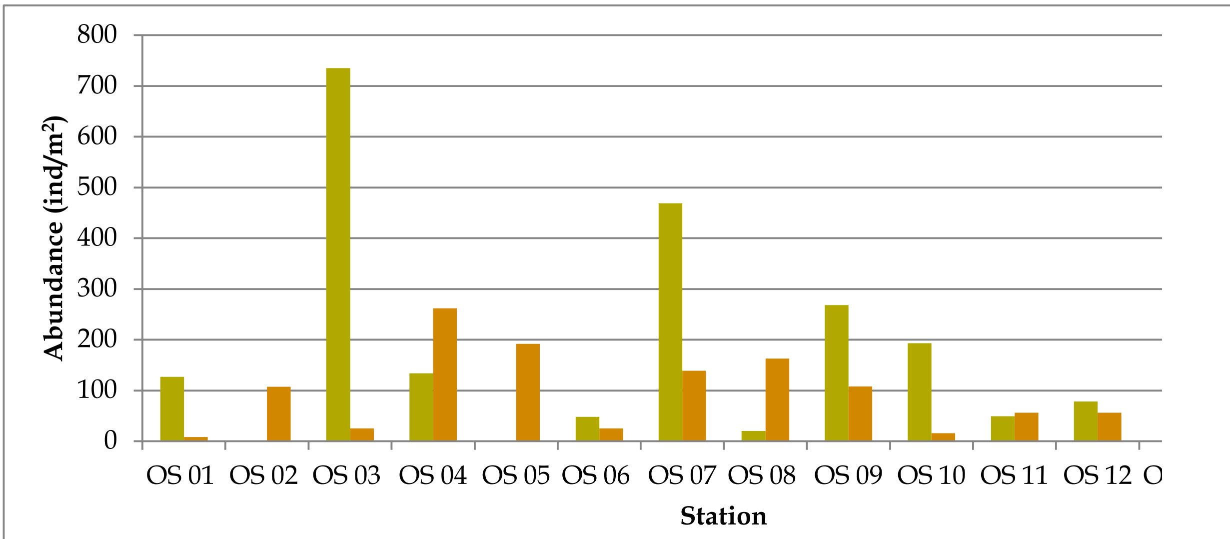
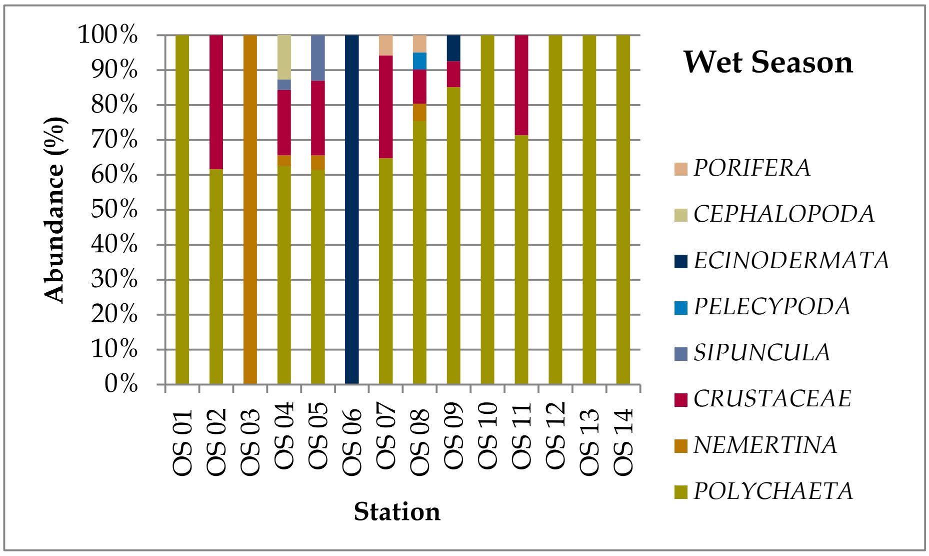


Figure III-12 Benthos Abundance Around the Drilling Site during the Dry and Wet seasons

Generally, the dominant species belong to the *Polychaeta* and *Crustacea* classes. However, during the dry season at OS-03 the dominant species originate from the *Nemertina* class and at OS-06 from the *Echinodermata* class. The *Polychaeta* are a class of marine worms measuring 5-10 cm with a diameter of 2-10 mm. Several species of Polychaeta live in the seabed. They drill/dig holes to live in.

Crustaceans occupy different types of coastal waters, such as sandy, rocky and muddy shores. The species that are found in all three types of shores differ according to the abilities of each species to adjust to the physical-chemical conditions of the waters (Nybakken, 1992).



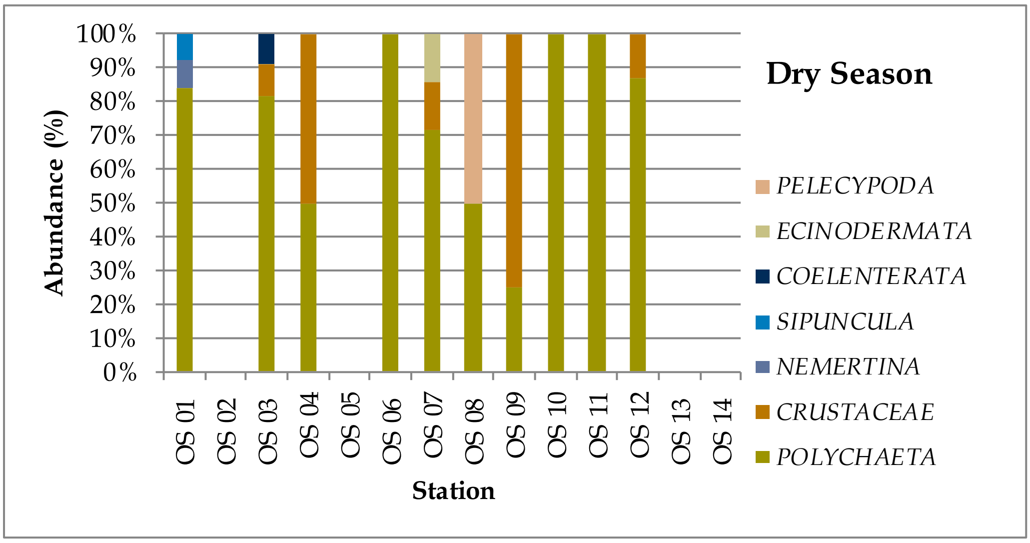


Figure III-13 Percentages of Benthos Classes (%) at Each Observation Station During the Dry and Wet seasons

- **Impact Prediction**

  The evaluation of this impact takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study. Two offshore gas platforms (ROA and WDA) will be built during the Initial Stage Development, and an addition of up to nine platforms will be built as part of the Future Development.

  The first phase drilling of exploitation wells is expected to begin around mid 2015 until 2023. During this period, drilling will not be performed continuously at the same location, but only for a period of 3-6 months for each well and a total of 1 -2 years for each platform. Disposal of drilling mud and cuttings is only done during the effective drilling time and up to 30 days from the total drilling period for one well.

The current plan is drilling of all depth stages (except for the reservoir zone) of production wells using Water Based Mud (WBM), with plans to use Synthetic-Based Mud (SBM) or Oil Based Mud (OBM) for the last phase (reservoir stage). The use of SBM or OBM at an interval of 17.5 "(other than the reservoir zone) is currently being assessed and will depend on the condition of the wellbore.

Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings produced from each well will be overboard discharged. The drilling mud and drill cuttings to be overboard discharged comprises the following:

- *Water-based mud* (WBM) from the final depths and/or WBM that no longer can be used;
- Drill cuttings from drilling with WBM;
- Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).

The discharge of drilling mud and drill cuttings potentially increase the TSS and turbidity of the waters around the discharge point of the drilling mud and drill cuttings in the Bintuni Bay. The increase in turbidity may affect producer organisms particularly, *Phytoplankton*. The increase in TSS will be directly proportional to the increase in turbidity of the waters that can hinder the maximum penetration of sunlight into the waters. This may disrupt the photosynthesis process of *Phytoplankton* and in worst cases can hinder the food production process and will lead to death. The reduction of producer organisms can have a secondary impact of a reduced food supply of organisms higher on the food chain, namely *Zooplankton* which are highly dependent on Phytoplankton and may be affected indirectly.

According to modeling results for the discharge of drilling mud and drill cuttings using the *Generalized Environmental Modeling System for Surface Waters* (GEMSS®), as described in section 3.1.1.2., the discharge of drilling mud and drill cuttings from one well can increase the concentration of TSS temporarily to a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the discharge point. Thus, the concentration of TSS around the discharge point during the dry season ranges from 9.2 to 26.2 mg/L and ranges from 24.1 to 51.1 mg/L during the wet season, which means they still meet the seawater TSS quality standards for marine biota (80 mg/L) according to the Regulation of Minister of the Environment No. 51 of 2004.

At the time of discharge after drilling activity, the TSS is quickly dispersed, there will be no accumulation of TSS around the disposal sites.

- **Impact Evaluation**

According to modeling results for the discharge of drilling mud and drill cuttings, the maximum thickness of sediment at each drilling site differs, ranging from 10.1 - 11.4 mm in ROA, 14.9 - 15 mm in TTB, 6.3 to 7.8 mm in WDA and 17.2 - 21.2 mm in UBA around the discharge point. The thickness of the sediment is reduced until it becomes zero at a maximum distance of 500m from the drilling site. The condition is temporary due to the hydrodynamic conditions that cause the thickness of the sediment to continually thin out. Evaluation of the impacts from the discharge of drilling mud and drill cuttings can be seen in greater detail in **Table III-16**.

Sedimentation rates at the discharge point will affect the aquatic biota, such as benthos. Benthos groups that dominate the bottom waters of the Bintuni Bay belong to the *Polychaeta* and *Crustacea* groups. *Polychaeta* live in the bottom substrate at depths of up to 150 mm. Thus they are estimated to have a low sensitivity to the effects of sedimentation at the bottom surface waters. *Crustacea* which is mostly composed of the *Epifauna* group is estimated to be more sensitive to the effects of sedimentation, however crustaceans have a high regenerative ability, so that their recovery will be relatively quick after exposure to the impact.

Recovery of benthic organisms either *Infauna* or *Epifauna* is relatively quick. The recovery time depends on the composition of the sediment in the environment, the type of benthic organism, and also the composition of the drilling mud and drill cuttings that are discharged. The potential impacts associated with the discharge of drilling mud and drill cuttings is estimated to be temporary.

Based on the description above, the significance of the impact of the discharge of drilling mud and drill cuttings into the sea on changes to the abundance of benthos is categorized as 'negligible-minor'.

Table III-16 Impact Evaluation – The Overboard Discharge Alternative of Drilling Mud and Drill Cuttings on Changes in Benthos Abundance

Impact Description	*The evaluation of this impact takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study. Two offshore gas platforms (ROA and WDA) will be built during the Initial Development, and an addition of up to nine platforms will be built as part of Future Development plans.* *The current plan is drilling of all depth stages (except for the reservoir zone) of production wells using Water Based Mud (WBM), with plans to use Synthetic-Based Mud (SBM) or Oil Based Mud (OBM) for the last phase (reservoir stage). The use of SBM or OBM at an interval of 17.5 "(other than the reservoir zone) is currently being assessed and will depend on the condition of the wellbore.* *Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings is expected to be discharged during normal drilling activity for each well.*			
	During this initial stage, the discharge of drilling mud and cuttings will consist of the following: - Water-based mud (WBM) *from the final depths and / or WBM that no longer can be used;* - *Drill cuttings from drilling with WBM;* - *Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).* *Overboard discharge may have an impact on benthos abundance.*			
Impact Nature	**Negative**	**Positive**		

	Drilling mud and drill cuttings will increase sedimentation at the seabed that will disturb benthos communities. Drilling mud and drill cuttings will disturb benthos habitats.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Drilling mud and drill cuttings have a direct impact on benthos due to increase in sedimentation on the seabed.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	During drilling, the impact duration will be for 30 days from the effective drilling time of 3 to 6 months for each well and approximately 1 to 2 years for one platform considering there will be 5 to 10 wells that will be drilled for each platform. *This evaluation takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during the Initial Development, and up to 9 platforms, with up to 60 production wells to be drilled as part of Future Development in the Bintuni Bay at different time and location (assuming there will only be one drilling platform at a time).*				
Impact Extent	**Local**	**Regional**	**Global**		
	According to modeling results for the discharge of drilling mud and drill cuttings, the maximum thickness of sediment on the seabed is 21.2 mm at the drilling site and the thickness of the sediment will be reduced to 0 at distances of up to 500 m from the drilling site. This model is based on normal activity.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The abundance of benthos found at each observation station within the Bintuni Bay highly varies with a range of 0 to 735 ind/m^2. During the dry season, at several locations, benthos is not found. These conditions differ during the wet season where there is a lower abundance and smaller range, i.e. 8 to 260 ind/m^2. *Generally, the dominant species belong to the Polychaeta and Crustacea classes. The Polychaeta are a class of marine worms measuring 5-10 cm with a diameter of 2-10 mm. Several species of Polychaeta live on the seabed. Crustaceans occupy different types of coastal waters, such as sandy, rocky and muddy coasts.* *According to modeling results for the discharge of drilling mud and cuttings, the maximum thickness of sediment at each drilling site differs, ranging from 10.1 - 11.4 mm in ROA, 14.9 - 15 mm in TTB, 6.3 to 7.8 mm in WDA and 17.2 - 21.2 mm in UBA around the discharge point. The thickness of the sediment is reduced until it becomes zero at a maximum distance of 500m from the disposal site. The condition is temporary due to the hydrodynamic conditions that cause the thickness of the sediment to continually thin out.* *Viewing from the extent of the impact that is categorized as' local 'and the modeling results of sedimentation at the discharge areas of drilling mud and drill cuttings, as well as the nature of the dominant benthos organisms in the waters of the Bintuni Bay that are not sensitive to sedimentation, the magnitude of the impact caused by this activity is categorized as 'medium.'*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Benthos biota found in the vicinity of the well is dominated by Polychaeta *and* Crustaceae. *Polychaeta live in the bottom substrate at depths of up to 150 mm. Thus they are estimated to have a low sensitivity to the effects of sedimentation at the bottom of surface waters. Crustacea which is mostly composed of the Epifauna group is estimated to be more sensitive to the effects of sedimentation, however crustaceans have a high regenerative ability, so that their recovery will be relatively quick after exposure to the impact.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Because the impact magnitude is 'medium' and the impact receptor sensitivity is 'low', the impact severity is 'low.'				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Taking into consideration the total number of platforms and wells to be drilled during the drilling program, the impact likelihood is categorized as 'medium'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*Because the impact severity is 'low' and the impact likelihood is 'medium', the impact significance is categorized as 'negligible-minor' and is an insignificant impact.*

3.1.2.4 Decrease in Plankton Abundance

- **Environmental Baseline**

Phytoplankton abundance during the dry season ranges from 4 x 10^6 cells/m^3 to nearly 16 x 10^7 cells/m^3, while during the wet season it ranges from 0.6 x 10^6 to 17 x 10^6 cells/m^3.

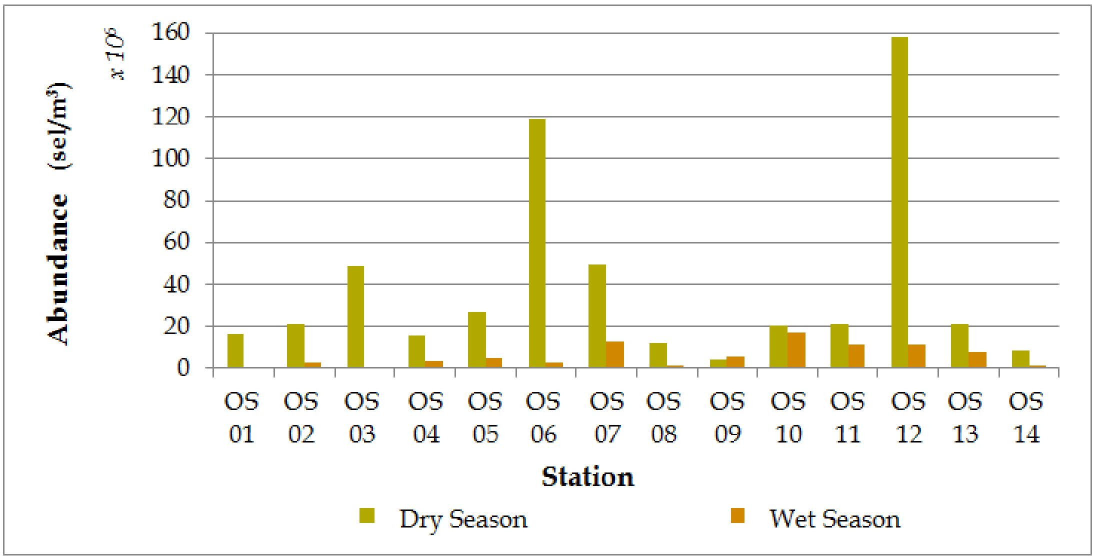


Figure III-14 Phytoplankton Abundance Around the Drilling Site During the Dry and Wet seasons

The dominant species found belong to the *Cyanophyceae* and *Bacillariophyceae* classes. Phytoplankton found from the *Cyanophyceae* class only originate from the *Trichodesmium* genus, while phytoplankton found from the *Bacillariophyceae* class originate from several genera, namely *Chaetoceros, Hemiaulus, Lauderia, Leptocylindus, Nitchia, Phizosolenia, Thalassionema, Tahalassiosira* and *Thalassiothrix*.

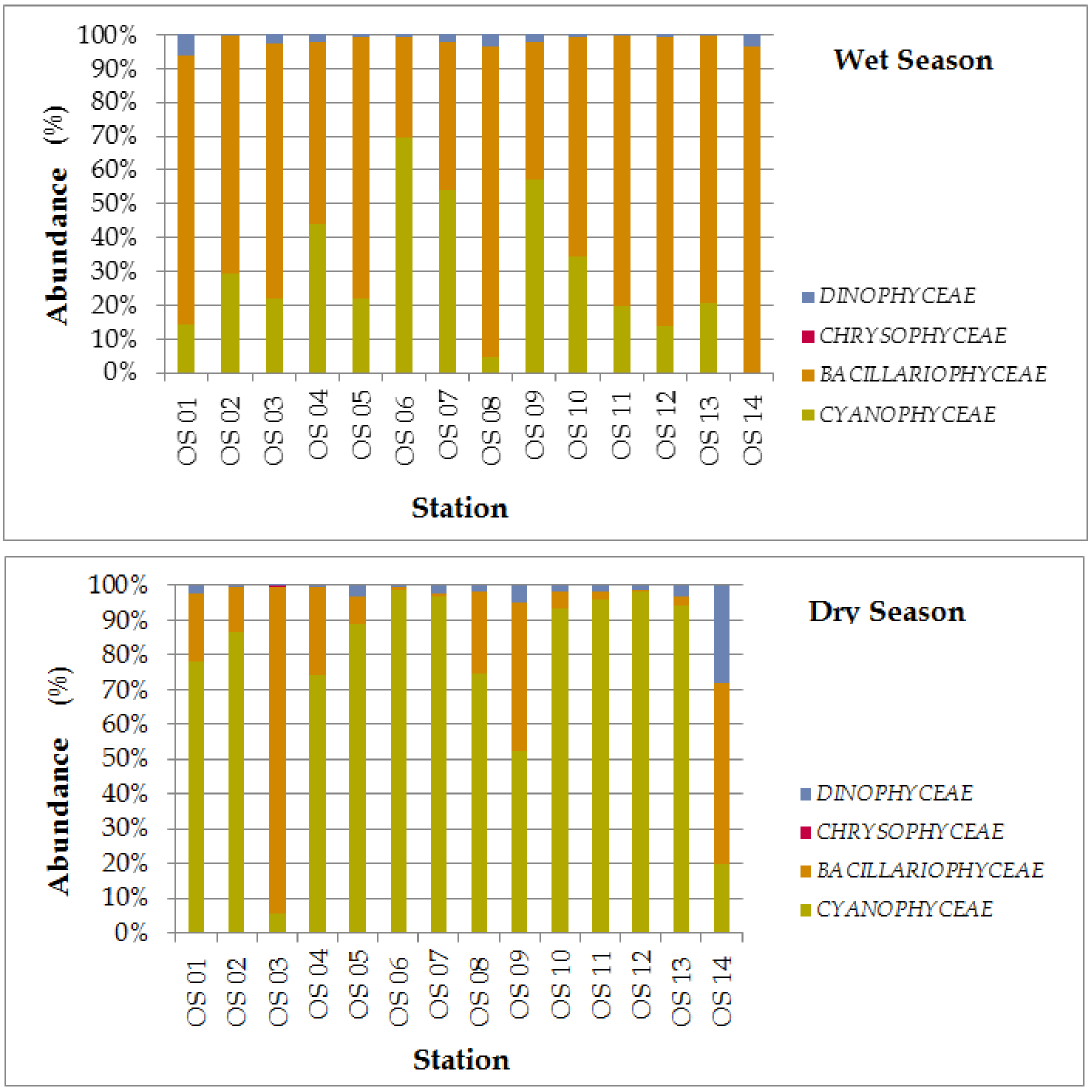


Figure III-15 Percentages of Abundance (%) of Phytoplankton Classes at Each Observation Station During the Dry and Wet seasons

- **Impact Prediction**

The evaluation of this impact takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study. Two offshore gas platforms (ROA and WDA) will be built during the Initial Development, and an addition of up to nine platforms will be built as part of the Future Development plans.

The first phase drilling of exploitation wells is expected to begin around mid 2015 until 2023. During this period, drilling will not be performed continuously at the same location, but only for a period of 3-6 months for each well and a total of 1 -2 years for each platform. Discharge of drilling mud and drill cuttings is only done during the effective drilling time and up to 30 days from the total drilling period for one well.

The current plan is drilling of all depth stages (except for the reservoir zone) of production wells using Water Based Mud (WBM), with plans to use Synthetic-Based Mud (SBM) or Oil Based Mud (OBM) for the last phase (reservoir stage). The use of SBM or OBM at an interval of 17.5 "(other than the reservoir zone) is currently being assessed and will depend on the condition of the wellbore.

Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings produced from each well will be overborad discharged. The drilling mud and cuttings to be overboard discharged comprises the following:

- *Water-based mud* (WBM) from the final depths and/or WBM that no longer can be used;

- Drill cuttings from drilling with WBM;

- Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm)..

The discharge of drilling mud and drill cuttings will increase the TSS and turbidity of the waters around the discharge point in the Bintuni Bay. The increase in turbidity may affect producer organisms particularly, *Phytoplankton*. The increase in TSS will be directly proportional to the increase in turbidity of the waters that can hinder the maximum penetration of sunlight into the waters. This may disrupt the photosynthesis process of *Phytoplankton* and in worst cases can hinder the food production process and will lead to death. The reduction of producer organisms can have a secondary impact of a reduced food supply for organisms higher on the food chain, namely *Zooplankton* which are highly dependent on Phytoplankton and may be affected indirectly.

According to modeling results for the disposal of drilling mud and drill cuttings using the *Generalized Environmental Modeling System for Surface Waters* (GEMSS®), as described in section 3.1.1.2., the discharge of drilling mud and drill cuttings from one well can increase the concentration of TSS temporarily to a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the discharge point. Thus, the concentration of TSS around the discharge point during the dry season ranges from 9.2 to 26.2 mg/L and ranges from 24.1 to 51.1 mg/L during the wet season, which means they still meet the seawater TSS quality standards for marine biota (80 mg/L) according to the Regulation of Minister of the Environment No. 51 of 2004.

At the time of discharge after drilling activity, the TSS is quickly dispersed, there will be no accumulation of TSS around discharge point.

- **Impact Evaluation**

The increase in TSS in the waters will affect the aquatic biota, such as plankton. Looking at the natural conditions of TSS in the Bay and the types of plankton identified, the type of plankton found in the waters of the Bintuni Bay is estimated to have a high adaptability to water conditions with high TSS. Within a wide range of TSS values, plankton abundance is still high. Furthermore, the location with the increase in TSS according to modeling results, show relatively low values with a localized distribution only at the discharge point of the drilling mud and drill cuttings and the surrounding area.

Based on the description above, the significance of the impact of the overboard discharge of drilling mud and cuttings on changes to the abundance of plankton is categorized as 'negligible-minor'.

Table III-17 Impact Evaluation – Overboard Discharge Alternative of Drilling Mud and Cuttings on Changes in Plankton Abundance

<table>
<tr><td>Impact Description</td><td colspan="5">The evaluation of this impact takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study. Two offshore gas platforms (ROA and WDA) will be built during the Initial Development, and an addition of up to nine platforms will be built as part of the Future Development plans.

The current plan is drilling of all depth stages (except for the reservoir zone) of production wells using Water Based Mud (WBM), with plans to use Synthetic-Based Mud (SBM) or Oil Based Mud (OBM) for the last phase (reservoir stage). The use of SBM or OBM at an interval of 17.5 "(other than the reservoir zone) is currently being assessed and will depend on the condition of the wellbore.

Approximately 15,000 bbls (1,900 m^3) of drilling mud and 6,000 bbls (960 m^3) of drill cuttings is expected to be discharged during normal drilling activity for each well.

During this stage, the discharge of drilling mud and drill cuttings will consist of the following:
- Water-based mud (WBM) from the final depths and / or WBM that no longer can be used;
- Drill cuttings from drilling with WBM;
- Drill cuttings from drilling with synthetic-based mud (SBM) with oil content ≤ 6.9% (≤ 69,000 ppm).

Overboardischarge may have an impact on plankton abundance.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">The overboard discharge of drilling mud and drill cuttings) will temporarily increase the turbidity of the water, blocking sunlight which may disrupt the process of photosynthesis of phytoplankton. A secondary impact may also occur to the Zooplankton group with the reduced food supply due to the reduced abundance of Phytoplankton.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Changes in the abundance of plankton is a secondary impact of the increase in TSS and turbidity from the overboard discharge of drilling mud and cuttings.</td></tr>
</table>

Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will last for 30 days from the effective drilling time of 3 to 6 months for each well and approximately 1 to 2 years overall for one platform considering there will be 5 to 10 wells that will be drilled for each platform. *This evaluation takes into consideration the Initial Development and Future Development as part of the scope of the Tangguh LNG Expansion Project in this AMDAL study, which includes two platforms and up to 13 production wells, 4 infill wells, and 3 DCRI option wells that are drilled during the initial development, and up to 9 platforms and 60 wells to be drilled as part of future development at the Bintuni Bay at different times and locations (assuming there will be only one drilling platform at a time).* *The initial drilling program will last approximately 8 years. Several exploration and appraisal wells may also be drilled during this period.*				
Impact Extent	**Local**	**Regional**	**Global**		
	According to modeling results, the discharge of drilling mud and cuttings from one well can cause an increase in the concentration of TSS temporarily with a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the discharge point, but generally decreases rapidly to 5 mg/L at a distance of 500 m (UBA scenario). Modelings conducted for this AMDAL study are based on normal drilling activity.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Environmental baseline studies for marine biology show that Phytoplankton abundance is dominated by the Cyanophyceae and Bacillariopycheae genera with an abundance during the dry season that range from $4x10^{6}$ *cells/*m^{3} *to* $16x10^{7}$ *cells/*m^{3}*, and <* $2x10^{7}$ *cells/*m^{3} *during the wet season.* *According to modeling results, the discharge of drilling mud and drill cuttings from one well can increase the concentration of TSS temporarily to a maximum of 21.1 mg/L during the wet season and 7.2 mg/L during the dry season at the disposal site. If this increase in concentration is added to the TSS concentrations according to the environmental baseline survey, the TSS concentration values obtained around the disposal site during the dry season ranges from 9.2 to 26.2 mg/L and a range of 24.1 to 51.1 mg/L during the wet season, which means they still meet the sea water TSS quality standards for marine biota (80 mg/L) according to the Regulation of Minister of the Environment No. 51 of 2004.* *At the time of disposal, after drilling activity, the TSS is quickly dispersed, there will be no accumulation of TSS around the disposal site.* *However, considering the total number of wells to be drilled as part of the Initial Development and Future Development and the duration of the entire drilling program, as a precautionary measure, the magnitude of the impact is categorized as 'medium.'*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The type of plankton found in the Bintuni Bay is estimated to have a high adaptability to the natural fluctuations of TSS. This is demonstrated by the high range of natural TSS values observed in the Bintuni Bay. Thus, the impact receptor sensitivity is considered 'low.'				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	A 'medium' impact magnitude and 'low' impact receptor sensitivity, results in a 'low' impact severity.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Taking into consideration the total number of platforms and wells to be drilled during the drilling program, the impact likelihood is categorized as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the impact severity is 'low' and the impact likelihood is 'medium', the impact significance is categorized as 'negligible-minor' and is an insignificant impact.				

3.1.3 Socio-Economic-Cultural

3.1.3.1 Workforce : Job Opportunities

a. **Environmental Baseline**

Construction Phase

Tangguh LNG presence in the Bintuni Bay has contributed to economic development in the region. This further accelerated by the establishment of Teluk Bintuni Regency as division of Manokwari Regency in 2005. In the last eight years, a change in the livelihood pattern of community in the Bay, especially with the increase in the percentage of people who work as employees.

Based on the census data of 2011, the unemployment rate in DAVs reached 8% of the labor force, declining from 2003 census data, which reached 21%. The decline in the unemployment rate is predicted to be affected by the rapid economic growth in the Bintuni Bay region.

At the level of household economy, the survey also showed that the community is at the level where they are able to meet the household's needs, but does not have the ability to save and invest.

Both of these problems raise a high sensitivity in the community when issues arise about job opportunities. Most of the people in the villages expect that Tangguh LNG activities can provide job opportunities to them to work at Tangguh. A data of public consultation conducted in 2012 showed that 8% of the aspirations and public attention to the Tangguh LNG related to job opportunities, and 7% related to economic development including business opportunities - which at the end associated with the employment.

b. **Impact Prediction and Evaluation**

Construction Phase – Impact Prediction

Gas exploration activities include gas well drilling production, transportation and installation of offshore platforms. The activity is projected to involve about 500-800 workers, which is largely a skilled workforce who work on offshore. The need for unskilled workforce is predicted no more than five people for building community relations with the villages around Tangguh LNG activities.

Job opportunities should offer a positive impact since it is projected to reduce unemployment in the villages. Gas well drilling activities and the installation of platform will last for about six months for each platform. Job opportunities will be offered directly once to community, at the beginning of drilling, transportation, and installation of platforms activities.

Construction Phase – Impact Evaluation

Employment issues have a high sensitivity in the community level due to several reasons such as a few of job opportunities offered to the Indigenous People* in the villages. However, the workforce requirement is specified to high and specific skill, as well as limited job opportunities offered only once at the beginning of the activities. Therefore, workforce impact on gas exploitation activities in construction phase is not significant ('minor'). Nonetheless, given the sensitive issue of workforce in society, the impact of this needs to be managed and monitored.

Table III-18 Impact Evaluation – Gas Well Drilling and Offshore Platform Installation Activities in the Construction Phase of the Workforce: Job Opportunities, Unemployment

Impact	*Production well drilling activities, transportation and installation of platforms as well as the installation estimated to raise impact to job opportunities for Indigenous People*.*				
Nature of Impact	**Negative**	**Positive**			
	This job opportunities is a positive impact for Indigenous People to work in construction of gas exploitation activities. However, the opportunity is limited because this type of work requires high skilled workers in which local community cannot get the opportunity due to low skilled and unskilled workers.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Production well drilling, transportation and installation of platforms require high skilled workers. Nevertheless, there will be a need for some workers in the low skilled or unskilled level to be recruited directly from nearby villages was facilitated by Workforce Management Team.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Production well drilling and installation of platform will last for six months for each platform. Workforce recruitment derived from the nearby villages will be done once at the beginning of drilling, transportation and installation of platforms, and will work over the duration of activity. Due to the impact of job opportunities lasting less than one year, then impact duration classified as temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	Low skilled and unskilled level recruitment will be prioritized for Indigenous People living in villages closest to the production well drilling activities, transportation and installation of platform and its installation. Thus, the impact extent is classified as local impact.*				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the UGM census data in 2011, unemployment in DAVs reached 8% of the labor force, declined from the 2003 census data which reached 21%. *Production well drilling, transportation and installation of platforms and its installation will cause a positive impact on Indigenous People* and local community living in villages closest to the location of project area. However, the number of job opportunities that are offered to the community is not much, and confined to the low skilled and unskilled community, and only once bidding for a period of six months. Impact magnitude is not broad because only nearby villages who will get the job opportunities. Taking into account the intensity, magnitude and duration of the impact, the impact is classified as 'small'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The 2011 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total workforce. While household income sufficient to meet the daily needs but insufficient to invest. By considering these criteria, the community can be classified DAVs have a high sensitivity to workforce issue.				

Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Production well drilling and installation of platform will last for approximately 6 months in Bintuni Bay waters. Most of workers are required to have a high skill and specific levels, while the results of the public consultation in 2012 described the presence of high expectations in the community to work on Tangguh LNG activities. Census data of PSKK UGM in 2011 showed that the majority of workforce is only elementary school graduates, and do not have the skills in the field of platform installation engineering. This led to the vulnerability arises because of the gap between community expectations and job opportunities that are offered to Indigenous People.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is estimated small by considering the quantity of job opportunities to Indigenous People is not much, just once, short term and limited to the positions of unskilled and low-skilled.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The emerging of positive impact of job opportunities are estimated as insignificant by considering at least job position offer, period of employment as well as the work conducted in the middle of the sea does not interact directly with the commutity. The positive impact of this activity does not significantly affect the changes in level of income and livelihood patterns of Indigenous People. However, taking into account the sensitivity of the issue of Indigenous People* on workforce issue, the positive impact is relatively not significant ('minor') but still need to be managed.*				

3.1.3.2 Changes in Local Businesses Growth

a. Environmental Baseline

Construction Phase

Types of businesses in the communities around Bintuni Bay area among other plantations, fishery, and agriculture. In general, local business growth is primarily driven by migrants. As it occured in Sebyar Rejosari Village, business growth driven migrant population that originally worked on sago processing company which has now been closed.

Table III-19 Economic Facilities in Village

No.	Economic Facilities	IRA[1]	TMG[1]	TM[1]	WER[2]	TMU[2]	MOG[2]	EKM[2]	Total
1	Bank	2	0	0	0	0	0	0	2
2	*Kios*/store	132	5	15	9	6	6	5	178
3	Cooperative and LKM	1	1	2	0	0	0	0	4
4	Market	6	0	1	0	0	0	0	7

Source : [1]Village Monographic, 2010; [2]PSKK UGM Data, 2009

Remarks : IRA = Irarutu III; TMG = Tomage; TM = Tanah Merah; WER = Weriagar; TMU = Tomu; MOG = Mogotira; EKM = Ekam

Based on the Food Security Survey conducted by IPB in 2010, Babo District, especially Irarutu III Village, has the largest economy facilities among all surveyed location and Teluk Bintuni Regency. Irarutu III Village has 132 kiosks / stalls and six markets.

Types of businesses owned by residents include plantations, fisheries, and agriculture. According to the above data survey, the orientation of economic activities is completely commercial. By seeing this, the existence of kiosks / stalls and markets are very important to local business growth. In addition to the existence of the stalls, there is also a betel nut seller to support local people's habit in chewing betel nut. This shows that local business growth managed by the community, has been developed.

Recruitment during gas exploitation activities which include: gas well drilling activities and installation of offshore platforms require approximately 525-810 workers. In addition, predicted it would take approximately six months to drilling as well as installation of platforms jackets and decks for each rig. The existence of workforce capacity and as much as it has become a term of the business opportunity and the potential impact on economic growth or small-scale local businesses around Bintuni; such as the provision of supply of vegetables, groceries, and fish for the workers every day. The work activities of installation of gas well drilling and performed at offshore locations, where the basic needs of workers should be provided. This can encourage business opportunities for local people that can support this project. For example, the growth and development of businesses related to supplying vegetables, groceries, and fish as well as encouraging local farmers and fishermen to meet project need.

Workforce demobilization is predicted to have an impact on the exit migration which also affect the demand for goods and services in the local market. Some workers may decide to stay in the villages surrounding Tangguh LNG operation site to gain other economic opportunities, not only from the Tangguh LNG operation.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Gas exploitation activities could potentially have an impact on local economic growth, such as supply of vegetable and fish supply for construction workers and gas well drilling, as well as the possibility of other services. Construction of offshore platforms and gas well drilling are conducted in offshore, where the basic needs of workers should be provided. Period of gas well drilling and platform installation activities, as well as jackets and decks lasted for approximately 6 months for each platform.

Local people are predicted to obtain business opportunities, such as meeting the needs of workforce, especially in the scope of foodstuff, which can support this project.

Workforce demobilization is predicted to have an impact on the exit migration which also affect the demand for goods and services in the local market. Some workers may decide to stay in the villages surrounding Tangguh LNG operation site to gain other economic opportunities, not only from the Tangguh LNG operation.

Construction Phase – Impact Evaluation

To determine or assess whether gas well drilling and installation of offshore platform activities is a significant impact, or not to the components of economic environment changes in local business growth, can be seen in **Table III-20** Impact Evaluation as a result of workforce recruitment and demobilization as follow:

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Table III-20 Impact Evaluation - Gas Well Drilling and Installation of Offshore Platform Activities against Changes in Local Business Growth in Construction Phase

Impact	*Gas exploitation activities (installation of offshore platform) of Tangguh LNG are estimated to recruit workforce approximately 500-800 workers who will work approximately 6 months. These activities will require food supplies to meet the needs of construction workers. It is predicted to affect changes in local business growth for local community.*				
Nature of Impact	**Negative**	**Positive**			
	Purchase of food supplies by Tangguh LNG contractor from local community is estimated to increase household income.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The presence of approximately 500-800 workers is estimated to increase the demand of food, so there will be changes in local business growth for local community to supply those needs.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Production well drilling and installation of platforms is estimated to last for approximately six months for each platform. During this time, it is estimated that there are business opportunities for local people to supply vegetables and fish for the construction workers. Due to the impact of changes in local business growth during less than one year, the impact is relatively temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	The purchase scope of food supplies which is conducted by Tangguh LNG contractor is estimated coming from community who lives close to the construction of installation of platform activities.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	At this time, Tangguh LNG always absorbs local products from fisheries and agriculture sectors which are provided from multiple stocking points. Throughout the year 2013, the August data showed that Tangguh LNG has absorbed as much as 209.542 kg of local products from agriculture and fisheries. *Tangguh LNG contractor will enable opportunity to groceries purchasing from local community with a relatively high intensity (2 times a week). Groceries purchasing are likely to result from the people living in the villages surrounding Tangguh LNG operation site. However, the business opportunities are predicted to last for approximately six months. Therefore, the magnitude of the impact is 'minor'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on a survey study of people's income by PSKK UGM in 2012, generally, the local community has been able to meet the needs of daily households. However, they have not been able to set aside part of their income to save and invest as business capital. Therefore, the impact sensitivity is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community expects to capture business opportunities from gas exploitation activities at the construction phase. However, local community is lack of ability to manage a large amount of investment, so that they are predicted to be less able to capture business opportunities. Since these business opportunities will only appear in less than 6 months, the vulnerability of business opportunities are assessed as medium.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	In the construction phase, food supplies will significantly high to meet the needs (approximately 500-800 workers), while community expectations are also high to provide food supplies for workers during temporary construction of gas exploitation activities. The contractor will be required to pick up groceries vegetables and fish from the villages around the project area, however not all foods can be provided by the community. Therefore, the impact likelihood is at a medium level.				

Impact Significance	Negligible	Minor	Moderate	Major	Critical
	There is a gap between high expectations of the community with the ability to supply food for workers. While the chance of community to be able to provide food is at a moderate level. However, since this business opportunity only appears in 6 months, so that the impact can be classified as a moderate or significant impact, and needs to be managed.				

The evaluation result which is described in the Impact Evaluation Table indicates that gas well drilling and installation of offshore platform classified as notable impacts (on the level of 'moderate') on the components of the changes in local business growth.

3.1.3.3 Fishery Activity Disturbance

a. Environmental Baseline

Construction Phase

People who live around Bintuni Bay still largely depend on the natural resources of coastal and marine resources, especially fish. Most communities also do not have sufficient capacity to manage a small business or work in other sectors in addition to fishing. On the other hand, the absence of other potential sources of livelihood is due to the unsupported condition of natural resources. This condition occurs in some villages, particularly in the northern region, where most of the territory is a swamp area. This area is affected by tidal events so it is not possible to develop alternative livelihood activities such as agriculture and livestock. Such environmental situation also occurs in most villages in the south, such as Otoweri, Onar, and others.

In general, the fishermen catch includes various types of fish and shrimp. Shrimp fishing activities carried out by small-scale category characterized by the limited use and capacity of boat and engine. Fishing range is relatively close (about 3 km from the coastline) and one day fishing.

Large-capacity fishing vessels with modern fishing equipments operating in the middle of Bintuni Bay waters tend to be a ship coming from outside region, which does not belong to the Bintuni Bay communities.

The main aquaculture production of Bintuni Bay region is marine fish (such as ikan kembung, mackerel, red snapper, *layang*), shrimp, and crab, with distribution in the North and South along the coastal waters of Bintuni Bay. In Arguni region, its people do cultivation of natural resources other than fisheries, namely by cultivating seaweed and pearl oysters. Fisheries Survey conducted in 2007, the region with abundant fishery resources, is Taroy Village, Magarina Village, Weriagar Village and Mogotira Village in northern coastal waters around the island of Babo, Wimbro, Tanah Merah-Saengga, Onar, and Otoweri in the south shore of Bintuni Bay.

Fishing ground of fishery resources in Bintuni Bay spread on three types of waters, namely rivers, estuaries, and the ocean. Fishing ground is still limited by the restriction of customary right which does not yet have firm administrative boundaries. However, a violation of customary fishing rights territory have a traditional sanctions in which consequences feared by the community. Therefore, people tend to be afraid to catch fish in other fishing ground.

In general, the fishermen do not yet have the capacity to reach larger fishing ground. It is because facilities and infrastructure fishing, and capital owned by fishermen are limited. On the other hand, the potential of fishery resource is only found in certain points according to their habitat, so the fishing ground just limited to these areas.

Those situations mentioned above, affect the limited of fishing ground area, and to get the same catches, the fishermen are not allowed to move to another fishing ground due to restriction of customary land of community. Fishermen from the villages of Tanah Merah, Saengga, Taroy, Weriagar-Mogotira, Babo and Wimbro mostly catch shrimp with trammel net fishing gear, whereas crab and fish are mostly caught by fishermen from Irarutu III and Babo Districts. Type of fishing gear used to catch fish are gill nets, fishing rods, and trammel net.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Teluk Bintuni community uses certain fishing gears (such as nets, lines) for fishing activities at a location / area of fishing (fishing ground). In a one-time fishing, fishing boat will depart from the fishing base to fishing ground, and back again to the boat located in each village.

Installation of offshore platform activities during the construction phase, expected to have a direct impact on the fishery activity disturbance in the fishing ground. In the construction phase, the disturbance is predicted to occur within a period of 6 months drilling and platform installation activities as well as the installation of jackets and decks. In general, production well drilling and installation of platform will be conducted above the ocean, and are slightly far away from the coastline. Nevertheless, in particular, there is a platform close to the coastline, which is the WDA platform. The existence of production well drilling, installation of WDA platform, and safety exclusion zone, as well as the supporting vessel movement, are estimated to have potential overlapping with the community fishing ground. Drilling and installation of platform on the WDA platform location are only within ± 2.8 miles from Weriagar Village, so there is an overlapping possibility with the fishing ground of Weriagar community. It is estimated to raise a insignificant impact related to fishery activity disturbance.

Fishing ground of Weriagar community is divided into communities' customary rights scope, in which the customary rights do not have a clear administrative boundaries. On the other hand, there are customary penalties feared by community associated with violation of customary rights area. This makes people tend to be consistent with their fishing ground area rather than moving from one to another place.

Catching fish and shrimp is the main livelihood of most people in Weriagar Village. Fishermen of Weriagar Village also do not have sufficient capacity to reach larger fishing area. This is due to the limited knowledge, facilities and infrastructure, and limited capital owned by fishermen. Based on the results of IPB Study Team (2007), fishing equipments used by fishermen in Weriagar village is limited to shrimp nets, fishing nets and fishing rod. In addition, the potential of fish population in Weriagar Village to community is only found in several spots in the Aranday Weriagar estuaries, whereas the potential of shrimp found only in the Siagian trench and surrounding.

Furthermore, the soil type of Weriagar Village is swamp influenced by the tide, so it is not possible to running agriculture and livestock activities as the alternative livelihoods and source of income for communities in Weriagar Village.

It is estimated that the location of installation of WDA platform, gas well drilling, safety exclusion zone application, and the presence of supporting vessel will overlap and disturb the fishing grounds. This affects the level of income of fishermen in Weriagar Village, and potentially eliminate the main livelihood of the Weriagar people as fishermen. Thus, disturbance on the local fishermen area by WDA platform in Weriagar Village is 'very important' or 'major' to be managed.

Construction Phase – Impact Evaluation

To determine or assess whether the activities of the production well drilling, installation of offshore platforms, safety exclusion zone application, and the existence of supporting vessel affect to the fishery activity disturbance, can be seen in the following **Table III-21** Impact Evaluation:

Table III-21 Impact Evaluation – Installation and Existence of Offshore Platform Activities against Fishery Activity Disturbance in Construction Phase

Impact	*The installation of platform will result in increased activity in the sea by Tangguh LNG vessels to support construction activities. The installation of platform will also implement safety* exclusion *zone which is predicted to disrupt community fishing ground.*				
Nature of Impact	**Negative**	**Positive**			
	Disturbance on community fishing ground will result negative impact to the household income of local fishermen.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The existence of offshore platform and safety exclusion zone as well as transportation of supporting vessel will result disturbance on community fishing ground.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Production well drilling, installation of platforms, jacket and deck will last for approximately 6 months. Since the impact will be affected local communities less than one year, so the impact is classified as temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	Disturbance on community fishing ground as the impact of installation of offshore platform, supporting vessel movement, is estimated occur along the local fishermen's fishing ground.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Teluk Bintuni in Figure 2012, indicated that 34,51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors. *Disturbance on community fishing ground is predicted occur every day during installation of platform activities. However, the disorder occurs in the interim period (about 6 months). Therefore, the impact magnitude is 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Local fishermen have a high dependence on fishing ground to meet their daily needs. As a result, the impact sensitivity is classified as high.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The dependence of local communities on fishing activities, while they do not have sufficient capacity to carry out alternative economic activities such as agriculture or business development. However, the impact is only occurred in interim period (6 months).				

Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The transportation and installation of platform will limit the fishing ground of local fishermen. Nevertheless, the safety exclusion zone is not too wide (500 m) compared to the community fishing ground. The fishery activity disturbance is likely to occur, but not necessarily close people's chance to catch a fish in the area. Thus, the impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Construction activity and reduced fishing ground for local fishermen are predicted to result a negative impact in the form of a decline in the income of fishermen. Meanwhile, the fishermen do not have alternative skills to improve their income due to disturbance on their fishing ground. Although the impact likelihood does not necessarily close to fishing activity at all, but their transportation of support vessel of construction activity is also predicted to greatly disturb the fishermen's fishing activities. However, given the impact only happens in the interim period (6 months), so the impact is classified as 'essential' at the level of 'moderate' and 'must be managed.				

<u>*Operation Phase – Impact Prediction*</u>

Teluk Bintuni community uses certain fishing gears (such as nets, lines) for fishing activities at a location / area of fishing (fishing ground). In a one-time fishing, fishing boat will depart from the fishing base to fishing ground, and back again to the fishing base located in each village.

The existence of installation of offshore platform activities is predicted to disturb fishermen activities directly on fishing activities in the fishing ground. In the operation phase, the disturbance is predicted to occur aprrroximately within 25 years since the beginning of operation. In addition, due to security issue, disturbance is also likely impacted by the application of safety exclusion zone, during the activities process, which is approximately 500 meters around the area of platform installation and drilling. This will restrict the access of local communities to conduct fishing activities in the area.

In general, production well drilling and installation of platform will be conducted above the ocean, and are slightly far away from the coastline. Nevertheless, in particular, there is a platform close to the coastline, which is the WDA platform. The existence of production well drilling, installation of WDA platform, and safety exclusion zone, as well as the transportation of supporting vessel, are estimated to have potential overlapping with the community fishing area. Drilling and installation of platform on the WDA platform location are only within ± 2.8 miles from Weriagar Village, so there is an overlapping possibility with the fishing ground of Weriagar community. It is estimated to raise a insignificant mpact related to fishery activity disturbance.

Fishing area of Weriagar community is divided into communities' customary rights scope, in which the customary rights do not have a clear administrative boundaries. On the other hand, there are customary penalties feared by community associated with violation of customary rights area. This makes people tend to be consistent with their fishing ground area rather than moving from one to another place.

Catching fish and shrimp is the main livelihood of most people in Weriagar Village. Weriagar fishermen village also does not have sufficient capacity to reach larger fishing area. This is due to the limited knowledge, facilities and infrastructure, and limited capital owned by fishermen. Based on the results of IPB Study Team (2007), shrimp catching equipment used by fishermen in Weriagar village is limited to shrimp nets, fishing nets and fishing rod. In addition, the potential of fish population in Weriagar Village to community is only found in several spots in the Aranday Weriagar estuaries, whereas the potential of shrimp found only in the Siagian trench and surrounding.

Furthermore, the soil type of Weriagar Village is swamp influenced by the tide, so it is not possible to running agriculture and livestock activities as the alternative livelihoods and source of income for communities in Weriagar Village.

It is estimated that the location of installation of WDA platform, gas well drilling, application of safety exclusion zone, and the presence of supporting vessel will overlap and disturb the fishing grounds. This affects the level of income of fishermen in Weriagar Village, and potentially eliminate the main livelihood of the Weriagar people as fishermen. Thus, fishery activity disturbance by WDA platform in Weriagar Village is 'very important' or 'major' to be managed.

<u>Operation Phase – Impact Evaluation</u>

To determine or assess whether the gas exploration activities during the operation phase affect towards fishery activity disturbance can be seen in the following Impact Evaluation Table:

Table III-22 Impact Evaluation - Installation and Existence of Offshore Platform Activities against Fishery Activities in Operation Phase

Impact	*The gas exploitation activities on the construction phase will implement the safety exclusion zone with a radius of 500 m on each platform. Application of safety exclusion zone in the long term, and is expected to disrupt the activities of local fishermen fishing.*				
Nature of Impact	**Negative**	**Positive**			
	The gas exploitation activities on the construction phase will implement the safety exclusion zone to ensure the safety of users of the waters surrounding activities. Implementation is predicted to disrupt the local fishermen's fishing grounds.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The existence of offshore platforms as well as safety exclusion zone in the operation phase will directly disturb the fishing activities of local communities. Particularly, for WDA platform, within 2.8 miles of shoreline will overlap with the local fishermen's fishing grounds.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Gas exploitation activities in the operational phase is predicted to last for approximately 25 years since the operation phase begins. Because of the local communities feel the impact of fishery activity disturbance in the long term				
Impact Extent	**Local**	**Regional**	**Global**		
	Most platforms will be installed in the middle of sea and indirectly disturb the local fishermen's fishing activities. However, the WDA platforms located within ± 2,8 mil from coastline will overlap with local fishermen's fishing activities.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Teluk Bintuni in Figure 2012, indicated that 34,51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors. *Disturbance on community fishing ground is predicted occur every day, especially in the WDA platforms located within ± 2,8 mil from coastline and overlapped with local fishermen's fishing ground. It is predicted to occur in the long term (±25 years) sin the beginning of operation phase. Therefore, the impact magnitude is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Local fishermen have fishing ground distance up to the limit of 3 miles of shoreline which has a high dependence on the fisheries sector. However, since there is no traffic on the sea transport from WDA platform activity, the fishermen can still catch fish outside the safety exclusion zone. Thus, the sensitivity of the impact is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The vulnerability impacts are 'high' because of the dependence of fishermen on the fishing ground on WDA platform-though other platforms located in the middle of the sea-- And there is an overlap with the local fishermen's fishing ground in the location of WDA platform.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The existence of platforms located in the middle of the ocean is predicted to disrupt fishing activities of local fishermen, but the existence of WDA platforms located within 2.8 miles from the coastline which is overlapped with the fishing ground of local fishermen cause the opportunity of fishery activity disturbance likely to be happened.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	WDA platforms located within 2.8 miles from the coastline which is overlapped with the fishing ground of local fishermen is predicted to cause a significant impact on the local fishermen activities of Weriagar. However, there is no traffic on the sea transport of WDA platform activities, so the fishermen can still catch fish outside the safety exclusion zone. On the other hand, there is still a possibility of fishery activity disturbance of local fishermen who have fishing ground in WDA location. Thus, the impact is classified as a 'major' or significant impacts and should be managed.				

3.1.3.4 Decline in Fishermen's Income

a. Environmental Baseline

<u>*Construction Phase*</u>

One of community's livelihoods in Bintuni Bay region, which have been source of income for community, is fishing activity. Based on the survey result of PSKK UGM (2009), people's income in fishery industry between 2009 to 2011 has increased, such as in North DAVs (Tomu, Ekam, Rejosari, Taroy, Weriagar, and Mogotira) of Rp1,716,697.00 and South DAVs (Tanah Merah, Saengga, Onar Lama, Onar Baru, and Otoweri) of Rp 1,521,930.00. While in 2011, North DAVs has reached Rp3.013.509.00 and in South DAVs reached Rp2,450,002.00.

Village resident in Weriagar District that is adjacent to the WDA platform amounted to 3,016 inhabitants and of that number approximately 11.87% livelihood as fishermen

(UGM Team 2011), especially as shrimp fishermen. Based on the IPB team study (2013), Weriagar fishermen income is at Rp 3,903,017.67 in a year.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

The decline in fishermen's income is a derivative impact of the fishery activity disturbance, particularly reduction on fishing ground at the time of installation of offshore platforms. By the application of safety exclusion zone within 500 m of the platform, fishermen reckon that the presence of construction activities will disturb their fishing activities. In the future, the disturbance will lead to decline in fishing revenues due to the disturbance on their livelihood. The impact of this disturbance is predicted to affect the fishermen for approximately 6 months.

Particularly for fishermen who reside in the villages in Weriagar District adjacent to WDA platform, income declining, in particular, will occur when fish / shrimp seasons come.

There is a difference of shrimp peak seasons between north shore of Bintuni Bay (Mangarina, Weriagar-Mogotira, Aranday Estuary, Weriagar Estuary, Siagian Trench and surrounding) and South shore of Bintuni Bay (Otoweri, Onar, Tanah Merah). In the north shore, the shrimp peak season occur between June – August, while the shrimp peak season occur between January – April in the south shore of Bintuni Bay.

In terms of difficulty in counting the quantity, there is a prediction about income declining for a number of fishermen. It is due to a high dependency of community on natural resources. On the other hand, the presence of supporting vessel movement in well drilling activities and installation of WDA platform is also predicted to remain fishery activity disturbance of local fishermen in Weriagar Village. Therefore, the impact is quite important ('major') and must be managed.

Construction Phase – Impact Evaluation

To determine or assess whether the activities of drilling andinstallation of offshore platforms affect to the decline in fishermen income, can be seen in the following **Table III-23** Impact Evaluation:

Table III-23 Impact Evaluation – Transport, Installation and Existence of Offshore Platform against Decline in Fishemen's Income in Construction Phase

<table>
<tr><td>Impact</td><td colspan="5">Installation of platform activities will require vessl transport to support the construction activity. The installation of platform also applies safety exclusion zone that is predicted to disrupt community's fishing ground.</td></tr>
<tr><td rowspan="2">Nature of Impact</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Disturbance on community's fishing ground will result negative impact on household income of local fishermen.</td></tr>
<tr><td rowspan="2">Type of Impact</td><td>Direct Impact</td><td>Derivative Impact</td><td>Indirect Impact</td><td>Cumulative Impact</td><td>Residual Impact</td></tr>
<tr><td colspan="5">Installation of offshore platform and safety exclusion zone as well as supporting vessel movement will result disturbance on community's fishing ground which result to the decline in fishermen's income.</td></tr>
</table>

Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Production well drilling and installation of platform will last for six months. Decline in fishermen's income occur less than a year. Therefore, local fishermen derived from local community will get decline in income in interim period.				
Impact Extent	**Local**	**Regional**	**Global**		
	Decline in income is predicted to be experienced by fishermen living in the villages located around platform, especially Weriagar Village close to the WDA platform.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Teluk Bintuni in Figure 2012, indicated that 34,51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors. Based on the survey results of PSKK UGM (2009), people's income per sector (including fisheries) between 2009 to 2011 increase in the fishing industry, such as in North DAVs (Tomu, Ekam, Rejosari, Taroy, Weriagar, and Mogotira) of Rp1. 716,697.00 and South DAVs (Tanah Merah, Saengga, Onar Lama, Onar Baru, and Otoweri) of Rp 1,521,930.00 whereas in 2011, North DAVs reached Rp3.013.509,00 and in South DAVs reached Rp2. 450,002.00. *Disturbance on fishing ground is predicted to occur every day during the platform installation activities. Hoever, the disturbance occur in interim period (6 months). Therefore, the impact magnitude is classified as 'small'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Local fishermen have high dependency on fishing ground to meet their daily needs. Therefore, the sensitivity of impact is classified as 'high'				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Income of local community still depends on the fishing activities, while they do not have sufficient capacity to carry out alternative economic activities such as agriculture or business development. However, the impact is only occurred in interim period (6 months), the impact severity is classified as 'medium'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The transportation and installation of platform will limit the fishing ground of local fishermen. Nevertheless, the safety exclusion zone is not too wide (500 m) compared to the community fishing ground. There will be a fishery activity disturbance, but not necessarily close the opportunity of fishermen to catch a fish in the area. Thus, the impact of vulnerabilities is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The restriction of fishing activities for local fishermen is predicted to result negative impact on decline in fishermen's income. While fishermen do not have alternative skills to recover their income due to disturbance on their fishing ground. Although, the impact significance is classified as ,medium',not necessarily close the fishing activities. Nevertheless, the vessels support transportation of construction activity is predicted to disturb the fishing activities of fishermen. Thus, the decline in fishermen's income impact is experienced in the interim period (6 month), the impact is classified as 'significant' ('moderat'), and must be managed.				

3.1.3.5 Sea Transportation Accessibility Disturbance

a. Environmental Baseline

<u>Construction Phase</u>

The Bintuni Bay and Berau Bay region is an area of water that is used by various types of commercial shipping originating both from domestic and abroad. Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. The total visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and *kapal opsi* (small tonnage merchant ship carried about 15 tons).

The local community has used the Bintuni Bay and Berau Bay for generations as traffic lanes between villages, the center of administrative area, district/sub-district, and fishing base. To visit between villages, community can across the Bintuni Bay and Berau Bay or from North to South shore or vice versa.

In addition, the community commonly use wooden boat with outboard engine (usually used as fishing boat) to move from villages to the center of administrative area or economic activities (such as market) in Bintuni, Babo and Kokas. To reach further location, for example, from Weriagar to Kokas or Babo, from Babo to Bintuni and vice versa, usually use longboat equipped with 15 HP, 25 HP or 40 HP engine. Meanwhile, river estuary and creeks are commonly passed by *ketinting* with 5 HP or 10 HP Honda engine brand owned by the community to reach shorter distance.

From the studies result of sustainable fisheries in the Bintuni Bay (2007), the description of population mobility by sea can be described as follows:

- Village residents of Weriagar-Mogotira (including Manggarina) buy various types of supplies in Aranday and Kokas (Fakfak) districts. Travel to Aranday District takes about 1.5 - 2 hours by longboat with 15 HP Johnson engine brand, while to reach Kokas is required about 5-6 hours by the same type of longboat.
- Village residents of Taroy Village buy various types of supplies in Aranday and Bintuni (Fakfak) districts. Travel to Aranday District takes about 2-2.5 hours by longboat with 15 HP Johnson engine brand, while to reach Bintuni is required about 5-6 hours by the same type of longboat.
- Village residents of Sidomakmur Village buy various types of supplies in Babo District with travel time more or less ½-1 hours by longboat with 15 HP Johnson engine brand.
- Village residents of Tanah Merah and Saengga villages buy various types of supplies in Babo and Kokas. Travel to Babo District requires 2.5-3 hours by longboat with 15 HP Johnson engine brand, while to reach Kokas, the trip requires 5-6 hours by the same type of longboat.
- Village residents of Onar and Otoweri villages buy various types of supplies in Kokas (Fakfak) with a travel time of about 4-5 hours by longboat Johnson 15 HP engine brands.

From the above explanation, it can be concluded that the mobility of both communities from the villages of north shore and south shore in the Bintuni Bay region use ships / small boats. Thus, the community is very high dependence on marine, especially as seawater channel.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Gas exploitation activities, in particular to the installation of offshore platforms in the construction phase will mobilize supporting vessel movement of installation activities and applies the safety exclusion zone The activity is predicted to disrupt the seawater channel activities and potentially harmful to seawater channel of community, especially for they who use ships / wooden boats.

During the construction activities, the types of vessels used include barge (barge and warehouse material barge), tugs / tug boats (for the transportation of platform and other heavy equipment), crew boats and supporting vessels. For security purposes, there will be a safety exclusion zone around the area of construction of offshore platforms during construction activities. In addition to the safety exclusion zone, the other source of imapct is a frequency of supporting vessel traffic which will have higher frequency during construction activities compared to the operation phase. The frequency of vessel traffic movement during drilling and transport, as well as the installation of platform is expected to increase along with the increase number of vessels. The vessels traffic frequency is predicted to increase based on the assumption that the total number of visits of various types cruise ships in port of Bintuni in the 2014 activities in is equal to 2011 as follows: 893 visits, which consists of 787 ship visits from domestic and 106 foreign vessels, Thus, the number of supporting vessel movement in Bintuni Bay during construction activity is predicted to increase each week with 4-5 times the ship visits.

Activities in the construction phase which lasts about 6 months, particularly on sea transport is predicted to raise impact on mobility traffic of people who use public transportation to go to the economic centers or between villages. The impact is predicted because of the presence of safety exclusion zone, so that the boat / ship will evade their community activity area. The Impact has a high intensity due to occur on daily lives. In addition, the potential of community's ship / boat crash will happen when there is no approriate sea transport management, such as a high speed of vessel passed with the community's ship / boat that likely to result inbalanced ('shaky') position of ship or be drowned. Although based on quantity, there is no traffic frequency of community with ships and boats, the transport frequency is considerably high when the ocean conditions is 'calm' and in the religious day celebration (such as Idhul Fitri and Christmas). The impact will be experienced by the time of development of WDA and ROA platforms activities (development of platforms on the early stage), since the location is close to the villages of Weriagar (WDA platform) and Tanah Merah / Saengga (ROA platform).

By recognizing a high dependence of community on sea traffic (jalur laut) as the main transport, the impact likelihood is classified as 'medium'. Meanwhile, the impact on disturbance of sea transportation accessibility due to the installation of offshore platform activities and safety exclusion zone, as well as supporting vessel movement are classified as 'significant' and 'need to be managed'.

Construction Phase – Impact Evaluation

To determine or assess whether the transportation and installation of offshore platforms activities towards on sea transportation accessibility disturbance, can be seen in the **Table III 24** Impact Evaluation as follows:

Table III-24 Impact Evaluation – Transportation and Installation of Offshore Platform against Sea Transportation Accessibility Disturbance in Construction Phase

Impact	*Transportation and installation of platforms activities will require vessels transport to support the construction activity. The gas exploitation activities and application of safety exclusion zone are predicted to disrupt the sea transportation accessibility of community.*				
Nature of Impact	**Negative**	**Nature of Impact**	**Negative**	**Nature of Impact**	
	Transportation and installation of platforms are predicted to disturb sea transportation accessibility of community in which community should take longer route to avoid safety exclusion zone.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Installation of offshore platforms and safety exclusion zone, as well as supporting vessel movement for contruction activity will directly disrupt sea transportation accessibility of community.				
Impact Duration	**Temporary**	**Impact Duration**	**Temporary**	**Impact Duration**	**Temporary**
	Drilling and installation of platform activities last for 6 months. Since sea transportation accessibility disturbance will occur less than a year, the impact is classified as 'temporary'.				
Impact Extent	**Local**	**Impact Extent**	**Local**	**Impact Extent**	**Local**
	Sea transportation accessibility disturbance of community due to installation of offshore platform, supporting vessel movement, and application of safety exclusion zone is predicted to occur in the sea transportation access of local community.				
Impact Magnitude	**Negligible**	**Impact Magnitude**	**Negligible**	**Impact Magnitude**	**Diabaikan**
	Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. While the visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and kapal opsi (small tonnage merchant ship carried about 15 tons). *Sea transportation accessibility disturbance in village level is predicted to occur every day, during the transportation and installation of platforms. Nevertheless, the sea transportation accessibility disturbance only occurs in interim period (6 months). Thus, the impact extent is classified as 'small'.*				
Impact Receptor Sensitivity	**Low**	**Impact Receptor Sensitivity**	**Low**	**Impact Receptor Sensitivity**	**Low**
	Community has high dependence to sea mobility as a main of sea transportation access. On the other hand, none of the road infrastructure is appropriately available as an alternative transportation. Thus, the impact sensitivity towards community is classified as 'high'.				
Impact Severity	**Very Low**	**Impact Severity**	**Very Low**	**Impact Severity**	**Very Low**
	Community has high dependence to sea mobility as a main of sea transportation access to reach a wide range region. On the other hand, the existence of safety exclusion zone and supporting vessel movement for installation of offshore platform directly restrict their sea transportation accessibility. The community should take longer sea transportation route to avid the safety exclusion zone and				

	supporting vessel movement of Tangguh LNG. However, the impact only occurs in interim period (6 months), the impact severity is classified as 'medium'.				
Impact Likelihood	**Very Small**	**Impact Likelihood**	**Very Small**	**Impact Likelihood**	**Very Small**
	The impact likelihood is classified as 'medium'. The transporation and installation of offshore platform is predicted to mobilize the supporting vessel movement, as well as the application of safety exclusion zone. Although these activities do not cover large area compare to sea transportation region of community, the impact likelihood is possible to be encountered.				
Impact Significance	**Negligible**	**Impact Significance**	**Negligible**	**Impact Significance**	**Negligible**
	The gas exploitation including production well drilling and installation of offshore platform is predicted to mobilize the supporting vessel movement as well as the application of safety exclusion zone. The zone will result negative impact such as sea transportation accessibility disturbance for community. The community has high dependence on sea transportation as main access. On the other hand, the impact likelihood is lassified as 'medium'. However, the impact only lasts for interim period (6 months), so sea transportation accessibility disturbance due to installation of offshore platforms and its safety exclusion zone, as well as supporting vessel movement, is classified as 'significant'' at the level of 'moderate', and should be 'managed'.				

Operation Phase – Impact Prediction

Gas exploitation activities in the operation phase are expected to disrupt the sea transportation accessibility, especially people who use ships / wooden boats. For security purposes, there will be a safety exclusion zone around the area of offshore platforms during construction activities within a radius of 500 meters. The impact on sea transportation for commercial shipping both passanger and goods (registered in Port Administrator) are not expected to result an impact, given the position of the platform will be reported in the shipping channel map, so the position known by captain.

However, for transportation route used by community is not recorded in the Port Administrator. The safety exclusion zone is predicted to have an impact on mobility. During the time, community use longboat to go to the economic centers or other villages. By the existence of safety exclusion zone, the community should take longer sea transportation route to avoid the safety exclusion zone. Ownership and use of sea transportation (boat engine), especially the community's ship / boat over a period of about 25 years is predicted to increase along with the development of governance, infrastructure, population, and socio-economic in the villages and district capital.

Community mobility on sea is also predicted to increase, since there is no alternative road or adequate public transportation. On the other side, the existence of platform and safety exclusion zone will restrict people's mobility. The impact of this disturbance will be significantly occurred in offshore WDA platform location within about ± 2.8 miles from the Weriagar Village and ROA within ± 11.5 km from Tanah Merah and Saengga Villages. By considering this, the impact nature is 'significant'.

Operation Phase – Impact Evaluation

To determine or assess whether the gas exploitation activities affect the sea transportation accessibility, can be seen in the following Table Impact Evaluation:

Table III-25 Impact Evaluation – Gas Exploitation Acitivity against Sea Transportation Accessibility Disturbance in Operation Phase

Impact	*Gas exploitation activities in the operation phase will apply safety exclusion zone in around offshore platforms within radius of 500 m. The regulation is predicted to disturb the sea transportation accessibility of local community.*				
Nature of Impact	**Negative**	**Nature of Impact**	**Negative**	**Nature of Impact**	
	The gas exploitation activities on the operation phase will implement the safety exclusion zone to ensure the safety of users of the waters surrounding activities. The activity is predicted to disrupt the sea transportation accessibility in wcich community should take longer distance to avoid safety exclusion zone.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The existence of offshore platforms and safety exclusion zone is directly disturbing the sea transportation accessibility of community.				
Impact Duration	**Temporary**	**Impact Duration**	**Temporary**	**Impact Duration**	**Temporary**
	Gas exploitation activities in the operation phase is predicted to last for approximately 25 years since the operation phase begins. Due to sea transportation accessibility disturbance of the local community will last for more than 5 years, the impact lasts longer and is classified as a long-term impact.				
Impact Extent	**Local**	**Impact Extent**	**Local**	**Impact Extent**	**Local**
	Sea transportation accessibility disturbance of the local community due to installation of offshore platform activities, and application of safety exclusion zone is predicted to occur in sea transportation access of local community.				
Impact Magnitude	**Negligible**	**Impact Magnitude**	**Negligible**	**Impact Magnitude**	**Negligible**
	Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. While the visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and kapal opsi (small tonnage merchant ship carried about 15 tons).				
	The existence of offshore platforms and safety exclusion zone is predicted to limit the community access to sea transportation of local community to go outside their village. The disturbance will last for 25 years since the operation begins. Thus, the impact extent is classified as 'large'.				
Impact Receptor Sensitivity	**Low**	**Impact Receptor Sensitivity**	**Low**	**Impact Receptor Sensitivity**	**Low**
	People have a high dependence on the sea transportation access to travel to other areas since there is no land transportation available or adequate means of transportation for community to date. Thus, the impact sensitivity is 'high'.				
Impact Severity	**Very Low**	**Impact Severity**	**Very Low**	**Impact Severity**	**Very Low**
	The impact severity is classified as 'high' because of the high dependence on sea mobility as a main of sea transportation to go to other areas. On the other side, the existence of offshore platforms and safety exclusion zone directly restricts the sea transportation accessibility in the long term. Coomunity will take longer sea transportation in order to avoid safety exclusion zone and				

	supporting vessel of Tangguh LNG.					
Impact Likelihood	**Very Small**	**Impact Likelihood**	**Very Small**	**Impact Likelihood**	**Very Small**
	The possibility of sea transportation accessibility disturbance is classified as 'medium'. It is because there is still possibility to them to avoid the safety exclusion zone by taking longer distance although their main transportation access disrupted.					
Impact Significance	**Negligible**	**Impact Significance**	**Negligible**	**Impact Significance**	**Negligible**
	The gas exploitation including offshore platform is predicted to apply safety exclusion zone. The zone will result negative impact such as sea transportation accessibility disturbance for community. The community has high dependence on sea transportation as main access since they do not have alternative land transportation or other available sea public transportation. On the other side, the possibility of impact significance is classified as 'significant' and 'to be managed"					

3.1.3.6 Community Perception

a. Environmental Baseline

<u>Construction Phase</u>

Tangguh LNG presence in Bintuni Bay region has contributed to economic development in the region. This is accelerated by the establishment of Teluk Bintuni Regency as a division of Manokwari Regency in 2005. In the last eight years, a change in livelihood pattern of Bintuni Bay community, especially with the increase of community percentage working as employees.

Based on the UGM census data in 2011, unemployment in DAVs reached 8% of the labor force, declined from the 2003 census data which reached 21%. The decline in unemployment rate is predited to be affected by the rapid economic growth in Bintuni Bay region.

At the level of the household economy, the survey also shows that the community is at a level where they are able to meet the needs of the household, but does not have the ability to save and invest.

Both of these problems raise a high sensitivity in the community when issues arise about job opportunities. Most of the people in the villages expect that Tangguh LNG activities can provide job opportunities to them to work at Tangguh. A data of public consultation conducted in 2012 showed that 8% of the aspirations and public attention to the Tangguh LNG related to job opportunities, and 7% related to economic development including business opportunities - which at the end associated with the employment.

People who live around Bintuni Bay still largely depend on the natural resources of coastal and marine resources. Most communities also do not have sufficient capacity to manage a small business or work in other sectors in addition to fishing. On the other hand, the absence of other potential sources of livelihood is because of the unsupported condition of natural resources. This condition occurs in some villages, particularly in the northern region, where most of the territory is a swamp area. This area is affected by tidal events so it is not possible to develop alternative livelihood activities such as agriculture and livestock. Such environmental situation also occurs in most villages in the south, such as Otoweri, Onar, and others.

In addition to these problems, the fishermen cannot directly move to other fishing ground. This is because each fishing ground is part of the customary rights area which can not be used freely. On the other hand there is a strict customary sanction in case of violation of customary territory by the community.

The fishermen do not have the capacity to reach larger area of fishing ground. This is due to the limited knowledge, facilities and infrastructure of fishing, as well as limited capital owned by fishermen. On the other hand, the potential of fish populations is only found in certain points according to their habitat, so the fishing ground is just limited to these areas.

Those situations mentioned above, affect the limited of fishing ground area, and to get the same catches, the fishermen are not allowed to move to another fishing ground due to restriction of customary land of community. Fishermen from the villages of Tanah Merah, Saengga, Taroy, Weriagar-Mogotira, Babo and Wimbro mostly catch shrimp with trammel net fishing gear, whereas crab and fish are mostly caught by fishermen from Irarutu III and Babo District. Type of fishing gear used to catch fish are gill nets, fishing rods, and trammel net.

In addition to the fishing activities, Bintuni Bay community also occupies marine area as transportation access to various places. Sea transportation become the primary means of transportation for people, since there is no land transportation available.

Furthermore, the Bintuni Bay and Fakfak waters, especially around the Kokas District area, is transportation access to local people, as well as used for sea transportation access for fishermen activities and family visits between villages. It can be said that community around Bintuni Bay and Kokas District, Fakfak Regency have close relationship with waters / marine for generation to generation.

For sea transportation accessiblity, Bintuni Bay community commonly uses small boat by longboat with 15 HP Johnson engine brand. The small size of boat makes the boat easily to be attacked by waves.

Gas exploitation activities in the construction phase, will involve the flaring activity or wells cleaning process. Well cleaning will be done before the production phase, which takes approximately 48-72 hours for each well. This process will lead to the emergence of flare in a short time on the platform. Flames are often visible and raises public concern and led to various perceptions. In a public consultation in 2012, the public complaints will reach 1% of flaring activity from various complaints there.

Gas exploitation activities in the operation phase is predicted to last for approximately 25 years since the operation phase begins. During that time period is predicted to result an impact to local community activities in catching fish in the fishing ground as well as in the use of water / sea as a transportation access. During gas exploitation activities, a safety exclusion zone will be implemented which covers every offshore platform with a radius of 500 m. These activities and safety exclusion zone are predicted to raise community perception about fishery activity and sea transportation accessibility disturbances for them.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Community expectation is to be able to work in the Tangguh LNG Expansion Project activities. On the other side, community has limited amount of workforce that can be absorbed by the project that is expected to lead to a negative perception from community. This is quite reasonable because of the workforce required in the Tangguh LNG Expansion Project is based on certain qualifications, while on the other side of the qualifications and skills of the local community is relatively limited.

One of the activities in the Tangguh LNG Expansion Project is drilling and installation of offshore platforms, followed by the presence of safety exclusion zone to local community. The application of safety exclusion zone will lead to a negative perception in society because of the limited access to fishing fround and sea transportation for local community. In addition to flaring, although the intensity and duration is quite short, but the appearance of light from flaring can cause a negative perception in the community. Community has been argued that flaring produced by gas can interfere with their health. Overall, the drilling and installation of offshore platforms is forecasted to cause a negative perception from community associated with employment, on fishery activities and sea transportation accessibility disturbances.

Operation Phase – Impact Evaluation

Accumulated negative perceptions of the expectations to work, fishery activities disturbance, sea transportation accessibility disturbance and flaring activities is classified as negative impact. The perception is very likely to occur because people experience it directly in their daily lives.

Table III-26 Impact Evaluation – Gas Exploitation in Construction Phase against the Community Perception

<table>
<tr><td>Impact</td><td colspan="5">During the transportation and installation of platforms, there will be job opportunities for the community, application of safety exclusion zone, and flaring activity. These activities are predicted to cause a variety of community perception.</td></tr>
<tr><td rowspan="2">Nature of Impact</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Activities of transportation and installation of platfoms will provide job opportunities to the community. However, the given opportunities are not as many as high expectations of the community to work together. Thus, the positive impact is not significant, while the expectations of the community perception will be negative. Implementation of a safety exclusion zone and flaring activity will increase the negative perception of community, particularly when people do not understand the activity.</td></tr>
<tr><td rowspan="2">Type of Impact</td><td>Direct Impact</td><td>Derivative Impact</td><td>Indirect Impact</td><td>Cumulative Impact</td><td>Residual Impact</td></tr>
<tr><td colspan="5">Negative perception of community related to job opportunities will arise when there is an expectation to be involved in the transportation and installation of platform. Meanwhile, the job opportunities offered is limited to less skilled and unskilled level.

Negative perceptions also arise when the contractor implement a fishing restricition around the installation of platform area, as well as due to the supporting vessel movement of construction activities that disturb fishing ground of community and sea transportation accessibility, as well as flaring activity.</td></tr>
<tr><td>Impact</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
</table>

Duration	*Well drilling and installation of platform will last for approximately 6 months. Community perception related to well drilling and installation of platform will occur less than a year. Thus, social, the impact duration is classified as 'temporary'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Community perception considered as significantis predicted to arise from community living in closest to the installation of platforms location.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a variety of perception growing in the community related to Tangguh LNG activities. In addition, community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural *Negative perception of community related to job opportunities, fishery activity disturbance and sea transportation accessibility as well as flaring activity. The instensity of fishery activity and sea transportation accessibility disturbance occur everyday to local community that arise accumulative negative perception. Nevertheless, since impact duration only occur in interim period (6 months) of, the impact is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact sensitivity is classified as 'high' because of the existence of unemployment in villages, community dependence on fisheries sector and sea transportation accessibility. Community is predicted to be more sensitive about the lack of flaring activity understanding. By considering this, the impact sensitivity is classified as 'high'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' because of the big gap between community knowledge related to job opportunities, installation of platform and flaring activity; as well as knowledge about safety exclusion zone. Nevertheless, the impact will occur in interim period (6 months).				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The opportunities for the rise of negative perception of community are likely to occur because of the community expectation to be able to work together in installation of platform activities. Negative perceptions also extremely arises when fishery activities disturbance and sea transportation accessibility disturbance as well as the presence of flaring activity.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Negative perception of community related to gas exploitation including the transportation and installation of platform is classified as significant (at the level of moderate) because of accumulative negative perception from community perception to job opportunities, fishing activities and sea transportation accessibility as well as flaring activity. The perception possibly occurs because community experiences disturbance directly in daily lives. However, it only occurs only in interim period (about 6 months). Thus, the impact is classified as 'moderat' or 'significant' and 'must be managed'.				

Operation Phase – Impact Prediction

Offshore platform activities and the application of safety exclusion zone will directly affect the local community in Bintuni Bay waters and waters District Kokas District. The condition is expected to result in disturbance on local community activities, both in the fishing activities and the utilization of waters / sea as a transportation access.

Operation Phase – Impact Evaluation

To determine or assess the impact of community perception of fishery activity and sea transportation accessibility disturbances, Impact Evaluation will explain as follows:

Table III-27 Impact Evaluation - Gas Exploitation against the Emergence of Community Perception in Operation Phase

Impact	*During gas exploitation activities will be applied to a safety exclusion zone surrounding each offshore platform with a radius of 500 m. These activities are predicted to raise community perception of fishery activity and sea transportation accessibility disturbances.*				
Nature of Impact	**Negative**	**Positive**			
	Offshore activities and safety exclusion zone are predicted to raise impact such as affected on fishery activity and sea transportation accessibility disturbances of local communities, which affects the derivative impact as in negative perception of community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Negative perception of community is a derivative impact of fishery activity and sea transportation accessibility disturbances which arises from the safety exclusion zone to offshore platforms activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Gas exploitation activities in the operation phase will last for approximately 25 years since the operation phase begins. Because the community perception will continue to exist in the local community for more than 5 years, then the impact lasts longer and is classified as a long-term impact.				
Impact Extent	**Local**	**Regional**	**Global**		
	Negative perception of community that is considered as significant is predicted to arise from people living in the villages closest to the area of offshore platforms.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a growing perception in community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Negative perception of community about fishery activities and sea transportation accessibility disturbances will appear repeatedly to the people living in the villages closest to the area of offshore platforms. This negative perception is a derivative impact of the on fishery activities and sea transportation accessibility disturbances of local community will occur in the long term period (± 25 years). Therefore, the magnitude of the impact is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Sensitivity of impact recipient is classified as 'high' because local community depend on fishing ground and sea transportation access. By considering this, the impact sensitivity is classified as 'high'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'high because of the big gap knowledge between community and Tangguh LNG related to operation of platform, including application of safety exclusion zone which is predicted to result fishery activity and sea transportation accesibility disturbances. Thus, the impact severity is classified as 'high'				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The likelihood of community perception due to fishery activity and sea transportation accesibiliy disturbances of community is possible to appear, because local communities will experience the impact in the long time period. Therefore, the impact likelihood is classified as medium.				

Impact Significance	Negligible	Minor	Moderate	Major	Critical
	The application of safety exclusion zone with a raius of 500 m surrounding the offshore platform is predicted to raise 'negative' perception of community related to on fishery activity and sea transportation accesibiliy disturbances. On the other hand, the impact likelihood of community perception is potentially high. Thus, the nature of impact is 'major' and classified as significant and 'must be managed'.				

3.1.3.7 Social Tension

a. Environmental Baseline

<u>*Construction Phase*</u>

People living in the coastal of Bintuni Bay have general livelihood as a fisherman. Thus, the level of community reliance on fish resources is very high, as a source of revenue / income. In addition, among the clan scattered in several villages / districts and even between the two districts (Teluk Bintuni and Fakfak Regencies) frequently visit each other in order to strengthen kinship with each other. In addition, local communities utilize the waters / sea as the main transport route to reach the village / district or another district. Thus, the level of dependence of local communities on the waters / sea is very high.

The existence of offshore platforms can lead to a negative perception in society, especially in relation to the impact on fishing activities and sea transportation accessibility. Existence of the platform and the activity of Tangguh LNG can limit community movement in the waters / sea. The existence of conflicts in utilization of resources is a great potential for increasing social tensions, both within the community and between the community and Tangguh LNG. Social tensions that occur can affect the operation of Tangguh LNG, either directly or indirectly.

At the time of public consultation activities, there are numerous public concerns appears related to the threat of disturbance of livelihood zones and transportation access that they have today. In general, the limited understanding about the activities of the Tangguh LNG Expansion Project motivates public concern. Nevertheless, this fact requires a treatment in order to avoid social unrest or social tension, especially in the operation phase that lasts a relatively long period of time (± 25 years since the operation phase starts).

b. Impact Prediction and Evaluation

<u>*Construction Phase – Impact Prediction*</u>

A derivative impact of community perception is the expectations to fishery activity and sea transportation accessibility disturbances as well as flaring activity. There is a high gap between people's expectations related to job opportunities; knowledge of basic health knowledge; and limited knowledge of the safety exclusion zone and flaring activities. On the other hand, there are mechanisms within the community to express grievances/complaints to community leaders and head of village who will then be discussed with the project parties, but if no agreement is reached then it is predicted to create social tensions.

Construction Phase – Impact Evaluation

Community perception related to job opportunities, fishery activity and sea transportation accesibility disturbances, as well as flaring activity, will not necessarily lead to social tension. Coupled with the mechanisms within the community to submit complaints to the community leaders and head of village which would then be discussed with the project parties. However, specifically in the on fishery activity and sea transportation accesibility disturbances, community perception arise in a high intensity. Therefore, social tensions are categorized as significant impacts ('major') and 'must be managed'.

Table III-28 Impact Evaluation – Gas Exploitation Activities in Construction Phase against the Emergence of Social Tension

Impact	*The transportation and installation of platform are predicted to social tension impact which is derived from the community perception associated with job opportunities; supporting vessel movement for the installation of offshore platforms; the application of safety exclusion zone surrounding the area of installation of offshore platforms, as well as flaring activity.*				
Nature of Impact	**Negative**	**Positive**			
	Social tension in community is the impact of community perception and a derivative impact from negative perception of community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tensions in community is the impact of 'derivative' impact' of community perception associated with the expectation to work, on fishery activity and sea transportation accessibility disturbances as well as flaring activity.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Production drilling wells and installation of platforms are predicted to occur in interim period (6 months). Due to the potential impact of social tensions in the local community, it is expected to last for less than one year, then the impact lasts longer and is classified as temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	Social tension is predicted to arise from local communities living in the villages closest to the area of installation of platform.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time there is a variety of perception growing in a community-related to activities Tangguh LNG. In addition, the growing community expectation is related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural *Social tensions related to perceptions of community about fishery activity and sea transportation accessibility disturbances; gaps about work expectations; and concerns of the health impacts affected by flaring activity are predicted to occur in low intensity. These impacts are caused by social perceptions increase which does not necessarily lead to social tensions. On the other hand, gas exploitation activities in the construction phase occurred in the interim period (6 months). Thus, the magnitude of the impact is 'minor'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Sensitivity of community perception is high but the rise of community perception does not necessarily lead to social tensions. There are mechanisms in the community related to grievances/complaints that are usually submitted to the community leaders or head of village, and then discussed with the project parties. Thus, the sensitivity of impact is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**

	There is a gap between the high expectations of community associated with job oppourtunities; basic health knowledge; and limited knowledge of safety exclusion zone and flaring activity. On the other hand, although there is a mechanism within the community to submit complaints to the community leaders and head of village which would then be discussed with the project parties, but if no agreement is reached then predicted to lead to social tensions. Thus, the impact of severity is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	There is a grievance mechanism from community to community leaders, as such, although there is a high negative perception of the community, it does not necessarily turn into social tensions.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Community perception related to job opportunities, fishery activity and sea transportation accesibility disturbances, as well as flaring activity, will not necessarily lead to social tension. Coupled with the mechanisms within the community to submit complaints to the community leaders and head of village which would then be discussed with the project parties. However, specifically in fishery activity and sea transportation accesibility disturbances, community perceptions arise in a high intensity (every day), while the dependence of communities on the area of fishing activity and sea transportation is still quite high. On the other hand, these impacts only last for interim period (6 months). Therefore, social tensions are categorized as significant impacts (at the level of 'moderate') and must be managed.				

Operation Phase – Impact Prediction

The application of safety exclusion zone will restrict fishing ground area in Bintuni Bay and Kokas District waters. This condition is predicted to raise negative perception of local community.

If these negative perceptions are not managed properly, for example, through an improved understanding of society, has the potential to cause social tension. The potential impact of social tensions will be seen as the overall impact of the Tangguh LNG Expansion Project. If the negative perception of community is not managed properly, could potentially lead to social tensions.

Operation Phase – Impact Evaluation

To determine or assess the impact of community perception of fishery activity and sea transportation accessibility disturbances can be seen in the following **Table III-29** Impact Evaluation:

Table III-29 Impact Evaluation - Gas Exploitation Activities against the Emergence of Social Tension in Operation Phase

Impact	*Gas exploitation activities is predicted to result social tension impact which is a derivative impact of community perception related to the presence of offshore platforms and application of safety exclusion zone*			
Nature of Impact	**Negative**	**Positive**		
	Social tension in community is a derivative impact of accumulated negative perception of community			

Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tension in community is a derivative impact of accumulated negative perception of community related to fishery activity and sea ransportation accessibility disturbances				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Gas exploitation activities in the operation phase will last for approximately 25 years since the operation phase begins. Because the community perception will continue to exist in the local community for more than 5 years, then the impact lasts longer and is classified as a long-term impact.				
Impact Extent	**Local**	**Regional**	**Global**		
	Social tension in community that is considered as significant is predicted to arise from people living in villages close to the area of offshore platforms.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time there is a variety of perception growing in a community-related to activities Tangguh LNG. In addition, the growing community expectation is related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural *Social tensions related to perceptions of community about fishery activity and sea transportation accessibility disturbances are predicted to high intensity. The impact is caused by social perceptions increase which does not necessarily lead to social tensions. Social tension appears in the villages closest to the area of offshore platform. On the other hand, gas exploitation activities in the operation phase occurred in the long term period (±25 years). Thus, the magnitude of the impact is 'high'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Sensitivity of community perception is high but the rise of community perception does not necessarily lead to social tensions. There are mechanisms in the community related to grievances/complaints that are usually submitted to the community leaders or head of village, and then discussed with the project parties. Thus, the sensitivity of impact is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	There is a gap between the community knowledge associated with safety exclusion zone for offshore platforms. On the other hand, although there is a mechanism within the community to submit complaints to the community leaders and head of village which would then be discussed with the project parties, the abscence of agreement is predicted to lead to social tensions. Thus, the impact of severity is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The community perception as the impact of fishing activity andea transportation accessibility does not necessarily impact the social tensions. There are mechanisms in the community if there are grievances/complaints to be submitted in advance to the community leaders and head of the village, which would then be discussed with the Tangguh LNG.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Community perception related to fishery activity and sea transportation accesibility disturbances will not necessarily lead to social tension. Coupled with the mechanisms within the community to submit complaints to the community leaders and head of village which would then be discussed with Tangguh LNG. However, the accumulative perception potentially results social severity which leads to social tension. Thus, the impact is classified as 'major' and must be managed.				

3.2 Gas Transmission Activities

3.2.1 Geophysical-Chemical

3.2.1.1 Seawater Quality

a. Increase in Total Suspended Solids (TSS)

- **Environmental Baseline**

The pipe installation nearshore is located at northeast of the Tangguh LNG. According to environmental baseline survey conducted during July-August 2012 (dry season) and March - April 2013 (wet season), TSS concentrations at this location (NS-04) was 43 mg/L during the dry season and 44 mg/L during the wet season. Results of routine monitoring during 2011 (47 monitoring data), showed TSS concentrations ranging from 32 mg/L to 267 mg/L with an average of 102 mg/L during the dry season, whereas during the wet season concentrations ranged from 23 mg/L to 369 mg/L with an average of 139 mg/L. From the 47 TSS monitoring data, a total of 27 or 57% TSS monitoring results exceeded the quality standards for mangroves which is ≤ 80 mg/L according to Minister of the Environment Decree No. 51 Year 2004. This indicates that the TSS concentrations nearshore, are naturally quite high.

At the location of offshore activities, TSS concentrations ranged from 2-18 mg/L during the dry season and 3-9 mg/L during the wet season.

- **Impact Prediction**

Subsea pipelines will be installed to channel gas from the offshore platform site to the Onshore Receiving Facility – ORF. The pipeline installation is estimated to take 10-12 months to complete for each pipeline with an estimated length of up to 30 km. Eventually there will be up to 11 subsea pipelines (two pipelines during the ROA and WDA initial development, and nine pipelines for future development) that will be developed at different time and location. The pipeline installation is not a continuous activity. After a pipeline is installed, there will be a grace period before the next pipeline installation.

The impact distribution will occur along the pipeline route, which has a length of up to 30 km with a width of 2 meters which will be installed at different time and location.

- **Impact Evaluation**

According to modelings of nearshore dredging activity, it was found that the maximum increase in TSS concentration was 4.8 mg/L during the dry season and 11.8 mg/L during the wet season.

If the maximum increase in TSS due to dredging during the dry season is added to the ambient TSS concentration during the dry season, the TSS value will amount to 37-279 mg/L, while the maximum increase of TSS due to dredging during the wet season, if added to the ambient TSS concentration during the wet season , will amount to a TSS value of 35-381 mg/L.

Table III-30 Impact Evaluation –Seabed Trenching, Pipeline Installation and Rock Dumping on Increase in TSS Concentration

Description of Impact	*Sediment on the seabed will be disturbed due to the seabed trenching, the pipeline installation and rock dumping during the pipeline construction. This will temporarily increase the TSS concentration along the pipeline.*				
Nature of Impact	**Negative**	**Positive**			
	Trenching at the seabed, the pipeline installation, and rock dumping will increase the concentration of TSS temporarily.				
Type of Impact	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Trenching will directly increase the concentration of TSS along the pipeline construction site.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The duration of the impact is 10-12 months for each pipeline that is estimated to measure up to 30 km in length. Later on, there will be up to 11 subsea pipelines (two pipelines during the ROA and WDA initial development, and up to nine pipelines during future development) that will be developed at different time and location. The pipeline installation is not continuous activity. After a pipeline is installed, there will be a grace period before the next pipeline installation. *TSS tends return to normal conditions rapidly.*				
Extent of Impact	**Local**	**Regional**	**Global**		
	The impact distribution will occur along the pipeline route, which has a length of up to 30 km with a width of 2 meters which will be installed at different location and time.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The installation of the pipeline will be carried out from the offshore platform site to the Onshore Receiving Facility - ORF. *The pipe installation nearshore is located northeast of the Tangguh LNG. According to an environmental baseline survey conducted during July-August 2012 (dry season) and March - April 2013 (wet season), TSS concentrations at this location (NS-04) was 43 mg/L during the dry season and 44 mg/L during the wet season. Results of routine monitoring during 2011 (47 monitoring data), showed TSS concentrations ranging from 32 mg/L to 267 mg/L with an average of 102 mg/L during the dry season, whereas during the wet season concentrations ranged from 23 mg/L to 369 mg/L with an average of 139 mg/L. From the 47 TSS monitoring data, a total of 27 or 57% TSS monitoring results exceeded the quality standards for mangroves which is ≤ 80 mg/L according to Minister of the Environment Decree No. 51 in 2004. This indicates that the TSS concentrations near shore, are naturally quite high.* *While at the location of offshore activities, TSS concentrations ranged from 2-18 mg/L during the dry season and 3-9 mg/L during the wet season.* *According to modelings of dredging nearshore, it was found that the maximum increase in TSS concentration was 4.8 mg/L during the dry season and 11.8 mg/L during the wet season.* *If the maximum increase in TSS due to dredging during the dry season is added to the ambient TSS concentration during the dry season, the TSS value will amount 37-279 mg/L, while the maximum increase in TSS due to dredging during the wet season, if added to the ambient TSS concentration during the wet season, will amount to a TSS value of 35-381 mg/L.* *The pipeline installation may create a smaller impact. Overall, the magnitude of the impact is categorized as 'medium'.*				
Impact Receptor	**Low**	**Medium**	**High**		

Sensitivity	*Trenching at the seabed, the pipeline installation and rock dumping will temporarily increase the concentration in TSS. However, conditions will return to normal quickly because of the sea currents.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is low considering the impact magnitude is medium and the impact receptor sensitivity is low.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Trenching at the seabed, the pipeline installation, and rock dumping will increase TSS concentrations along the pipeline construction site. *Later on, there will be up to 11 subsea pipelines (two pipelines during the ROA and WDA initial development, and up to nine pipelines during future development) that will be developed at different time and location. The pipeline installation is not a continuous activity. After the pipeline is installed, there will be a grace period before the next pipeline installation.* *TSS usually settle quickly, so that during trenching, the turbidity caused by a section of the pipeline will have been reduced when moving to the next section of the same pipeline.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the impact severity is 'low' and the impact likelihood is 'medium', the impact significance is considered 'negligible-minor' and is an insignificant impact.				

Based on the evaluation results it can be seen that the impact significance of the seabed trenching, the pipeline installation, and rock dumping on TSS levels is categorized as 'negligible-minor'. Therefore, the impact is categorized 'insignificant'.

b. Decrease in Dissolved Oxygen (DO) Concentrations

- **Environmental Baseline**

The DO concentration at offshore locations varies between 4.86 to 6.17 mg/L during the dry season and 5.33 to 6.86 mg/L during the wet season.

DO content at the area of the disposal point near shore varies between 5.16 to 6.04 mg/L during the dry season and 5.30 to 5.60 mg/L during the wet season. In general, the DO concentration during the dry and wet seasons at all sampling locations meets the quality standards according to Minister of the Environment Decree No. 51 Year 2004 for marine biota, i.e. > 5 mg/L, except at the OS 09 location (the waters around the ROA Platform) where during the dry season DO concentration are slightly lower than the threshold value of 5 mg/L i.e. 4.86 mg/L (however this DO value is not considered low).

- **Impact Prediction**

– **Discharge into the Sea**

There will be an installation of two subsea pipelines during the initial development and up to nine subsea pipelines during future development.

The volume of water used for hydrotests is estimated at 250 m^3 per km for a pipeline with a diameter of 24 ". The length of the pipelines varies up to 30 km.

After hydrotests are conducted, the water in the pipeline will be driven out with the use of a pig. The speed of the pig used in modeling is 0.5 m/s. The volume is approximately 250 m^3/km. Thus, the flow rate is 450 m^3/h. The Discharge is carried out at -3 m LAT. **Table III-19** shows a the hydrotest discharge into sea. Four modeling scenarios, namely ROA, VRF, WDA and UBA were chosen to represent the whole hydrotest (up to 11 pipelines).

Table III-31 Hydrotest Water Discharge

Location	Length of Pipe (km)	Volume (m^3)	Duration of Discharge (hours)
ROA	14	3,500	7.8
VRF	21	5,250	11.7
WDA	32	8,000	17.8
UBA	56	14,000	31.1

Additive concentration input is assumed as shown in **Table III-20**.

Table III-32 Hydrotest Water Additive Concentration Input

Parameter	Concentration (mg/L)
Oxygen scavenger	100
Biocide	550
Fluorescein Dye	30

Figure III-16 and **Figure III-17** shows the contour of minimum dilution factor during hydrotest water discharge at the ROA platform during the dry and wet seasons. The lowest dilution factor (equivalent to the largest concentration) during the dry season is 2,600 times and during the wet season is 1,300 times at the outfall. Predicted maximum concentrations are shown in **Table III-20**.

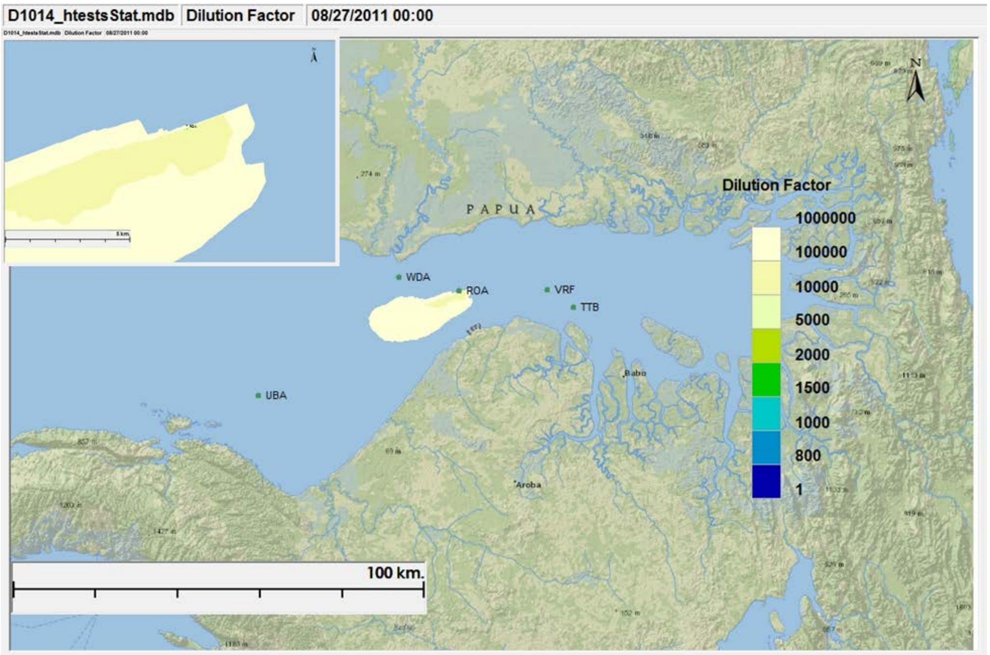


Figure III-16 **Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at ROA during the Dry Season**

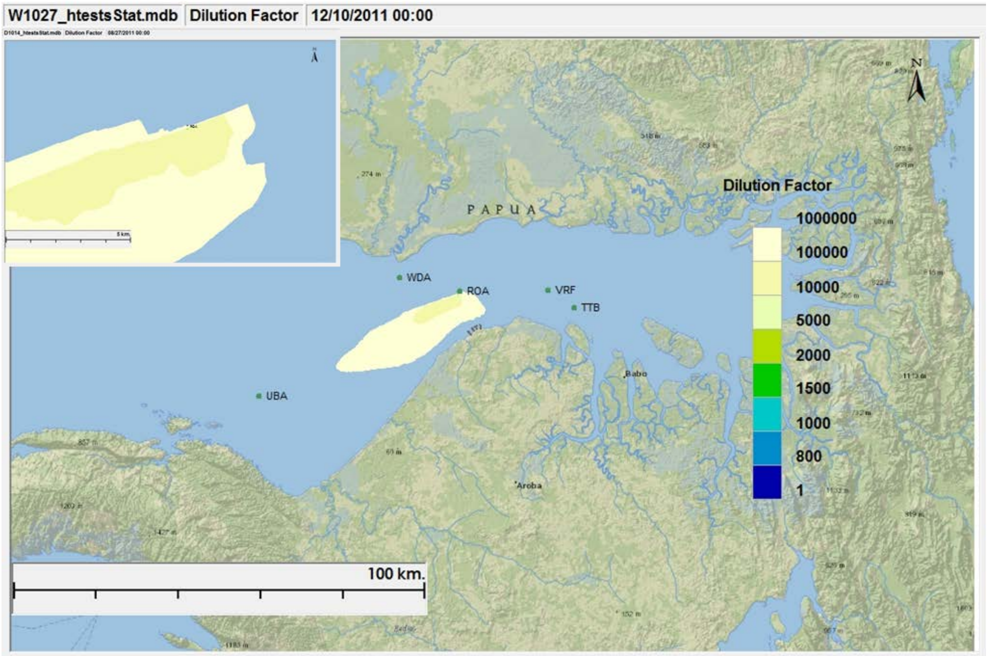


Figure III-17 **Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at ROA during the Wet season**

Figure III-18 and **Figure III-19** shows the contour of minimum dilution factor during hydrotest water discharge at WDA. The lowest dilution factor is 3,300 times during the dry season and 2,200 times during the wet season. The maximum concentrations are shown in **Table III-20**.

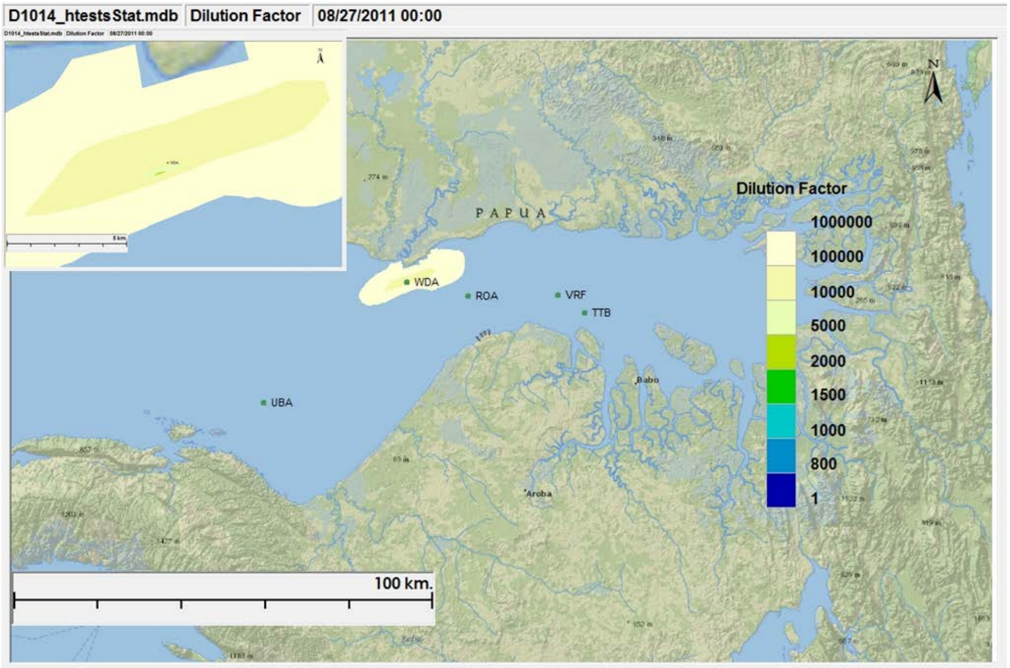


Figure III-18 Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at WDA during the Dry Season

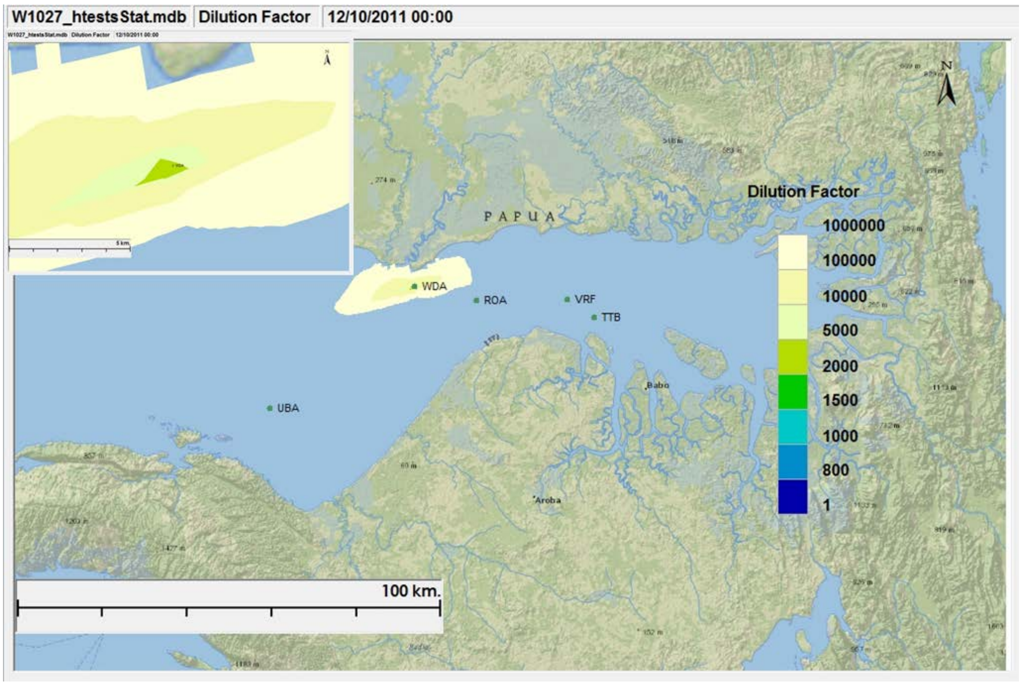


Figure III-19 Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at WDA during the Wet season

Figure III-20 and **Figure III-21** shows the contour of minimum dilution factor during hydrotest water discharge at VRF. The lowest dilution factor is 2,000 times during the dry season and 780 times during the wet season. The maximum concentrations are shown in **Table III-20**.

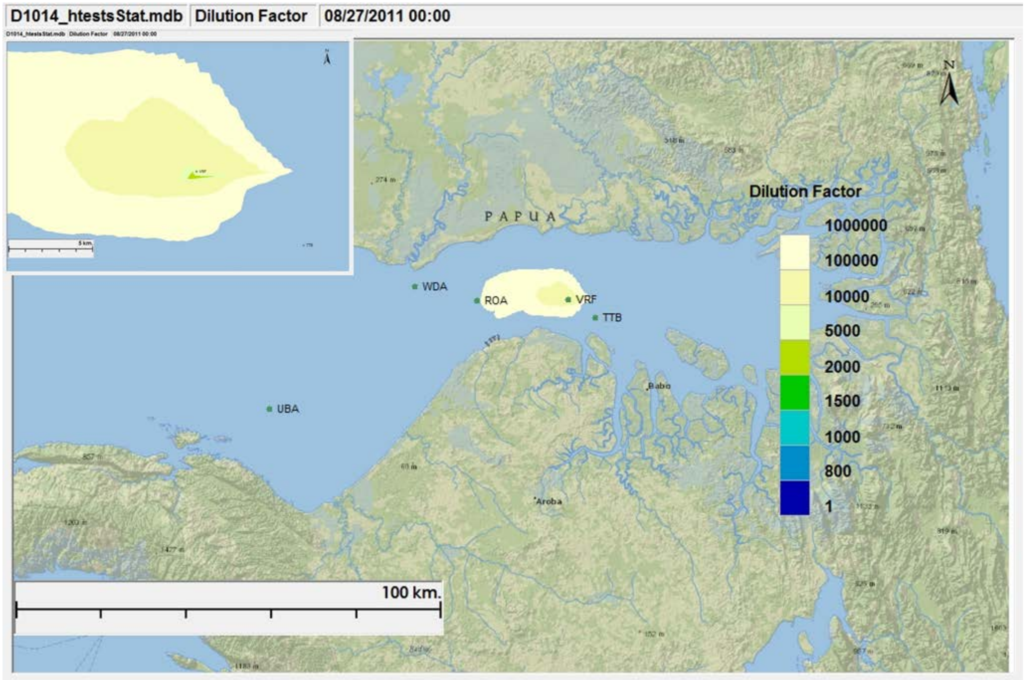


Figure III-20 **Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at VRF during the Dry Season**

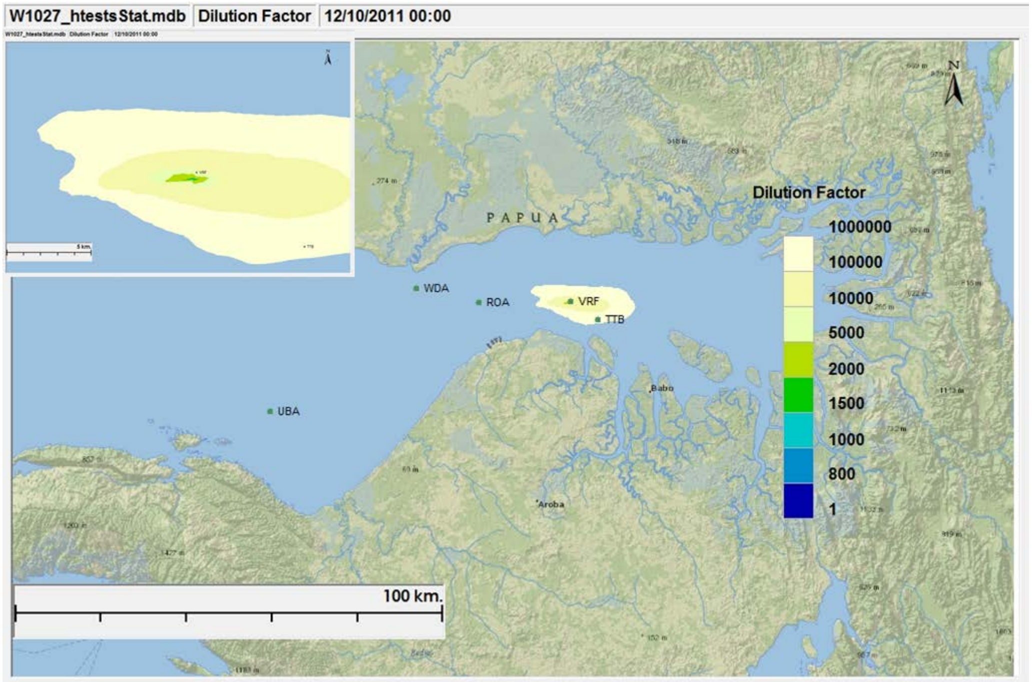


Figure III-21 **Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at VRF during the Wet season**

Figure III-22 and **Figure III-23** shows the contour of minimum dilution factor during hydrotest water discharge at UBA. The lowest dilution factor is 4,400 times during the dry season and 3,300 times during the wet season. The maximum concentrations are shown in **Table III-20**.

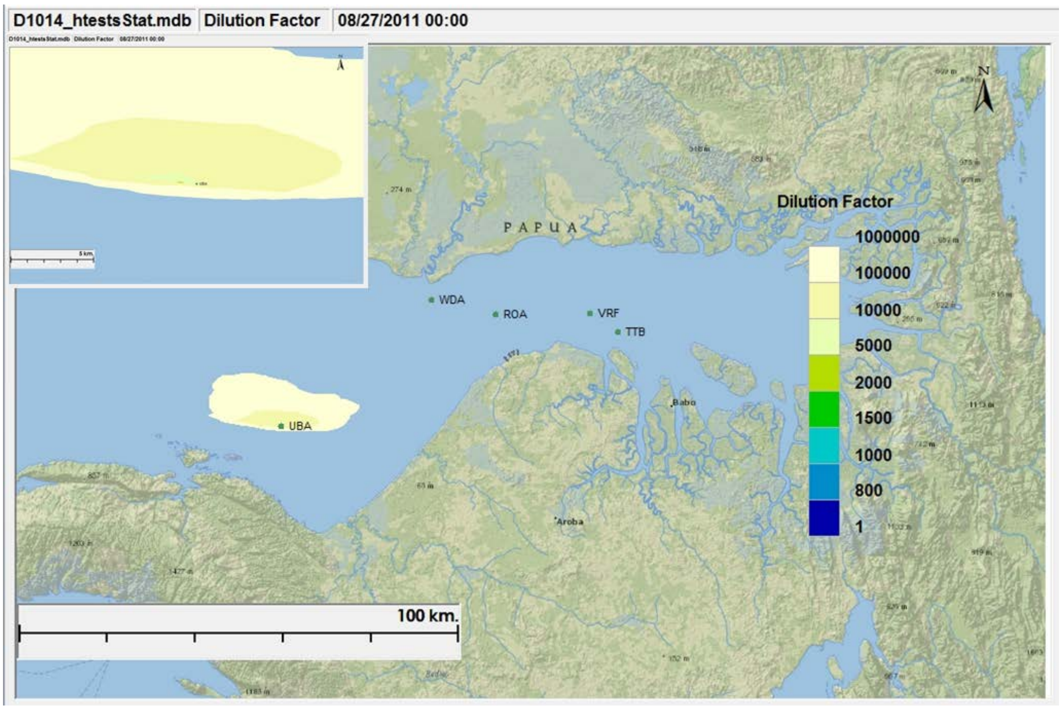


Figure III-22 Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at UBA during the Dry Season

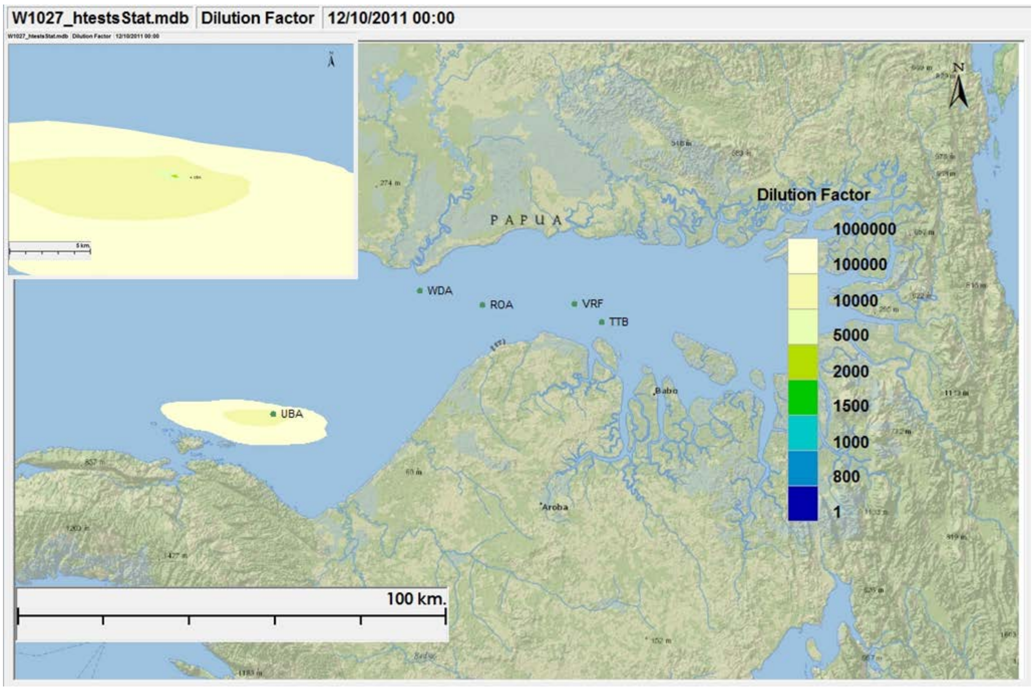


Figure III-23 Minimum Dilution Factor Contour Plot of Hydrotest Water Discharge at UBA during the Wet season

Table III-33 Predicted Maximum Concentrations based on the Result of Hydrotest Modelings at the Outfall

Parameter	Maximum Concentration (mg/L)							
	ROA		WDA		VRF		UBA	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Oxygen scavenger	0.038	0.075	0.030	0.045	0.049	0.13	0.022	0.032
Biocide	0.21	0.41	0.16	0.24	0.27	0.71	0.12	0.17
Fluorescein Dye	0.011	0.022	0.009	0.013	0.014	0.038	0.0067	0.0096

Although there are no seawater quality standards for the three parameters, with a minimum dilution factor of 700 times at a distance of 500 m, it is predicted that the concentrations of the three parameters at a distance of 500 m will be very low.

– **Hydrotest Water Discharge to Onshore Temporary Storage Facilities before into the Sea at LNG Jetty 1 or LNG Jetty 2**

For this alternative, water from hydrotests will be sent to an onshore temporary storage facility before it is discharged at the same outfall of other wastewater from the Tangguh LNG activities (common outfall) at the LNG Jetty 1 or LNG Jetty 2. The total wastewater discharge used for modeling is 1,900 m^3/h (with a four LNG trains operating scheme) and the highest hydrotest water use, i.e. 14,000 m^3 with a discharge flow of 450 m^3/h.

Figure III-24 and **Figure III-25** shows the minimum dilution factor of hydrotest water at the LNG Jetty 1 outfall during the dry and wet seasons. The lowest dilution factor is 21 times during the dry season and 27 times during the wet season. The maximum concentration parameters are shown in **Table III-22**.

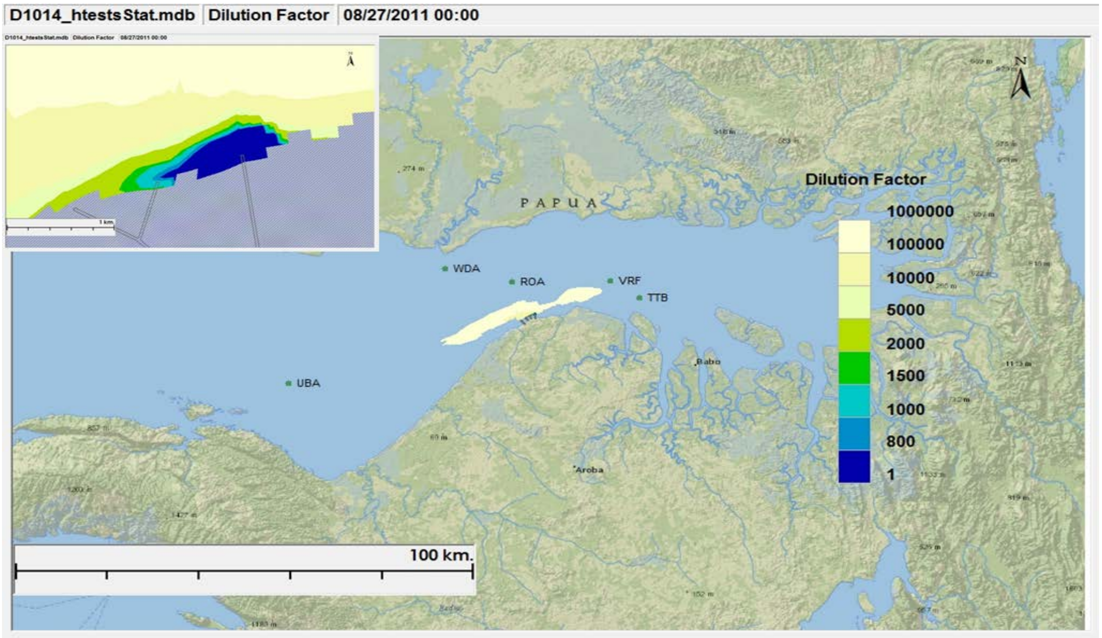


Figure III-24 Minimum Dilution Factor Contour Plot of the Combined Hydrotest Water and Comingled Wastewater Discharge at the LNG Jetty 1 during the Dry Season

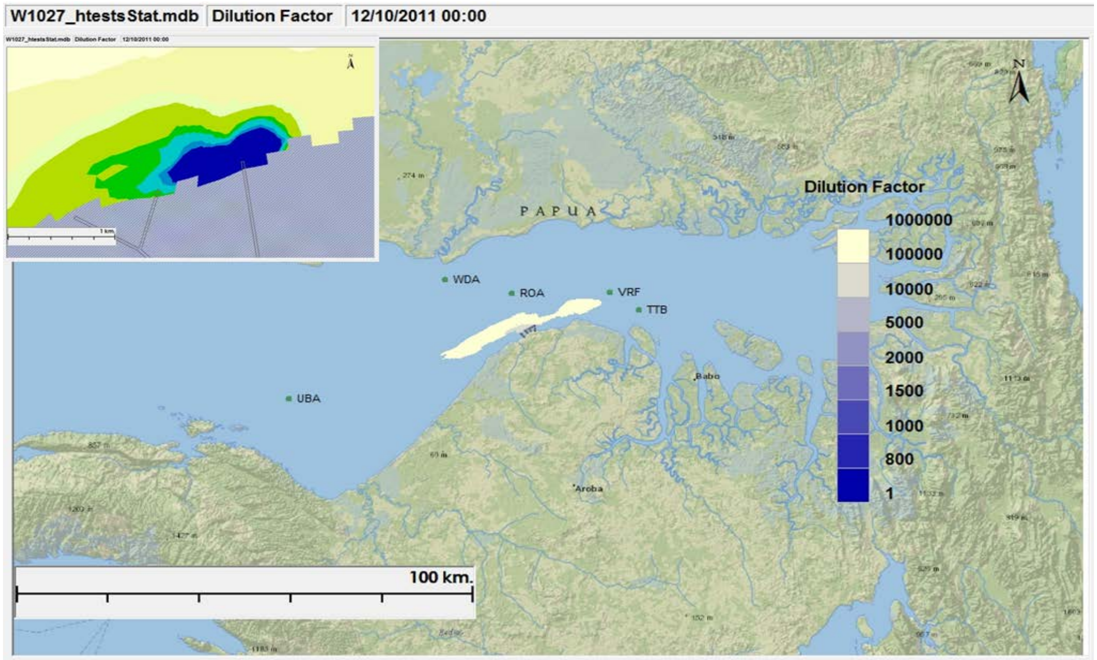


Figure III-25 Minimum Dilution Factor Contour Plot of the Combined Hydrotest Water and Comingled Wastewater Discharge at the LNG Jetty 1 during the Wet season

Figure III-26 and **Figure III-27** shows the minimum dilution factor of the combined hydrotest water and comingled wastewater at LNG Jetty 2 during the dry and wet seasons. The lowest dilution factor is 49 times during the dry season and 44 times during the wet season. The discharge dilution factor at LNG Jetty 2 is higher than LNG Jetty 1. The maximum concentration parameters are shown in **Table III-22**.

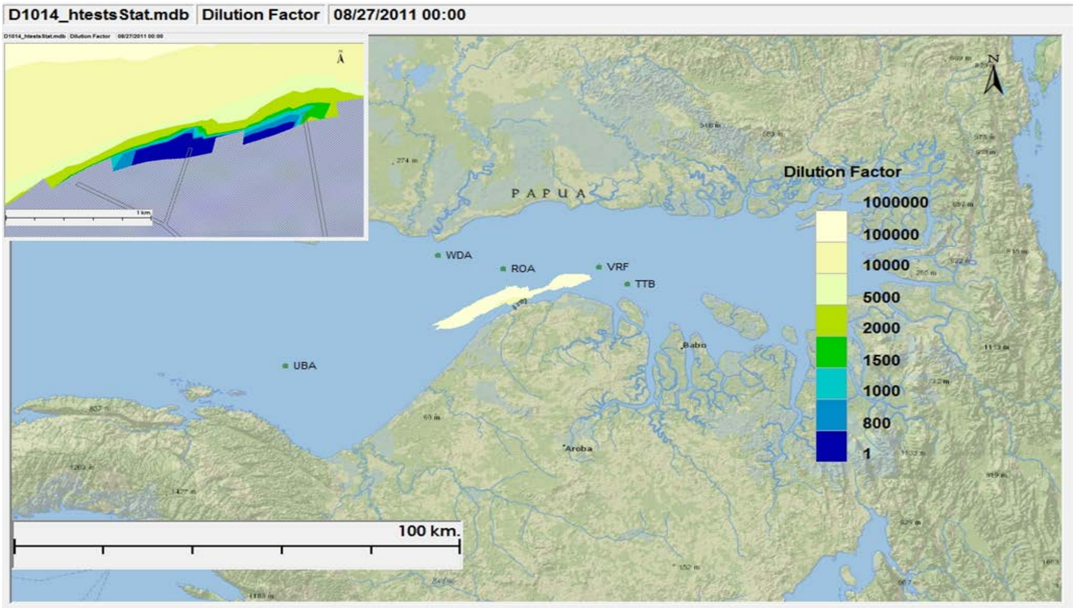


Figure III-26 **Minimum Dilution Factor Contour Plot of the Combined Hydrotest Water and Comingled Wastewater at the LNG Jetty 2 during the Dry Season**

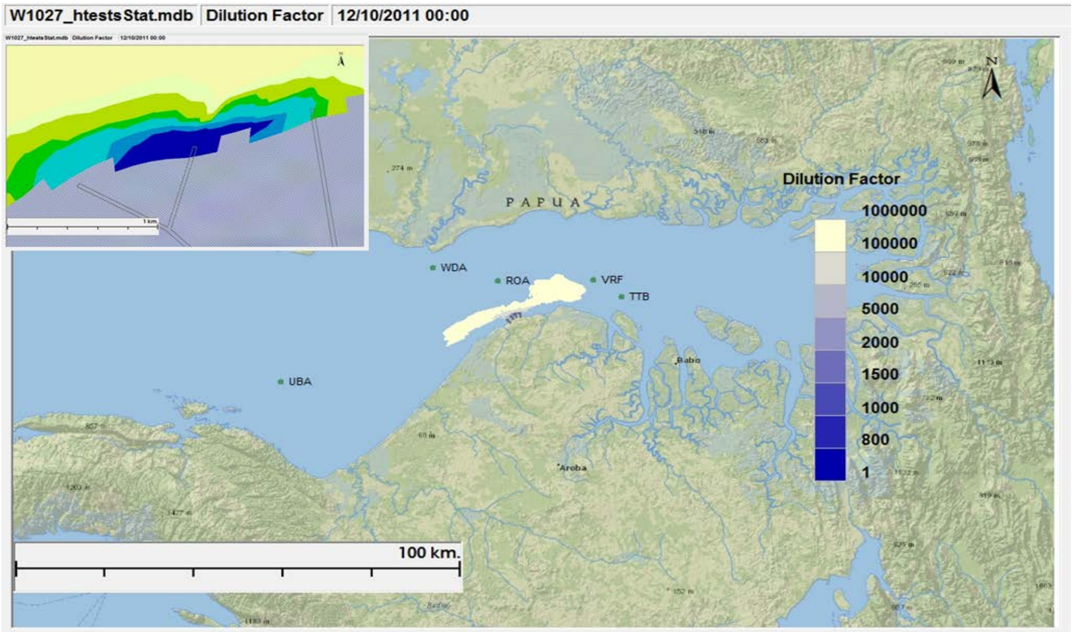


Figure III-27 **Minimum Dilution Factor Contour Plot of the Combined Hydrotest Water and Comingled Wastewater at the LNG Jetty 2 during the Wet season**

Table III-34 Predicted Maximum Concentrations of Oxygen Scavenger, Biocide and Fluorescein Dye in the Seawater from the Discharge of the Combined Hydrotest Water and Comingled Wastewater at a Distance of 50 M and 100 M from the Outfall

Parameter	Maximum Concentration (mg/L)							
	LNG Jetty 1				LNG Jetty 2			
	Dry		Wet		Dry		Wet	
	50m	100m	50m	100m	50m	50m	50m	100m
Oxygen scavenger	4.8	3.1	3.7	2.2	2.0	0.6	2.3	0.7
Biocide	26.0	17.0	20.0	12.0	11.0	3.6	13.0	3.9
Fluorescein Dye	1.4	0.9	1.1	0.7	0.6	0.2	0.7	0.2

- **Impact Evaluation**

Hydrotest water will be pushed out of the piping using nitrogen and TEG. The nitrogen used is approximately 50 m^3 and TEG approximately 40 m^3, depending on the diameter of the pipe. If the interval between the hydrotest and water discharge is long, hence there is possibility to change the water every six months to ensure that the pipeline is protected.

According to the modeling results, oxygen scavenger concentration at each outfall of the four pipelines modeled, oxygen scavenger concentrations ranged from 0.022 to 0.049 mg/L during the dry season and 0.032 to 0.130 mg/L during the wet season. Generally, the type of oxygen scavenger used is ammonium bisulfite, sodium bisulfite or sodium sulfite.

DO concentrations in the area around the outfall varies between 4.86 to 6.17 mg/L during the dry season and 5.33 to 6.86 mg/L during the wet season. Eight parts sodium sulfite will bind with one part oxygen in the water, so that the oxygen level is estimated to decrease to approximately 0.003 to 0.006 mg/L during the dry season and 0.004 to 0.015 mg/L during the wet season for approximately 8 -31 hours after discharge at each point. The DO standard of seawater in accordance with Minister of the Environment Decree No. 51 Year 2004 is > 5 mg/L for marine biota.

Table III-35 Impact Evaluation – Alternative of Offshore Hydrotest Water Discharge and its Correlation with Decrease in DO Concentration

Impact Description	*DO concentration will decrease due to the discharge of hydrotest water. Hydrotest water will be discharged after the hydrotest process is completed at the platform site. There will be an installation of two subsea pipelines during the initial development and up to nine subsea pipelines for future development.* *The volume of the hydrotest water is estimated at 250 m^3 per km for a 24" diameter pipeline. Pipeline lengths vary up to 30 km.*

	Hydrotest water will contain an oxygen scavenger (100 ppm), biocide (550 ppm) and fluorescein dye (30 ppm). The chemicals that will be used are environmentally friendly based on the recommendation of the Director General of Oil and Gas. During the water discharging process, hydrotest water will be pumped out of the pipeline using feed gas or nitrogen using a series of pigs, and chemicals (approximately 50 m^3 of nitrogen and 40 m^3 of TEG, depending on the diameter of the pipe) between the pigs to prevent hydration. If the interval between the hydrotest and water discharge is long, a water replacement may be done every six months to ensure the pipeline is protected.				
Nature of Impact	**Negative**	**Positive**			
	The discharge will decrease the DO concentration of the seawater at the outfall, which may have an impact on nekton in the area.				
Type of Impact	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The directly discharge of residual oxygen scavenger from the hydrotest water will decrease DO concentration through the process of oxygen binding, at the waters around the hydrotest water disposal site.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The time required before hydrotest water is discharged varies from 8-31 hours. Later on there will be up to 11 undersea pipelines (two pipelines during the initial development of ROA and WDA, and nine pipelines during future development) which will be developed at different locations. *Oxygen concentrations will temporarily experience a decrease. However, in a short time it will return to normal levels after oxygen scavenger concentrations begin to decrease in the water body.*				
Extent of Impact	**Local**	**Regional**	**Global**		
	According to offshore hydrotest water discharge experimental models, the solubility factor of 700 times will occur at a radius of 500 m from the outfall. Thus, the extent of the impact can be categorized as local.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	According to oxygen scavenger concentration modelings at each outfall of the four pipelines modeled, oxygen scavenger concentrations ranged from 0.022 - 0.049 mg/L during the dry season and 0.032 to 0.130 mg/L during the wet season. Generally, the type of oxygen scavenger used is ammonium bisulfite, sodium bisulfite or sodium sulfite. *DO concentrations in the area around the discharge point varies between 4.86 - 6.17 mg/L during the dry season and 5.33 - 6.86 mg/L during the wet season. Eight parts sodium sulfite will bind with one part oxygen in the water, so that the oxygen level is estimated to decrease to approximately 0.003 - 0.006 mg/L during the dry season and 0.004 - 0.015 mg/L during the wet season for approximately 8 -31 hours after discharge at each point. The use of other types of oxygen scavengers is estimated to produce similar results. The DO Standards in accordance with Minister of the Environment Decree No. 51 Year 2004 is > 5 mg/L for marine biota. Considering the small decrease of DO concentration, the magnitude of the impact is categorized as 'small'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**Large**		
	The impact receptor (resources) of the decrease in DO content is the water body at the Bintuni Bay (ecosystem) and nekton (active organisms) that will move away from the location where the impact occurs, which will make the receptor sensitivity to be categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is categorized by the combination of the impact magnitude and impact receptor sensitivity. Since the magnitude of the impact is categorized as 'small' and the impact receptor sensitivity is 'low', the impact severity is categorized as 'slight'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	A hydrotest will be conducted once for each pipeline, however if the duration of the hydrotest and water discharge is too long, the water in the pipeline may be replaced every 6 months. Thus, the impact likelihood is also categorized as 'low'.				

Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the severity of the impact is very low, and the impact likelihood is small, the impact significance is negligible and is not a significant impact.				

Based on the evaluation results it can be seen that the significance of the impact of offshore hydrotest water discharge alternatives on decrease in DO concentration, is categorized as 'negligible'. Therefore, the impact is categorized as an 'insignificant impact'.

Table III-36 Impact Evaluation –Alternative of Hydrotest Water Discharge to Offshore Temporary Storage Facilities before it is Discharged into the Sea at LNG Jetty 1 or LNG Jetty 2

Impact Description	*The alternatives being considered include temporary storage at an offshore temporary holding facility before being discharged at the same discharge point of other wastewater from Tangguh LNG activities (common outfall) at the LNG Jetty 1 or LNG Jetty 2. Decrease in DO concentration may occur due to the discharge of hydrotest water nearshore.* *There will be an installation of two subsea pipelines during the initial development and up to nine subsea pipelines during future development. The volume of the hydrotest water is estimated at 250 m³ per km for a 24" diameter pipeline. Pipeline lengths vary up to 30 km.* *The hydrotest water will contain an oxygen scavenger chemical (100 ppm), biocide (550 ppm) and fluorescein dye (30 ppm). During the water dewatering process, hydrotest water will be pumped out of the pipeline using feed gas or nitrogen using a series of pigs, and chemicals (approximately 50 m³ of nitrogen and 40 m³ of TEG, depending on the diameter of the pipe) between the pigs to prevent hydration. If the interval between the hydrotest and water discharge is long, a water replacement may be done every six months to ensure the pipeline is protected.*				
Impact Nature	**Negative**	**Positive**			
	The discharge will temporarily decrease the DO concentration of the water at the outfall, which may have an impact on nekton in the surrounding estuaries.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The discharge of residual oxygen scavenger from the hydrotest water will directly decrease DO concentrations. Residual oxygen scavenger compounds will consume the oxygen contained in the waters around the disposal site.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The hydrotest is performed after the installation of the pipeline is completed. A hydrotest will be conducted once for each pipeline, however if the duration of the hydrotest and water discharge is too long, the water in the pipeline may be replaced every 6 months. *There will be an installation of two subsea pipelines during the initial development and up to nine subsea pipelines during future development. The impact will occur at different time and location during the hydrotest of each pipeline.* *The time required for the discharge of the hydrotest water is approximately 31 hours. Oxygen concentrations will temporarily be reduced. However, after a short time it will return to normal levels after the oxygen scavenger concentrations in the water body begins to decrease.* *Thus, the impact is categorized as 'temporary'. This impact will be repeated at different time and location during each pipeline hydrotest.*				
Impact Extent	**Local**	**Regional**	**Global**		
	According to the modelings of hydrotest water discharge nearshore, the dilution factor varies between 20 times - 50 times for the first 50m from each outfall. Thus, the extent of the impact is categorized as 'local'.				

Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Discharge Scenario at LNG Jetty 1: *According to the modeling results, oxygen scavenger concentrations amount to 4.8 mg/L during the dry season and 3.7 mg / L during the wet season at a distance of 50 m from the outfall.* *DO concentration in the area surrounding the discharge point varies between 5.16 - 5.95 mg/L during the dry season and 5.30 - 5.60 mg/L during the wet season. The oxygen scavenger that is commonly used is sodium sulfite. Eight parts sodium sulfite will bind with one part oxygen in the water, so that the oxygen level at the area of the disposal is estimated to decrease to approximately 0.61 mg/L during the dry season and 0.45 mg/L during the wet season for approximately 31 hours hours after the discharge. The DO Standards according to Minister of the Environment Decree No. 51 Year 2004 is > 5 mg/L for marine biota. Therefore, during discharge, the decrease in DO concentration is still in accordance with the quality standard.* ***Discharge Scenario at LNG Jetty 2:*** *According to the results of experiment models, the concentration of oxygen scavenger amounts to 2.0 mg /L during the dry season and 2.3 mg/L during the wet season at a distance of 50 m from the outfall.* *DO concentration in the area surrounding the outfall varies between 5.16 - 5.95 mg/L during the dry season and 5.30 - 5.60 mg/L during the wet season. The oxygen scavenger that is commonly used is sodium sulfite. Eight parts sodium sulfite will bind with one part oxygen in the water, so that the oxygen level at the area of the disposal is estimated to decrease to approximately 0.26 mg/L during the dry season and 0.27 mg/L during the wet season for approximately 31 hours hours after the discharge at the specified point. The DO Standards according to Minister of the Environment Decree No. 51 Year 2004 is > 5 mg/L for marine biota. Therefore, during discharge, the decrease in DO concentration is still in accordance with the quality standard.* *Both discharge at LNG Jetty 1 & 2 have the same impact on nekton. However, they do not significantly decrease the concentration of DO. Dissolution occurs up to 50 times at a distance of 50 meters from the outfall so the effects are temporary and normal conditions is reversible. Therefore, the magnitude of the impact is categorized as 'small'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The receptor of the decrease in DO concentration is the marine ecosystems nearshore of the Bintuni Bay and nekton (active organisms) that will move away from the location where the impact occurs. Therefore, the impact receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is categorized by the combination of the impact magnitude and impact receptor sensitivity. Since the magnitude of the impact is categorized as 'small' and the impact receptor sensitivity is 'low', the impact severity is categorized as 'slight'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Later on there will be up to 11 undersea pipelines (two subsea pipelines during the initial development of ROA and WDA, and up to nine pipelines during future development) which will be developed at different time and location. *A hydrotest will be conducted once for each pipeline, however if the duration of the hydrotest and water discharge is too long, the water in the pipeline may be replaced every 6 months. Thus, the impact likelihood is also categorized as 'low'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the severity of the impact is very low, and the impact likelihood is small, the impact significance is negligible and is not a significant impact.				

Based on the evaluation results it can be seen that the significance of the impact of hydrotest water discharge alternatives onshore and disposal nearshore, is categorized as 'negligible', therefore the impact is categorized as an 'insignificant impact'.

3.2.2 Biology

3.2.2.1 Marine Biota

a. Changes in Nekton Diversity (Including Marine Mammals)

- **Environmental Baseline**

The predicted impact on all types of nekton is focused on marine mammals because this type of marine biota is sensitive to disturbances from human activities.

Several studies and monitoring of marine mammals at the Bintuni Bay conducted by Tangguh LNG from 2005 until 2013, show records of sightings of at least five species of marine mammals, all from the Cetacea ordo consisting of four species of dolphins and one whale species, namely:

a. Indo-Pacific Humpback Dolphins (*Sousa chinensis*);

b. Spinner Dolphins (*Stenella longirostris*);

c. Indo-Pacific Bottlenose Dolphins (*Tursiops aduncus*);

d. Bottlenose Dolphins (*Tursiops truncatus*); and

e. Bryde's Whales (*Balaenoptera brydei*).

Marine mammals are divided into three Ordo, namely *Cetacea, Sirenia,* and *Carnivora*. In tropical waters, especially the waters of the Bintuni Bay, so far, only marine mammals from the Cetacea Ordo have been found which are divided into two groups, namely *Odontocetes* and *Mysticete*. All dolphin species found in the waters of the Bintuni Bay are from the *Odontocetes* group, while the Bryde's whales found belong to the *Mysticete* group.

Based on the frequency of encounters and the types found, *Sousa chinensis* is the species most often found, while the species that is most rarely found is the Bryde's whale. As for other species of dolphins such as the Stenella longirostris, Tursiops aduncus and Tursiops truncatus the percentage of encounters are nearly the same.

- **Impact Prediction**

<u>Source of Impact</u>

Impacts on changes in nekton diversity (including marine mammals) are derived from marine transportation activities for the workforce, equipment and materials.

Vessel traffic is likely to occur in the Bintuni Bay during construction (pipeline installation) that lasts between 10-12 months for the installation of each pipeline measuring 30 km in length (± 4 months for pipe laying, ± 2 months for trenching and ± 6 months for rock dumping). Later on there will be up to 11 undersea pipelines (two subsea pipelines during the initial development of ROA and WDA, and up to nine pipelines during future development). The pipes to be installed are estimated to measure between 10-30 km which will be installed at different times and locations. Pipeline installation is not continuous. There will be a grace period between the installation of one pipeline with another pipeline. For the initial pipeline installation (ROA and WDA) it will be installed in stages using one pipelay barge.

During construction, the initial estimate of the types of vessel that will be used are as follows:

- Approximately 10 material barges, including tug boats;
- Approximately 3 anchor handling tugs;
- Approximately 3 supply boats;
- Approximately 2 crew boats, and
- Construction vessels, consisting of: pipelay barges, trenching barges, rock dumping barges, cable lay vessels, survey vessels, support vessels (including diving work, LCT, pre commissioning), HDD support vessels.

The transportation and installation of the pipeline will begin around mid-2017 and will be completed in 2018.

<u>Prediction</u>

In marine waters, especially where vision becomes a limiting factor, sounds and the sense of hearing becomes a vital factor and is essential for the survival of marine mammals. Sounds and hearing is used to maintain unity of the group in social interactions, for echolocation to identify and obtain food, to detect sounds from approaching predators, and also to avoid potentially dangerous situations such as getting hit by an object in the sea (J. Gordon et al., 2004).

Most marine mammals produce and receive sounds. Underwater vocalizations include *Clicking*, vibrational sounds (*Trills*), singing (*Warbles*), whistling (*Whistles*), and vocalizations that resemble the sound of bells (J.Gordon et al., 2004). The *Odontocetes* group is known to produce a variety of sounds, while the vocalization details of the sounds produced by marine mammals from the Mysticetes group are still not quite understood. The *Odontocetes* group is known to communicate at a medium frequency (from 1 kHz to over 20 kHz) with several species performing echolocation at high frequencies (from 20-150 kHz). In contrast, the *Mysticetes* group uses an echolocation system at a low frequency (<10 Hz - <10 kHz) (**Figure III-28**).

Activity of vessels is one of the contributors of underwater noise, especially low-frequency noise, however higher frequency noises can also be generated depending on the size of the vessel and the propulsion system used. It is estimated that approximately 85% of the noise of shipping activity is caused by the propulsion system generated by the rotation of the propellers (Barlow

& Gentry 2004 in Genesis 2011). The noise generated may mask the sounds of marine mammals.

As shown in **Figure III-28** most of the noise radiated from commercial vessels is below 1 kHz, however noise from smaller vessels with a powerful propulsion system is capable of generating ambient noise at frequencies over 1 kHz (Kipple 2002 in Genesis 2011). These conditions could interfere with marine mammals that emit and receive sounds at a low frequency.

Masking at higher frequencies (1-25 kHz) can occur when vessels are near the group of marine mammals. During these conditions, the *Odontocetes* group, which also operates at the same frequency may experience sound masking due to the noise from the vessels.

In addition to masking due to sounds from shipping, vessel noise can also affect the behavior of marine mammals. Ranging from small effects such as a shift in orientation towards a sound source, to greater effects such as long-term behavioral changes in foraging, navigation and reproductive activities.

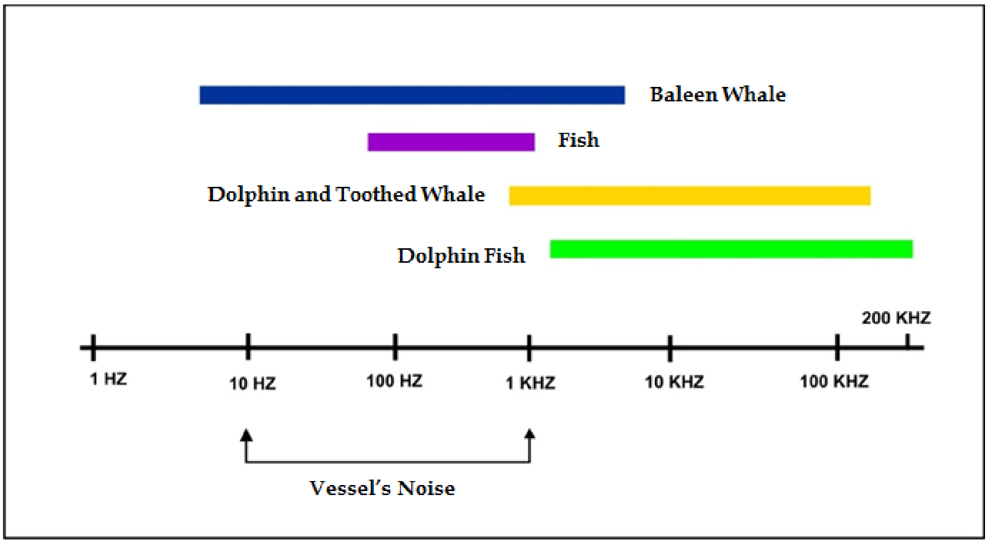


Figure III-28 **Frequency Relationships between Marine Mammal Sounds and Sounds from Shipping (Source: B. Southall, NMFS/NOAA)**

In response to vessels, marine mammals may modify or cease producing sounds that they use to communicate, forage, avoid predators, or gain awareness of their environment (Au & Green 2000, Van Parijs & Corkeron 2001). For instance, bottlenose dolphins (Tursiops truncates) have been observed to reduce their calling rates when vessels are approaching.

An auditory study of the Indo-Pacific Bottlenose Dolphin by Houser et al.2008 describes that the hearing ability of these animals ranges from 150 Hz to 160 kHz.

- **Impact Evaluation**

  As described above, noise produced from human activities (Anthropogenic), including those produced from marine transportation, activities have the potential to disrupt some of the physiological functions of marine mammals, including short-term behavioral changes with the worst assumption being long term behavioral changes. The type and magnitude of the impact depends on the characteristics of the sound source, the environment, and the marine mammals as the impact receptor. The large number of small vessels which generally use powerful propulsion systems that emit noise at low to moderate frequencies, are expected to have an impact of masking the noises of marine mammals from the Odontocetes group (including dolphins) that are widely found in the waters of the Bintuni Bay.

  The possibility of mammals colliding with vessels may occur, although to date, throughout the existence of Tangguh LNG, there have been no records of such incidents due to the activities of Tangguh LNG. Some types of marine mammals will move away from the area disturbed by the vessel movement, however some types of marine mammals, especially the Sousa chinensis dolphins will move closer in groups to the movement of the vessel (Erftemeijer, et al. 1989). For current operations, Tangguh LNG has implemented procedures for the protection of marine mammals, such as the setting of the route and speed of the vessels. This procedure will continue to be applied to the activities of the Tangguh LNG Expansion Project.

  Given that the duration of the planned activities (project) is relatively short, especially for the pipeline installation, which is one year for each pipeline installation with intervals between each activity as well as the potential impact that is expected to be localized only in the area of activities as described above, the impact of changes to nekton diversity (including marine mammals) is categorized as 'minor'.

Table III-37 Impact Evaluation – Sea Transportation for the Workforce, Equipment and Materials to Changes in Nekton Diversity (including Marine Mammals)

Impact Description	*Impact on nekton diversity (including marine mammals) may be caused by sea transportation for the workforce, equipment and materials during the construction phase of the gas transmission.*				
Impact Nature	**Negative**	**Positive**			
	Marine mammals (dolphins and whales) are sensitive to direct disturbances from the movement of vessels in the form of waves generated and the possibility of collisions in addition to the acoustic energy generated by the transportation activity which can disrupt the communication and navigation systems of marine mammals, causing them to avoid the area.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Disturbances due to the increase in noise, generation of waves and the possibility of collisions with marine mammals are direct impacts of vessel movement.				

Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact from marine transportation will last between 10-12 months for each pipeline installation measuring 30 km in length. Later on there will be up to 11 undersea pipelines (two subsea pipelines during the initial developments of ROA and WDA, and up to nine pipelines during future developments) with an approximate length of 10-30 km to be developed at different time and location. The pipeline installation is not continuous. There will be a grace period between the installations of the pipelines. Therefore, the impact is categorized as 'Short Term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The disturbance to nekton (including marine mammals) only occurs within the area closest to the pipeline installation. Therefore, the impact is categorized as a local impact.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The Bintuni Bay serves as the habitat for several protected species of marine mammals. According to survey results, there are five species of marine mammals that belong to the Cetacea ordo consisting of four species of dolphins and one species of whales as described in the environmental baseline study section. *Based on the frequency of encounters and the types found, Sousa chinensis is the species most often found, while the species that is most rarely found is the Bryde's whale. As for other species of dolphins such as the Stenella longirostris, Tursiops aduncus and Tursiops truncatus the percentage of encounters are nearly the same.* *Underwater noise may cause various changes in the behavior, navigation, and communication of marine mammals. Direct and indirect disturbances will cause dolphins and other marine mammals to temporarily avoid the area with the increased sound levels. Various observations and studies have shown that marine mammals also interact with the shipping activity, where they are sometimes seen swimming in parallel with the movement of the vessels that are operating under normal conditions. This indicates that the impact that may occur due to marine transportation activity on marine mammals (especially those found in the Bintuni Bay) is relatively small* *Furthermore, given that the extent of the impact is local, and the impact duration is short term, and marine mammals can get used to the increase in the underwater noise so that they are able to remain in the area, the magnitude of the impact from these activities is categorized as 'low'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact receptor is nekton (including marine mammals) which are highly sensitive to acoustic energy, however nekton has a high swimming ability and are able to avoid the area. Thus, the impact is categorized as 'medium'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the magnitude of the impact is categorized as small and the impact receptor sensitivity is categorized high, the impact severity is categorized as medium.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	The likelihood of the disturbance to marine mammals caused by transportation activity is relatively small based on current occurrences where dolphins are commonly encountered and are even seen swimming with the vessels.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the impact severity is categorized as medium and the impact likelihood is categorized as 'small', the impact significance is categorized as 'minor' and the impact is insignificant.				

b. Decrease in Benthos Abundance

- **Environmental Baseline**

According to environmental baseline data of benthos during the dry season (2012), the abundance of benthos found at each observation station in the Bintuni Bay highly varies with a range of 0 to 735 ind/m². At several locations such as OS-02, OS-05, OS-13 and OS-14, benthos is not found. These conditions differ during the wet season where there is a lower abundance and smaller range, i.e. 8 to 260 ind/m².

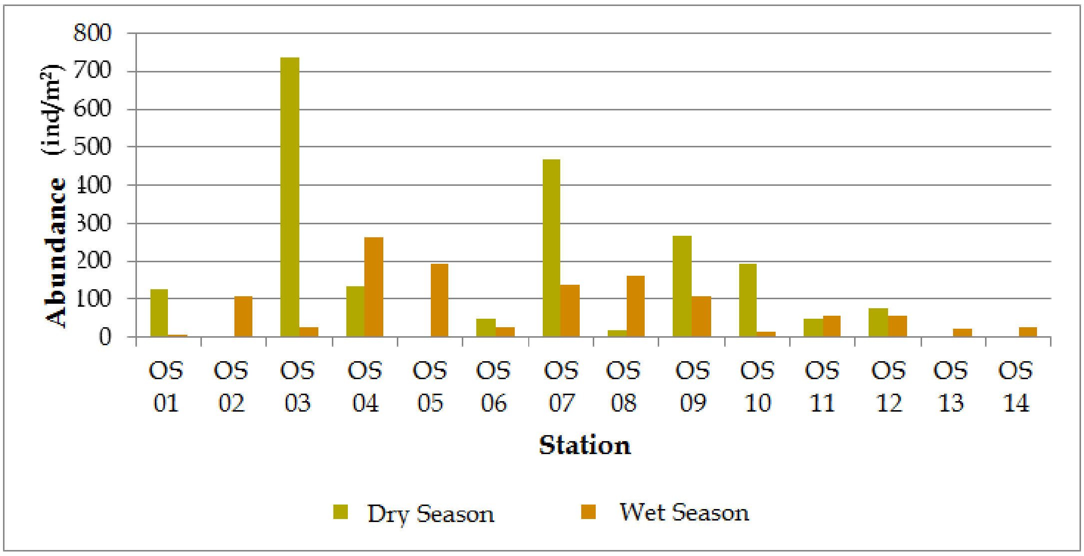
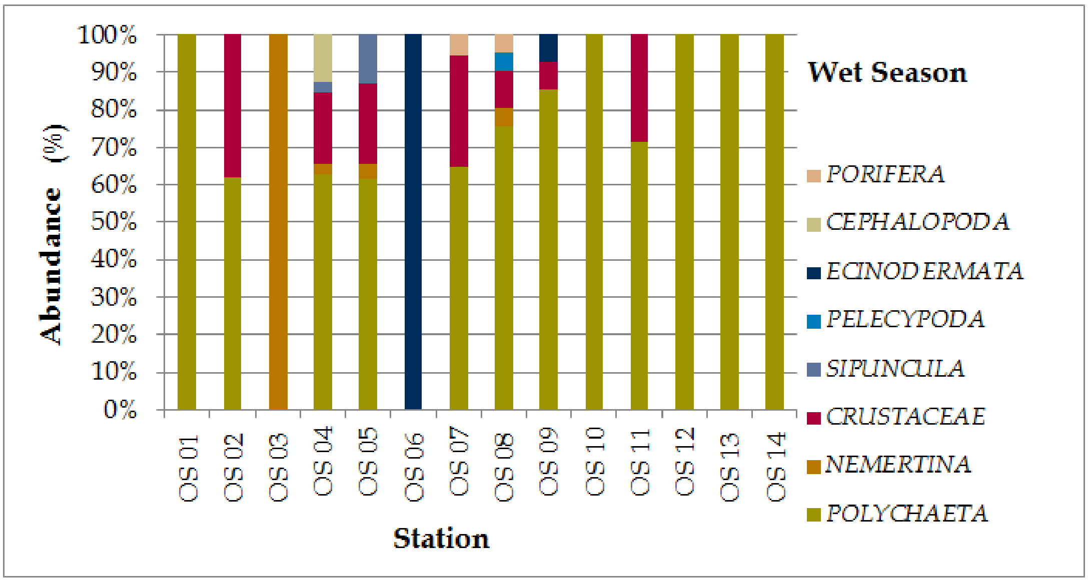


Figure III-29 Benthos Abundance Around the Drilling Site during the Dry and Wet seasons

Generally, the dominant species belong to the *Polychaeta* and *Crustacea* classes. However, during the dry season at OS-03 the dominant species originate from the *Nemertina* class and at OS-06 from the *Echinodermata* class. The *Polychaeta* are a class of marine worms measuring 5-10 cm with a diameter of 2-10 mm. Several species of Polychaeta live in the seabed. They drill/dig holes to live in.

Some crustacean species found in the Bintuni Bay, come from the Heterotanais, Alpheus and Metaphoxus genera. All the species found are commonly found in marine habitats (sandy, rocky and muddy shores in the shallow sublitoral zone). The Heterotanais is a genus of hole-digging species, that have a tolerance to a wide range of salinity, from freshwater and estuary conditions to sea conditions (Sars 1897 and Hildict, 1983).



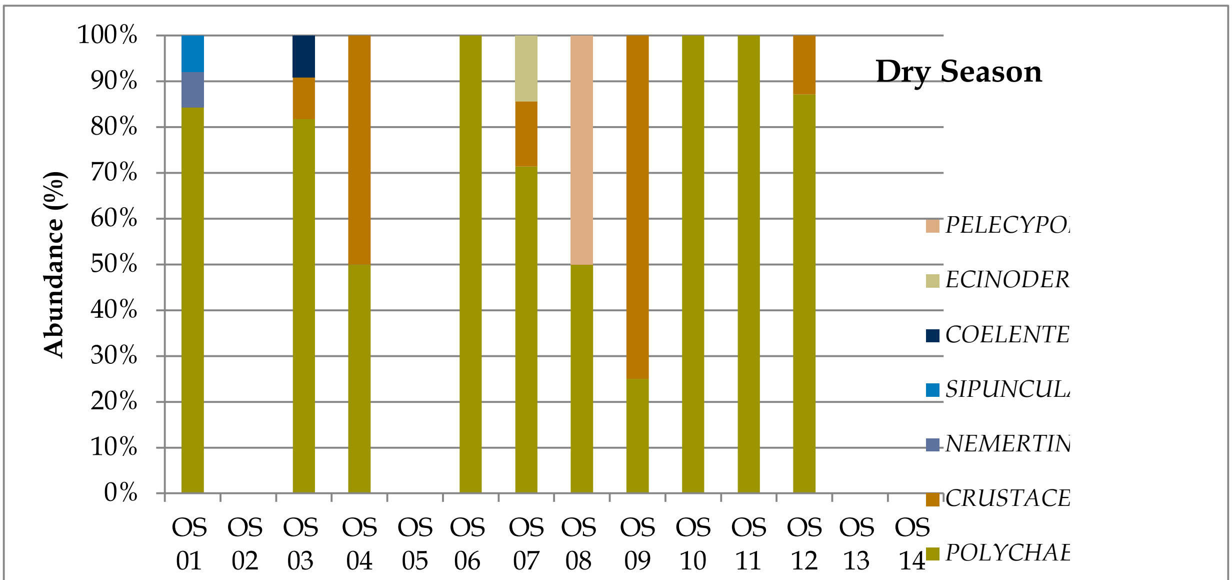


Figure III-30 Benthos Abundance Around the Drilling Site during the Dry and Wet seasons

- **Impact Prediction**

  Source of Impact

  Activities that are likely to have a significant impact on the decrease in the abundance of the benthos are trenching, pipeline installation and rock dumping at the seabed.

  When the pipeline has been installed on the seabed, a trench will be made under the piping network using jetting and plowing methods or mechanical cutting techniques. The three trenching methods will place the dredged material on the side of the trench. Trenchers or cutter suction dredgers will likely be used before the pipe is laid out for pre-lay seabed intervention.

Trenching, installation of the pipelines and rock dumping will be carried out during the construction phase, during approximately mid-2017 until 2018. During this period, trenching, pipeline installation and rock dumping are not conducted continuously at one location, but in stages at different time and location. Overall, there will be up to 11 subsea pipelines (two pipelines during the Initial Development of ROA and WDA and up to nine other pipelines during Future Development).

Trenching for the pipeline will use water jetting. The proposed target depth of the trench is 1 to 2 meters (above the pipe), then piled with rocks with a thickness of 0.3 to 2 m above the pipe.

For areas closer to shore, the method being considered is Horizontal Directional Drilling (HDD). If HDD is technically not possible, the sea trenches will be constructed using a shorepull method.

The estimated seabed sediment that will be removed during trenching is a range of 2 to 4 m^3 / m of the pipeline for a trench target depth of 1 m. The total length of the pipelines is approximately 10-30 km so that the area to be affected will total 0.02 to 0.12 km^2.

Potential Impact

The potential of the impact from the activities as mentioned above is the loss of benthic communities at the dredging site (trenching). When sediment is dredged, benthos living in the area are estimated to also be carried away, causing the benthic community in that location to become lost. It is estimated that Epifauna and Infauna organisms will be disturbed due to dredging that is not only performed on the surface of the seabed substrate, but also at a depth of 1 m. However, the impact from this activity is considered "minor" because the dredged sediment will then be placed on the sides of the trench so that the benthos will be able to regenerate quickly in that area.

- **Impact Evaluation**

The affected area (0.12 km^2) is very small, when compared to the overall area of the Bintuni Bay (12 x 106 km^2).

The disturbance to benthos is expected to be relatively small because not only is the dredging area relatively small, the disturbance will also be temporary until the pipe laying process is completed. Furthermore, the dominant type of benthos (*Polycaheta* and *Crustacea*) that are found in the waters of the Bintuni Bay are the types that are estimated to regenerate and recover quickly to re-fill the area above the pipeline that has been laid (at the substrate for Epifauna, and in the subtrate column above the pipeline for Infauna).

Based on the above, the significance of the impact of trenching, pipeline installation and rock dumping on changes in the abundance of benthos is categorized as 'negligible'.

Table III-38 Impact Evaluation – Sea Bed Trenching, Pipeline Installation, and Rock Dumping on Changes in Benthos Abundance

Impact Description	*The decrease in benthos abundance due to trenching, installation of pipelines and rock dumping.* *According to the preliminary designs, sea bed trenching for subsea pipelines is proposed to be performed at a depth of 1 to 2 meters (above the pipe) and rock dumping will have a thickness of 0.3-2 meters along the top of the pipeline.* *For areas closer to the shore, the method being considered is Horizontal Directional Drilling (HDD). If HDD is technically not possible, the sea trenches will be constructed using a shorepull method.*				
Impact Nature	**Negative**	**Positive**			
	Trenching, installation of pipelines, and rock dumping will temporarily disturb the benthos communities along the pipeline.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Trenching, installation of pipelines, and rock dumping will temporarily disturb benthos communities. Therefore, the impact is a direct impact.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The duration of the impact is expected to last 10-12 months for each pipeline measuring 30 km in length. Later on there will be up to 11 subsea pipelines (two subsea pipelines during the initial development of ROA and WDA, and up to nine pipelines during future development) to be developed at different time and location. The pipeline installation is not continuous. There will be a grace period before the installation of the next pipeline.				
Impact Extent	**Local**	**Regional**	**Global**		
	Disturbance to benthos will only occur along the pipeline installation corridor (measuring 10-30 km in length and 2-4 m in width). Later on there will be up to 11 subsea pipelines (two subsea pipelines during the initial development of ROA and WDA, and up to nine pipelines during future development) to be developed at different time and location.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The abundance of benthos found at each observation station in the Bintuni Bay highly varies with a range of 0 to 735 ind/m². During the dry season, at several locations, benthos is not found. These conditions differ during the wet season where there is a lower abundance and smaller range, i.e. 8 to 260 ind/m². *The dominant species generally belong to the Polychaeta and Crustacea classes. The Polychaeta are a class of marine worms measuring 5-10 cm with a diameter of 2-10 mm. Several species of Polychaeta live on the seabed. Crustaceans occupy different types of coastal waters, such as sandy, rocky and muddy shores.* *Considering the extent of the impact which is local, only in area of the gas transmission pipeline installation, the impact duration that is short term, and the rapid recovery of the dominant benthic groups (Polichaeta and Crustacea) that are found in the Bintuni Bay, the magnitude of the impact from these activities is categorized as 'small'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Benthos has a low ability to move. Therefore, when environmental conditions change, the benthos is not able to avoid it. However, benthos has the ability to recover naturally and in relatively large amounts. Therefore, the receptor sensitivity is categorized as low.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Because the magnitude of the impact is small and the impact receptor sensitivity is also low, the impact severity is categorized as very low.				

Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Later on there will be up to 11 subsea pipelines (two subsea pipelines during the initial development of ROA and WDA, and up to nine pipelines during future development). Each pipeline installation measuring 10-30 km in length will require 10-12 months to complete however, there will be a grace period between each pipeline installation. Therefore, the likelihood of the impact to occur due to this activity is categorized as low.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Because the impact severity is very low and the impact likelihood is small, the impact significance is categorized as 'negligible' and is an insignificant impact.				

3.2.3 Socio-Economic-Cultural

3.2.3.1 Workforce : Job Opportunities

a. **Environmental Baseline**

<u>*Construction Phase*</u>

Tangguh LNG presence in Bintuni Bay region has contributed to economic development in the region. This is accelerated by the establishment of Teluk Bintuni Regency as a division of Manokwari Regency in 2005. In the last eight years, a change in livelihood pattern of Bintuni Bay community, especially with the increase of community percentage working as employees.

Based on the UGM census data in 2011, unemployment in DAVs reached 8% of the labor force, declined from the 2003 census data which reached 21%. The decline in unemployment rate is predited to be affected by the rapid economic growth in Bintuni Bay region.

At the level of the household economy, the survey also showed that the community is at a level where they are able to meet the household needs, but does not have the ability to save and invest.

Both of these problems raise a high sensitivity in the community when issues arise about job opportunities. Most of the people in the villages expect that Tangguh LNG activities can provide job opportunities to them to work at Tangguh. A data of public consultation conducted in 2012 showed that 8% of the aspirations and public attention to the Tangguh LNG related to job opportunities, and 7% related to economic development including business opportunities - which at the end associated with the employment.

b. **Impact Prediction and Evaluation**

<u>*Construction Phase – Impact Prediction*</u>

Transmission gas activity (installation of seabed pipeline) is from platform to the production facility in Tangguh LNG. This activity is estimated to recruit approximately 500-800 workers who are largely skilled workers in offshore activity. The need for unskilled workforce is predicted no more than 5 people for the purpose of building community relations with the villages around construction activities.

Job opportunities should be offered a positive impact because it is expected to reduce unemployment in the villages. The construction activities of installation of seabed pipeline installation will last approximately 8-10 months. These job opportunities will be offered directly to the community once at the beginning of the seabed pipeline installation activities.

Construction Phase – Impact Evaluation

Despite the workforce problems have a plenty high sensitivity in the community, but the magnitude of the impact of transmission activity is low / 'minor'. This is due to several factors, including: job opportunities that can be filled by Indigenous People* is only few and the job opportunities will be only provided once at the beginning of the activities. Nevertheless, although the impact is low considering the workforce problem is sensitive to Indigenous People*, management and monitoring of the impact is still required.

Table III-39 Impact Evaluation – Gas Transmission Activities in Construction Phase against Job Opportunities for Indigenous People*

Impact	*Job opportunities for Indigenous People* and local community to work in construction phase of gas transmission activities.*				
Nature of Impact	**Negative**	**Positive**			
	Job opportunities given to Indigenous People and local community in construction phase of gas transmission activities will give opportunity to enhance the local income, although the offered opportunity is limited only for low skilled and unskilled level.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The gas transmission installation included pipeline installation, trenching and rock dumping, require workers with high skill levels. Nevertheless, there will be recruitment for some workers in the low skill level or unskilled to be recruited directly from nearby villages were facilitated by the Community Relations team.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Installation of seabed pipeline activities, trenching and rock dumping, will last for 8-10 months. Due to the impact of job opportunities occurs for less than a year, and job opportunities will only be offered once at the early stag. Thus, the impact lasts longer and is classified as temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	The scope of workoforce recruitment is not only implemented to Indigenous People and local community living in the villages surrounding Tangguh LNG operation site.*				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the UGM census data in 2011, unemployment in DAVs reached 8% of the labor force, declined from the 2003 census data which reached 21%. *The pipeline installation, trenching and rock dumping activities will cause a positive impact on Indigenous People* and local community living in villages closest to the location of project activity. However, the number of job opportunities that are offered to the community is not much, and confined to the low skill and unskilled levels, and only offered once for a period of 8-10 months. The impact magnitude is not broad because only the villages surrounding Tangguh LNG operation site who will get the job opportunities. Taking into account the intensity, the impact magnitude is classified as 'negligible'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The 2011 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total labor force. While household income is sufficient to meet the daily needs but insufficient To save and invest. Thus, the impact sensitivity towards Indigenous People and local community living in villages surrounding Tangguh LNG operation site can be classified as high.*				

Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Installation of seabed pipeline activities, trenching and rock dumping will last for 8-10 months in the Bintuni Bay and Berau Bay waters and the entire workers involved in the activities has high skill competence. Meanwhile, based on the public consultation in 2012 showed that there is high expectation from community to work in Tangguh LNG activities. Census data of PSKK UGM in 2011 showed that the majority of the labor force is only elementary school graduates, and do not have the skills in the gas transmission activities. Thus, the impact severity of job opportunities to Indigenous People is classified as 'low'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is predicted to be at medium level by considering the offered opportunities for Indigenous People and local community are not much, once, and limited on several unskilled and low skilled positions.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The positive impact of emerging job opportunities are not significant by considering at least position being offered, and the time period is only temporary jobs. The positive impact of this activity does not significantly affect the changes in income and livelihoods of Indigenous People and local community. However, taking into account the sensitivity of community related to workforce, the positive impact is classified as 'minor' and the impact is not significant but still need to be managed.*				

3.2.3.2 Fishery Activity Disturbance

a. Environmental Baseline

<u>*Construction Phase*</u>

People who live around Bintuni Bay and Berau still largely depend on the natural resources of coastal and marine resources, especially fish. The livelihood activities generally related to catching fish and shrimp. Shrimp fishing activities carried out by small-scale category characterized by the limited use and capacity of boat and engine. Fishing range is relatively close (about 3 km from the coastline) and one day fishing. Large-capacity fishing vessels with modern fishing equipments operating in the middle of Bintuni Bay waters tend to be a ship coming from outside region. Production of major fisheries is marine fish (such as mackerel, mackerel, red snapper, and overpasses), shrimp, and crab, with distribution in North and South along the coastal waters of Bintuni Bay and Berau Bay. In Arguni region, its people do cultivation of natural resources other than fisheries, namely by cultivating seaweed and pearl oysters. Based on the survey conducted by IPB Fisheries in 2007, the north shore region of Bintuni Bay which has abundant fishery resources is at Taroy, Margarina, Weriagar, and Mogotira villages, while in the South shore region is around the island Babo, Wimbro, Tanah Merah-Saengga, Onar, and Otoweri.

Fishing ground of fishery resources in Bintuni Bay and Berau Bay spread on three types of waters (rivers, estuaries, and the ocean). The fishing ground generally does not have waters territory boundaries based on the customary right. The fishermen come from each surrounding villlages (both local community and migrants) can catch fish freely to the other area rely on the technology capabilities owned by the fishermen to reach the fishing ground. However, in general, the fishing activities is frequently done in the administrative area of village or district where the fishermen coming from.

Fishermen from Tanah Merah, Saengga, Taroy, Weriagar-Mogotira, Babo, and Wimbro villages catch shrimp with fishing gear such as trammel net, while crab and fish are most widely caught by fishermen from Irarutu III Village using gill net, fishing rod, and trammel net.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Fishing activities use certain fishing gear (such as nets, rods) and conin the fishing ground. In a one day fishing activities, fishing boats departing from the fishing base to fishing ground and back again to the fishing base located in each village. During the construction period, there will be sea transportation activities to support mobilization of workforce, equipments and materials as well as the activity of trenching, installation of seabed pipeline installation, and rock dumping. These activities is predicted to have a negative impact on fishing activities in the fishing ground, especially during the installation of pipeline of WDA and ROA platform. In the completion of the job for a while, fishermen are not allowed to catch fish within a radius of 500 meters.

The activities will take place between 8-10 months. For security purposes, during construction activities, there will be a safety exclusion zone around the area of activity. Although the fishermen generally still can perform fishing activities during construction activities, there will be restrictions on fishing activities in locations where construction activities is ongoing. Restrictions on fishing activities are potentially to cause a reduction in the daily fishing revenue. To minimize the potential hazards during construction of transmission pipelines, outreach to local communities and fishermen will be done before construction proceeded, so that the community and fishermen will find out over the pipeline transmission construction activities as well as to their impact. Therefore, the impact of these activities is categorized as the impact of 'moderate', i.e. significant impacts as much as possible can be addressed and managed.

Construction Phase – Impact Evaluation

To determine or assess whether the activities affects on fishery activity disturbance, the following Table III-40 Impact Evaluation will explain it:

Table III-40 Impact Evaluation – Transmission Gas Activity in Construction Phase against Fishery Activity Disturbance

Impact	*During the construction phase, sea transportation activities will exist to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping. These activities are potentially to result disturbance for community, especially local fishermen. For safety issue, during the construction phase, there will be safety exclusion zone along the pipelines corridor that restricts the fishermen to their fishing ground.*			
Nature of Impact	**Negative**	**Positive**		
	The sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping will result negative impact to local community living in the villages surrounding Tangguh LNG operation site, especially for the fishermen. For safety issue, during the construction phase, there will be safety exclusion zone along the pipelines corridor that restricts the fishermen to their fishing ground.			

Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping are direct impact affected to local fishermen due to the restriction of fishing ground.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping will last for 8-10 months. Since the fishery activity disturbance will affect the local community less than a year, the impact is classified as 'temporary'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The scope of sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, pipeline installation and rock dumping is local. Pipeline installation and other support activities will be impelemented along 30 km from platform to onshore facility of Tangguh LNG.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Teluk Bintuni in Figure 2012, indicated that 34.51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors. *The impact magnitude from sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, pipeline installation and rock dumping will occur around project area, with a temporary period. Thus, the impact magnitude for these activities is small.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping is classified as high sensitivity. The local fishermen will have limited fishing grounds because they are possibily difficult to find another fishing ground, and to reach the economic centers.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' due to the high sensitivity of receptor and the 'small' impact magnitude. The local fishermen should be also concerned because these activities will affect their daily income.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	During the sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping will be determined a safety exclusion zone which cause the restriction of local fishing ground.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	During the sea transportation activities to support mobilization of workforce, equipments and materials as well as trenching, seabed pipeline installation and rock dumping will be determined a safety exclusion zone which cause the restriction of local fishing ground. Meanwhile, the restriction of local fishing ground will cause the lost of daily income. Thus, the impact of these activities is classified as 'moderate' as well as a significant impact that should be addressed and managed.				

3.2.3.3 Sea Transportation Accessibility Disturbance

a. Environmental Baseline

Construction Phase

The Bintuni Bay and Beray Bay are areas of waters accessed by various types of commercial shipping coming both from domestic and abroad. Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. Meanwhile, total visits of foreign ship were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and kapal opsi (small tonnage merchant ship carried about 15 tons).

The Bintuni Bay and Berau Bay have been used by the local community for generations as traffic lanes between villages, the center of administrative area, district/sub-district, and fishing base. To visit between villages, community can across the Bintuni Bay and Berau Bay or from North to South shore or vice versa.

In addition, the community commonly use wooden boat with outboard engine (usually used as fishing boat) to move from villages to the center of administrative area or economic activities (such as market) in Bintuni, Babo and Kokas. To reach more distant location, for example, from Weriagar to Kokas or Babo, from Babo to Bintuni and vice versa, usually use longboat equipped with 15 HP, 25 HP or 40 HP engine. Meanwhile, river estuary and creeks are commonly passed by *ketinting* with 5 HP or 10 HP Honda engine brand owned by the community to reach shorter distance.

From the studies result of sustainable fisheries in the Bintuni Bay (2007), the description of population mobility by sea can be described as follows:

- Village residents of Weriagar-Mogotira (including Manggarina) buy various types of supplies in Aranday and Kokas (Fakfak) districts. Travel to Aranday District takes about 1.5 - 2 hours by longboat with 15 HP Johnson engine brand, while to reach Kokas is required about 5-6 hours by the same type of longboat.
- Village residents of Taroy Village buy various types of supplies in Aranday and Bintuni (Fakfak) districts. Travel to Aranday District takes about 2-2.5 hours by longboat with 15 HP Johnson engine brand, while to reach Bintuni is required about 5-6 hours by the same type of longboat.
- Village residents of Sidomakmur Village buy various types of supplies in Babo District with travel time more or less ½-1 hours by longboat with 15 HP Johnson engine brand.
- Village residents of Tanah Merah and Saengga villages buy various types of supplies in Babo and Kokas. Travel to Babo District requires 2.5-3 hours by longboat with 15 HP Johnson engine brand, while to reach Kokas, the trip requires 5-6 hours by the same type of longboat.

- Village residents of Onar and Otoweri villages buy various types of supplies in Kokas (Fakfak) with a travel time of about 4-5 hours by longboat Johnson 15 HP engine brands.

From the above explanation, it can be concluded that the mobility of both communities from the villages of north shore and south shore of Bintuni Bay region use ships / small boats. Thus, the community is very high dependence on marine, especially as seawater channel.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

During the gas transmission activities, the sea transportation activities will exist to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping. These activities are potentially to result sea transportation accessibility and sea traffic disturbances, especially for local fishermen who use traditional boat. For safety purpose, a safety exclusion zone will exist along the project area within a radius of 500 metres. In addition to safety exclusion zone, a higher frequency of vessels traffic during the construction activities than the operation phase. The vessels traffic frequency during the gas transmission activities in construction phase is predicted to increase based on the assumption that the total number of visits of various types cruise ships in port of Bintuni in the activities in 2014 is equal to 2011 as follows: 893 visits, which consists of 787 ship visits from domestic and 106 foreign vessels, Thus, the number of supporting vessel movement in Bintuni Bay during construction activity is predicted to increase each week with 4-5 times the ship visits.

Gas transmission activities during the construction phase that lasts between 8-10 months, especially sea transportation activities is predicted to impact on mobility of merchant vessels (optional vessels) passing through the central of local economy (i.e. Bintuni, Babo) to villges in the northern or southern of Bintuni Bay. In addition, the gas transmission activities are expected to have an impact on the mobility of the people who use the longboat to go to the economic centers or villages. It is predicted that the impact is also created due to the implementation of a safety exclusion zone for trenching, seabed pipeline installation and rck dumping. The community's boat will avoid the activity area, so it takes time for local fishermen to reach their fishing ground. The local fishieren also have difficulty in doing their daily activities. Moreover, there will be a potential impact on the boat chrash if there is no appropriate sea transportation management, such as a high speed of vessel passed with the community's ship / boat that likely to result inbalanced ('shaky') position of ship or be drowned. The impact will be experienced by the time of development of WDA and ROA platforms activities (development of platforms on the early stage), since the location is close to the villages of Weriagar (WDA platform) and Tanah Merah / Saengga (ROA platform). Thus, the impact of disturbance on sea transportation accessibility of local community caused by the gas transmission activities in construction phase is classified as 'moderate' which is a significant impact that should be addressed and managed.

Construction Phase – Impact Evaluation

To determine or assess whether the gas transmission activities in construction phase affect the sea transportation accessibility, the following **Table III-41** Impact Evaluation will explain it:

Table III-41 Impact Evaluation - Gas Transmission in Construction Phase against Sea Transportation Accessibility Disturbance

Impact	*During the construction phase, the sea transportation activities will exist to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping. These activities are potentially to result disturbance for community, especially for daily activities of local fishermen. For safety reason, during the construction phase, there will be safety exclusion zone along the pipelines corridor that restricts the sea transportation accessibility of local fishermen.*				
Nature of Impact	**Negative**	**Positive**			
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping will result negative impact to local community, particularly on the sea transportation accessibility for daily activities. For safety reason, there will be safety exclusion zone along the pipelines corridor that restricts the sea transportation accessibility.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping result direct impact t local fishermen due to the limited sea transportation accessibility.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping will last for 8-10 months. Since the fishery activity disturbance will affect the local community less than a year, the impact is classified as 'temporary'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The scope of sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, pipeline installation and rock dumping is local. Pipeline installation and other support activities will be impelemented along 30 km from platform to l onshore facility of Tangguh LNG.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. While the visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and kapal opsi (small tonnage merchant ship carried about 15 tons).				
	The scope of impact magnitude from sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, pipeline installation and rock dumping will occur around project area, with a temporary period. Thus, the impact magnitude for these activities is small.				
Sensitivitas Penerima Dampak	**Rendah**	**Sedang**	**Tinggi**		
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping is classified as high sensitivity. The local fishermen will have limited sea transportation accessibility that will result difficulty for their daily activities. Moreover, local community has not other transportation access to reach the economic centers.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**

	The impact severity is classified as 'medium' due to the high sensitivity of receptor and the 'small' impact magnitude. The local fishermen should be also concerned because these activities will affect their daily income.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	During the sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping will be determined a safety exclusion zone which cause the restriction of sea transportation accessibility of local community.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The sea transportation activities to support mobilization of workforce, equipment and material as well as trenching, seabed pipeline installation and rock dumping will be determined a safety exclusion zone which cause the restriction of sea transportation accessibility of local community. Meanwhile, the restriction of sea transportation accessibility will result impact both economic and social. Thus, the impact of these activities is classified as 'moderate' as well as a significant impact that should be addressed and managed.				

3.2.3.4 Community Perception

a. Environmental Baseline

<u>*Construction Phase*</u>

The fabrication and pipelines installation of production facility in early stage of the Tangguh LNG Expnasion Project is estimated to recruit approximately 500-800. The local community may have expectation to be hired as workers in the gas transmission activities in construction phase. However, specialized skills are required to this activities cause the limited number of local workforce that can be hired to these activities. It is potentially to build negative perception of local community.

The trenching in the sea floor, seabed pipeline installation, and rock dumping result community concerns about the threat and disturbance on their fishing ground. = The existence of a variety of activities during the gas transmission activities in construction phase of Tangguh LNG will affect total area of fishing ground as well as access to local public transportation.

In the installation of the pipelines corridor of gas transmission and application of safety exclusion zone will limit local community in making a living and sea transportation accessibility. In the construction phase, supporting vessel movement likely to occur in the Bintuni Bay and Berau Bay during construction activities (pipelines installation). It takes about 8-10 months for pipeline installation activities. During construction, the type of vessel that will be used are as follows: approximately 10 material barges, 3 tug boat; about 3 supply boats; about 2 crew boats, and construction vessels, which consist of: pipelay barge, trenching barge, hook up barge, cable / umbilical lay vessel, survey vessels and submarines and HDD supporting vessel.

b. Impact Prediction and Evaluation

Construction Phase – Impact Prediction

Workforce recruitment is expected to lead to available job opportunities in the gas transmission activities for the local community. However, considering the majority of the workforce required with specialized skills, the possible impact is relatively small. However, the demobilization of construction workforce is expected to remain an impact on community perception either due to loss of livelihood, or as a result of decline in economic activity in the villages.

The activity of pipelines installation of gas transmission and safety exclusion zone around the location of pipeline installation, is expected to cause potential fishery activity and sea transportation accessibility disturbances, i.e. during the trenching activities on the sea floor, installation of seabed pipeline and rock dumping. Although the impacts are temporary during the pipelines installation of gas transmission, but the impact on fishing activities and sea transportation accessibility are categorized as a 'significant impact hypothetical' and will be assesed further in the AMDAL study.

Although the number of workers recruited from the local community at this phase is relatively small, but the impact on employment still need to be managed properly.

Construction Phase – Impact Evaluation

To determine or assess the impact of perceptions of job opportunities and the workforce demobilization, as well as fishery activity and sea transportation accessibility disturbances of local community can be seen in the follwong **Table III 42** Impact Evaluation:

Table III-42 Impact Evaluation – Gas Transmission Activities in Construction Phase against Perception of Job Opportunities and Demobilization of Workforce , as well as Fishery Activity and Sea Transportation Accessibility Disturbances

Impact	*The seabed pipeline installation, trenching and rock dumping in the construction phase is predicted to result community perception which is 'a derivative' impact from job opportunities, workforce demobilization and fishery activity and sea transportation accesibility disturbances.*				
Nature of Impact	**Negative**	**Positive**			
	Community perception related to job opportunities, workforce demobilization and fishery activity and sea transportation accesibility disturbances is a negative impact. It is related to the expectation of Indigenous People to work on the activities, which does not equal to the capacity of Indigenous People* to fulfill workforce requirement in the seabed pipeline activities in the construction phase of the Tangguh LNG Expansion Project. Moreover, the supporting vessel movement and trenching will result community concerns related to the fishery activity and sea transportation accesibility disturbances.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**

	The seabed pipeline installation, trenching and rock dumping in the construction phase is predicted to result community perception which is 'a derivative' impact from job opportunities. The seabed pipeline installation in construction phase requires workers mostly high skilled workers recruited from outside region. The amount of local community living in the surrounding area of Tangguh LNG operation site that meet the skills standards to work in the seabed pipeline installation is very limited. The job opportunities to support the seabed pipeline installation activities result high expectation of Indigenous People to work at the project activities and further to develop carrier in Tangguh LNG. On the other side, trenching, seabed pipeline installation and support vessel traffic related to the fishery activity and sea transportation accesibility disturbances.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Installation of seabed pipeline activities, trenching and rock dumping, will last for 8-10 months. Due to the impact of job opportunities occurs for less than a year, and job opportunities will only be offered once at the early stag. Thus, the impact lasts longer and is classified as temporary.				
Impact Extent	**Local**	**Regional**	**Global**		
	The community perception considered as the most significant impact is perception of government officials and local community living in the villages surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a growing perception in community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Negative perception of community about the job opportunities, workforce demobilization, as well as fishery activity and sea transportation accesibility disturbances will appear repeatedly during the seabed pipeline installation activities. The negative perceptions arise from government officials and community living in the villages surrounding Tangguh LNG operation site. Nevertheless, the construction activities will last for temporary period, so the impact magnitude is at the 'small' level.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on the 2012 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total workforce force of Indigenous People living in the villages surrounding Tangguh LNG operation site is low. Also the skills and working experience of the Indigenous People* tend to be at low level. These situations will create the high expectation of Indigenous People* to work on the project activities; and continue their carrier in Tangguh LNG. Nevertheless, these activities require many high skilled workers which cannot be fulfilled by Indigenous People* and only small number of job opportunities will be provided to the Indigenous People*. On the other hand, the community has high dependency on fishing activities and sea transportation as a main transportation access for community. Thus, the impact sensitivity is classified as 'high'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The high expectation of Indigenous People to gain job opportunities at seabed pipeline installation activities which does not in line with the community capacity to fulfil the expectation. Furthermore, the high expectation of Indigenous People* that have worked in Tangguh LNG is to gain permanent position in the company. Nevertheless, the expectation cannot be fulfilled by considering the temporary period of activities, so that the workforce demobilization for Indigenous People* which has obtained job opportunities on the activities.* *The community also has a high dependency on the fishing ground to meet their daily needs. People are also still relies heavily on sea transportation accessiblity to mobilize. By the installation of seabed pipeline activity, trenching, and rock dumping, then these create big concerns that these activities will result the limited area of fishing activities, and disturbance on sea transportation accessibility as the impact of supporting vessel movement activities. However, the overall perception is predicted appearing in the interim period. Therefore, the impact of severity is classified as 'medium'.*				

Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The opportunities for the rise of community perception as a 'derivative' impact from job opportunities, workforce demobilization as well as fishery activity and sea transportation accesibility disturbances are likely to occur. Thus, the impact likelihood is classified as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Negative perception of community as a 'derivative' impact from job opportunities, workforce demobilization as well as fishery activity and sea transportation accesibility disturbances on the seabed pipeline, trenching and rock dumping on the Tangguh LNG construction are classified as 'moderate'. By considering gap between Indigenous People expectations to work permanently and the workforce needs on the pipeline installation activities in the Tangguh LNG construction; and the community capacity to meet the expectation. The community also has big concerns related to the disturbance on their fishing activities and sea transportation accessibility. On the other side, the community perception is likely to occur in the gas transmission activities. Thus, the impact is significant and must be managed.*				

3.2.3.5 Social Tension

a. Environmental Baseline

<u>*Construction Phase*</u>

Local community have great expectations to be employed as construction workers for gas transmission activities. Nevertheless, the available workforce qualifications in the area is very limited, so the workforce requirements are generally recruited from outside the area. This can lead to jealousy and potentially cause social tensions.

The activities of Tangguh LNG Expansion Project in gas transmission activities will lead to limited community opportunities in the fishery business and sea transportation accessibility. This led to a negative perception that potentially results a derivative impact to raise social tensions if not managed properly.

b. Impact Prediction and Evaluation

<u>*Construction Phase – Impact Prediction*</u>

Negative perceptions associated with job and business opportunities, both at the recruitment and demobilization of workforce; potentially cause social tensions if not managed properly. It is also similar to negative perceptions towards disturbance on fishing ground and sea transportation accessibility. The impact on the social tensions of the gas transmission activities during the construction phase is considered relatively small, but still will be discussed as the overall impact of the Tangguh LNG Expansion Project.

<u>*Construction Phase – Impact Evaluation*</u>

To determine the social tension derived from the community perception of recruitment and demobilization of workforce, as well as fishery activity and sea transportation accesibility disturbances of local communit, can be seen in the following **Table III-43** Impact Evaluation:

Table III-43	Impact Evaluation – Gas Transmission Activitiy in Construction Phase against Social Tension related to Job Opportunities and Workforce Demobilization, as well as Fishery Activity and Sea Transportation Accesibility Disturbances

Impact	*The installation of seabed pipeline in the construction phase is predicted to create community perception such as the expectation gap of Indigenous People* related to ob opportunities and workforce demobilization; as well as the community concerns associated with the restriction and disturbamce on fishing activities and sea transportation accessibility. The community perception which arises in local community tends to create social tension.*				
Nature of Impact	**Negative**	**Positive**			
	Social tensions associated with community perceptions of job opportunities, workforce demobilization, as well as disturbamce on fishing activities and sea transportation accessibility are negative impacts. Social tensions exist related to the expectation of Indigenous People to work on activities that are not in line with the capacity of Indigenous People* to meet the workforce needs of the seabed pipeline installation activities; and community concerns regarding the restriction, fishery activity and sea transportation accesibility disturbances.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	*Social tension is a 'derivative' impact of community perception impact on job opportunities and workforce demobilization, as well as community concerns about the fishery activity and sea transportation accesibility disturbances. The gap expectations related to job opportunitie and big concerns which are constantly on Indigenous People * is predicted to lead to social tension.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Installation of seabed pipeline activities in the construction phase of Tangguh LNG, will last for 8-10 months. Since the social tension is predicted to occur less than a year, the impact is classified as 'temporary'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The community perception considered as the most significant impact is perception of government officials and local community living in the villages surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a growing perception in community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Negative perception of community about the job opportunities, workforce demobilization, as well as concerns about the disturbance on their fishing activities and sea transportation accessibility does not necessarily create the social tension. If the social tension exist, the social tension is considered as significant in the community and government officials in the villages surrounding Tangguh LNG operation sire. Nevertheless, the construction activities will be impelemented in the interim period, so the impact magnitude is classified at the 'small' level.*				

Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on the 2012 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total labor force of Indigenous People living in the villages surrounding Tangguh LNG operation site is low. Also the skills and working experience of the Indigenous People* tend to be at low level. These situations will create the high expectation of Indigenous People* to work on the project activities; and continue their carrier in Tangguh LNG. Nevertheless, these activities require many high skilled workers which cannot be fulfilled by Indigenous People* and only small number of job opportunities will be provided to the Indigenous People*. On the other hand, the community has high dependency on fishing activities and sea transportation as a main transportation access for community. Thus, the impact sensitivity is classified as 'high'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The unemployment rate and workforce needs of Indigenous People tend to be high that create the high expectation to obtain job opportunities in the seabed pipeline installation. Nevertheless, Indigenous People* do not have skills required by the available workforce needs. On the other side, the community also has high dependency on fisihing activities and sea transportation accessibility. Thus, the overall aspect of gas transmission is possibly to create big concerns related to the fishery activity and sea transportation accessibility disturbances of community. The gap and concern is potentially to create social tension in certain level. Based on the experience in the past, the social tension is potentially to disrupt the project activities and security of workforce. However, the community perception does not necessarily creates the social tension by considering the community perception only occurs in interim period. Thus, the impact severity is classified as 'medium'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The opportunities of the rise of community perception as a 'derivative' impact from community perception related to job opportunities, workforce demobilization as well as fishery activity and sea transportation accessibility disturbances are likely to occur. Thus, the impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The negative perception of community as a 'derivative' impact from job opportunities, workforce demobilization as well as fishery activity and sea transportation accessibility disturbances on the seabed pipeline, trenching and rock dumping on the Tangguh LNG construction are classified as 'moderate'. By considering gap between Indigenous People expectations to work permanently and the workforce needs on the pipeline installation activities; and the community capacity to meet the expectation. On the other side, the high dependency of community to fishing activities and sea transportation create big concerns related to the disturbance on their fishing activities and sea transportation accessibility as the impact of the overall aspect of transmission gas activity. However, based on the experience, community perception does not always create social tension. By considering this, the social tension is predicted to likely (possibly) occur in the activities, so this impact is classified as significant ('mdoerate') and must be managed.*				

3.3 LNG PLANT ACTIVITIES

3.3.1 Geophysical- Chemical

A. Air Quality

3.3.1.1 Light Emission

Environmental Baseline

The flare system at the Tangguh LNG in LNG Train 1 and LNG Train 2 consist of Wet and Dry Flare, Tankage Flare and Liquid Drain System. The Dry Flare and Wet Flare are operated continuously during the period of LNG Plant operation (± 25 years since the operation phase commenced), while the Tankage Flare operates intermittently when there is excess boil off gas at the time of LNG loading to tanker. The amount of gas burnt in the flare of LNG Train 1 and 2 are shown in **Table III-44**. The flaring reduction continuous improvement program currently implemented by the Tangguh LNG for LNG Train 1 and 2 operation succeeded in reducing the annual amount of gas burned in flare.

Table III-44 Total Gas Burned in Flare (LNG Train 1 and 2)

Year	Flare	
	(MMSCF per year)	(MMSCFD)
2010	13,291	36
2011	9,222	25
2012	6,668	18
2013	2,383 [1]	91

Note:
[1] Data from January to September 2013

Although the flare volume will decrease significantly during LNG Train operation , light emission will still be present. In flare operation at Tangguh LNG Train 1 and LNG Train 2 of the Tangguh LNG shows light emission that is monitored from flare.

Impact Prediction

The presence of light emission monitored from flare operation pottentially cause disturbance to several specific fauna.

Certain insect species, mainly nocturnal insects have behavior of approaching sources of light, for instance insects of the Coleoptera ordo (bees) and Hemiptera ordo (bugs). Besides that, some of the insects use light as navigation system. Light caused by flares from the Tangguh LNG activities cause insects to move approaching light. The light from flares can disturb the natural navigation system, so it can affect their activities and growth patterns.

Light produced by flare is also accompanied by heat so that insects and other flying fauna such as birds could be killed when approaching the flare, since the fauna cannot adapt to high temperature.

Impact Evaluation

Light originating from flare will continue during operation of the LNG Plant (± 25 years since the operation phase commenced). Light produced from flare will attract insects to approach, and these insects will be followed by their natural predators, i.e. insect eating birds (wallet/sriti) and insect eating bats (Subordo Microchiroptera). Experience from LNG Train 1 and LNG Train 2 operation showed that several wallet/sriti birds were killed during initial startup and commissioning for several months. However, this only occurred temporarily for the first few months in the initial phase of operation and did not affect the total population of the fauna. The experiences (from operation of LNG Train 1 and 2, and from other locations) showed birds or insects were adaptable to artificial light.

Based on the above description and the explanation in **Table III-44**, therefore the operation of flares producing light emission is categorized asa minor impact.

Table III-45 Impact Evaluation of Light Emission from Flare Activities of the LNG Plant

Impact Description	*Light emission comes from* flare *during LNG Plant operation activity. Light emission from* flare *is known to be able to attract certain bird types (wallet or sriti) as well as certain nocturnal insect types, such as those of the* Coleoptera *and* Hemiptera Ordo.				
Impact Nature	**Negative**	**Positive**			
	*The impact is negative thus will affect behavior of certain insect species (*Coleoptera *and* Hemiptera ordo*) and bird species (Sriti/Wallet).*				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Light emission produced by gas combustion in flare.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Light from the flare will continue during the period of Tangguh LNG Train operation (± 25 years since the operation period commenced).				
Impact Extent	**Local**	**Regional**	**Global**		
	Flare is visible from a sufficiently far distance however still in the study area boundary.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Light emission caused by gas combustion in flare. The amount of gas burned in 2013 in LNG Train 1 and LNG Train 2 flare totaled 2,383 MMSCF. The volume reduction program of gas burned currently applied by the Tangguh LNG for operation of LNG Train 1 and 2 succeeded in reducing the annual amount of gas burned in flares.				
	Experience from LNG Train 1 and 2 operation showed that environmental impact will be very limited. Several birds were found killed during initial startup *and* commissioning *for several months. This will not have an impact on the total bird population inhabiting the vicinity of Tangguh LNG. This is reinforced by experience from other countries, where it was found that birds became used to the presence of artificial light. The number of insects with potential to be impacted is negligible compared with the number of species present in the area of Tangguh LNG and the vicinity.* *Flare volume may increase during initial startup and commissioning of LNG Train 3 and future phases for LNG Train 4, and during shutdown* schedule *due to TAR (maintenance activity) or in the event of disruption to the LNG Train, then will decrease to condition of normal operation.* *Although the flare volume will decrease significantly during LNG Plant operation, light emission will continue but will not cause significant impact for the environment. Thus the impact magnitude is in the category of 'low'.*				
Receptor	**Low**	**Medium**	**High**		

Sensitivity	*Receptors of light emission impact are fauna, particularly birds. Light emission from flare or artificial light may influence activity pattern, however based on previous experience and in other places, birds have adaptability so that after several months will avoid the area of the flare stack. Thus, the sensitivity of impact recipient is in 'medium' category.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude is classified as 'low' and receptor sensitivity is categorized as 'medium', thus the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	The impact likelihood is categorized as 'low' in the normal operation phase due to adaptability of birds and insects.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact severity is classified as 'medium' and impact likelihood is classified as 'low', thus the impact significance is categorized as 'minor' and insignificant.				

3.3.1.2 Increase in Opacity

Environmental Baseline

The flare system at the Tangguh LNG found in LNG Train 1 and 2 and amount of gas burnt in the flare system have been explained above in the sub chapter of the light emission.

In flares, the combustion process proceeds in order to destroy combustible gases. In the complete combustion process, combustible gases will be converted into CO2 and H_2O, while in incomplete combustion, there will be smoke, CO, as well as products of incomplete combustion (PIC).

Opacity is a measure (in %) indicating decreasing the level of visibility caused by the presence of smoke (particulates) during gas combustion in flare. The higher the opacity level, the darker the smoke or the lower the level of visibility, indicating efficiency of incomplete combustion. However with good design, operation, and maintenance, products of incomplete combustion can be reduced.

The Tangguh LNG performed monitoring toward opacity level of flare with monitoring results shown in **Table III-46**. In general, opacity was measured with range between 11 to 31%, which is below the quality standard of 40% based on Minister for the Environment Decree Number 13 Year 2009 Annex I 1.d concerning The Quality Standard of Emission for Oil and Gas Industry, Emission Sources of Production Process, Flare Units.

Table III-47 Measurement Results of Flare Opacity

Monitoring Period	Unit	Quality Standard[1]	Opacity
			Flare
April-October 2010	%	40	11
October 2010-April 2011	%	40	13
April–October 2011	%	40	12.8
October 2011 - April 2012	%	40	11.5

April – October 2012	%	40	20
October 2012 – April 2013	%	40	31

Note:
[1] Minister of the Environment Decree Number 13 Year 2009 Annex I 1.d on Quality standard of Emission for Oil and Gas Industry, Emission Sources of Production Process, Flare Units

Among the routine activities of the Tangguh LNG are to conduct annual TAR (LNG Train Maintenance). During the TAR several gases must be released through flare to stabilize the train before performing the total shutdown process. Black smoke in the flare is also likely to be produced during abnormal condition such as trip/shutdown, caused by heavy fraction hydrocarbon carried and burned off in flare.

Impact Prediction

Opacity is one of the issues arising during flare operation and among the emission parameters monitored during oil and natural gas activities. Monitoring results of 2010-2013 of LNG Train 1 and 2 operation so far showed that opacity had a range of 11-31% so that it complied with the acceptable quality standard (40%).

With planned development of flare for LNG Train 3 and future phase of LNG Train 4 it is estimated that condition of opacity will be more or less similar to the present condition. The possibility of incomplete combustion by the presence of heavy fraction hydrocarbon that can occur during abnormal condition and increased flaring volume during TAR or trip/shutdown are also taken into consideration in the impact evaluation of the LNG Plant operation.

Impact Evaluation

As mentioned above the emission produced in flare when incomplete combustion occurs can be an increase of opacity. Although so far opacity level at the location around the Tangguh LNG ranges between 11-31%, the flare system operated will continue until ± 25 years since the operation phase is commenced, i.e. during duration of the Tangguh LNG Expansion Project. Besides, there will be periods where the Tangguh LNG will conduct TAR prior to total shutdown process and also in abnormal situations such as trip or shutdown that will likely cause thick smoke due to heavy fraction carbon combustion.

Based on the above description and the explanation in **Table III-48** operation of flare for LNG train operation in normal condition producing increased opacity is in category of ‘minor’ impact .

Table III-49 Impact Evaluation – Increased Opacity of Flare in the LNG Plant Activities

Impact Description	*The impact possibly occurring as a result of increased opacity of* flare *during* startup *and operation of the LNG Plant. Combustion of gas and other elements will cause smoke that will likely have an impact of increased opacity in the air.*			
Impact Nature	**Negative**	**Positive**		

	Smoke caused by flaring gas combustion will have a negative impact with the increase of opacity in the air.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Increased opacity is a direct impact of gas flaring *in the operation phase of the LNG Plant.*				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Flare system will continue for the duration of the Tangguh LNG project (± 25 year since the start of the operation phase).				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact produced is local. Experience and observation during operation of the Tangguh LNG Train 1 and Train 2 , show that distance of smoke dispersion from flare *is limited and will quickly be thinned out by ambient air at distance of several hundred meters.*				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	From monitoring of current LNG Train operation, opacity level in condition of normal operation indicates within quality standard, or maximum of 31%. According to Minister for the Environment Decree No. 13 of 2009, the quality standard for opacity is 40%. *Opacity level exceeding quality standard may occur at any moment during abnormal operation including startup and commissioning of LNG Train 3 and further LNG Train 4, also during Train* shutdown *schedule due to TAR or maintenance activity or during disruption of Train.* *The current flare gas combustion reduction program will be maintained and learning from flare gas combustion in the current operation will be applied during the Tangguh LNG Expansion Project activities including during startup and commissioning of LNG Train 3 and the next phase for LNG Train 4. Tangguh LNG will continue to monitor opacity level.* *However, since flaring activities will still need to be done during normal operation, the impact of opacity will continue to be present and expected to meet quality standard in effect. Characteristics of climatology in the Tangguh LNG area and the vicinity as described in Chapter II on Environmental Baseline can also reduce opacity in ambient air with the dispersion of air influenced by wind speed.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Opacity is among the parameters used to determine ambient air quality. High opacity level will generally be linked with air pollution. With ambient air quality in the Tangguh LNG area and the vicinity that is naturally still good, receptor sensitivity is categorized as 'high'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact magnitude is categorized as 'small' and receptor sensitivity is categorized as 'high', thus impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Results of monitoring during operation of LNG Train currently indicate that opacity level still meets quality standard in effect. Therefore, in normal operating condition, the opportunity for impact incidence is 'low'. *In abnormal operating condition, high opacity level can occur during* shutdown *schedule due to TAR or maintenance activity (once a year) or disruption to train (trip/shutdown) occurs.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact severity is categorized as 'medium' and impact likelihood is categorized as 'small', thus impact significance is 'minor' and insignificant.				

3.3.1.3 Greenhouse Gases

a. Increase of CO_2 Emission

- Environmental Baseline

The Tangguh LNG has performed annual calculation of CO2 and CH_4 emission from current Tangguh LNG operation activities (LNG Train 1 and 2 and the supporting activities). With reference to IPCC (2007) stating that global warming potential is computed through equivalency of greenhouse gas emission (CO_2, CH_4, N_2O, SF_6, HFC and PFC) toward CO_2 emission, therefore calculation of greenhouse gas emission in the Tangguh LNG is focused on the calculation of CO_2 emission.

The calculations of CO_2 emission from activities in the Tangguh LNG are based on total CO2 emission from consumption of low and high pressure gas fuel, gas flaring, and CO_2 derived from feed gas. Apart from that, the calculation also included consumption of diesel fuel, gasoline and avtur, despite their small contributions (less than 1%). Overall, calculation of CO2 and CH_4 emission by the Tangguh LNG is shown in **Table III-50**.

Table III-51 Total CO_2 and CH_4 Emission in the Tangguh LNG (including CO_2 Emission from Burning of Oil Fuel)

Type of Greenhouse Gas	2008	2009	2010	2011	2012
CO_2 (Kilo Ton)	101	2,498	4,561	4,513	4,657
CH_4 (Kilo Ton)	0	21	44	46	6

Data in **Table III-52** shows that in 2012 total CH_4 emission was 6 kilo tons and total CO_2 was 4,657 kilo tons. With reference to IPCC (2007) and duration of LNG Train 1 and 2 operations, so the equivalence of CH_4 emission toward CO_2 emission through GWP (Global Warming Potential) coefficient for the duration of more than 20 years is 25. Through the conversion factor, concentration of CH_4 emission in 2012 was obtained equivalent to 150 kilo tons CO_2. Thus, in 2012, total greenhouse gas emission produced from Train-1 and 2 operation was 4,807 kilo tons CO_2.

Gas Combustion and Release of CO_2 from Feed Gas

Based on **Table III-53,** in the operation of LNG Train 1 and 2 gas combustion was done that encompassed burning of low pressure gas fuel , high pressure gas fuel and gas flaring, with total approximately 44% (2,033 kilo tons CO_2) of total emission in 2012. Low pressure gas fuel was used to operate three boiler units (boiler A, B and C), while high pressure gas fuel was used to operate two turbine units as power generator at LNG Train 1 and 2.

CO_2 gas from feed gas was released through Acid Gas Incinerator/AGI and flaring, amounting to 2,580 kilo tons or 56% of total CO_2 emission in operation of LNG Train 1 and 2 in 2012.

Table III-54 CO_2 Emission from the Operation of LNG Train 1 and 2 in 2012 (excluding CO_2 Emission from Burning of Oil Fuel)

Year	CO_2 Emission			CO_2 Release from Feed Gas through AGI and Flaring	Total CO_2 Emission
	Low Pressure Gas Fuel	High Pressure Gas Fuel	Flaring		
	(Kilo Ton)	(Kilo Ton)	(Kilo Ton)	(Kilo Ton)	(Kilo Ton)
2012	394	1,308	331	2.580	4,613

Use of Diesel Fuel, Gasoline, and Avtur

Total diesel fuel consumption in Babo site, for operation of vehicles and vessels in the Tangguh LNG was 11,433 m^3 in 2012. Diesel fuel consumption produced CO2 emission was 29,798 tons. Total avtur consumption for operation of chartered flights for the Tangguh LNG requirement was 5,381 m^3/year that emiied 14,025 tons CO_2. Gasoline consumed both at the Tangguh LNG Plant and Babo site was 3.3 m^3/year with CO_2 emission of 9 tons. Total CO2 emission from the entire oil fuel consumption in the Tangguh LNG was 43,832 tons (44 kilo tons) in 2012 as shown in **Table III-50.**

Table III-55 Total CO_2 Emitted from Use of Oil Fuels (Diesel Fuel, Gasoline and Avtur) in 2012

Description	Volume (m^3)	CO_2 Emission (Ton)
• Diesel fuel consumption at Babo *Site*	683	1,779
• Diesel fuel consumption for vehicles <600 hp at Tangguh LNG	6,160	16,056
• Diesel fuel consumption for vessels **Total Diesel Fuel Consumption :**	4,590 **11,433**	11,963 **29,798**
Total Gasoline Consumption (LNG *site* and Babo *site*)	**3,302**	**9**
Total use of *Avtur*	**5,381**	**14,025**
Total CO_2 emission		**43,832**

- **Impact Prediction**

Predicted CO_2 emission from the operation of LNG Train 3 and LNG Train 4 was based on total annual CO_2 emission from gas fuel combustion (low pressure and high pressure) and flaring, as well as CO_2 gas from feed gas, burning of oil fuel and emission of CH_4 gas that equivalent with CO_2 gas.

Based on the calculation results it was estimated that total CO2 emission in Train 3 operation will be 3,097 kilo tons per year, with the detail as follows:

- CO_2 emission from burning of gas fuel (low pressure and high pressure) and flaring of 1,040 kilo tons per year (33.6% of total gas emission).
- Emission of CO_2 gas from feed gas is 1,960 kilo tons per year (63.3% of total CO_2 emission). CO_2 concentration in feed gas ranges between 10-15%.
- Oil fuel consumption to support LNG Train 3 operation is estimated to be half of oil fuel consumption for operation of LNG Train 1 and 2 that will emit CO_2 of approximately 22 kilo tons (0.7% of total CO_2 emission)
- It is estimated that LNG Train 3 operation will also release 3 kilo tons CH_4 gas or equivalent to 75 kilo tons CO_2 (2.4% of total CO_2 emission)

It is assumed that LNG Train 4 operation will emit CO_2 gas with equal quantity as the LNG Train 3, i.e. 3,097 kilo tons (3.1 million tons) annually.

CO_2 emission from the operation of LNG Train 1 and 2, originating from burning of gas fuel (low pressure and high pressure) and flaring, as well as CO_2 gas from feed gas that was released through AGI and flaring, oil fuel combustion, including CH_4 emission (equivalent with CO_2) in 2012 was 4.8 million tons. With predicted emission of CO_2 gas originating from LNG Train 3 of approximately 3.1 million tons per year, it is estimated that total CO_2 emission from the operation of LNG Train 1, 2 and 3 will be approximately 7.9 million tons annually. It is estimated that Future development with the addition of LNG Train 4 will increase emission to be equal to that of LNG Train 3 of approximately 3.1 million tons per year.

Referring to the IPCC (2000) report, increase of CO_2 emission with the operation of LNG Train 1, 2 and 3 can contribute to global greenhouse gas effect, i.e. 0.05% compared with total global CO_2 emission of 15,000 million tons per year. Contribution of greenhouse gases of 0.05% will potentially impact toward global climate change. It should be noted that this comparison is based on the IPCC report of 2000 whereas the LNG Train 3 is scheduled to operate in 2019 and the LNG Train 4 is part of the future development.

- **Impact Prediction**

  The Green House Protocol published by the World Resources Institute (WRI) expects that every activity emitting greenhouse gas to report the greenhouse gas emission according to reporting scope, namely Scope 1, Scope 2 and Scope 3. For the Tangguh LNG activities, the impact evaluation is focused on direct CO_2 emission from the LNG Plant operation (Scope 1). Indirect emission (Scope 2) originating from electrical and other energy supply are not applicable to the Tangguh LNG activities since all energy used is produced internally from the LNG Plant facilities.

Based on the explanation in the environmental baseline section and impact prediction, total cumulative CO_2 gas emitted from LNG Train 1, 2 and 3 operations are estimated to be 7.9 million tons and will be an emission increase of about 3 million tons upon future development with LNG Train 4. Considering the impact receptors due to increase in CO_2 emission are human beings, animals and the environment , as well as the duration of LNG Plant operation is continuous for approximately 25 years from start of the operation phase, therefore the cumulative impact of the four trains operations to the increase of CO_2 emission is categorized as 'major'.

Table III-56 Impact Evaluation for Greenhouse Gases (CO_2)

Impact Description	*Operational activities of LNG Train 1, 2, 3 and 4 will release CO_2 emission, mainly originating from gas combustion encompassing burning of low pressure gas fuel (boiler unit, Regeneration Gas Heater), burning of high pressure gas fuel (turbine unit), and flaring, as well as release of CO_2 from feed gas. Emission of CH_4 gas made equivalent to CO_2 gas and oil fuel combustion will also contribute to CO2, emission although in small amount (less than 1% for burning of oil fuel and 2.5% from CH_4).*				
Impact Nature	**Negative**	**Positive**			
	CO_2 emission produced from the Tangguh LNG operation can contribute to greenhouse effect of global nature.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	CO_2 emission is a direct impact of low and high pressure gas fuel burning, release of CO_2 gas from feed gas, *as well as burning of oil fuel. The amount of CO_2 emission is the accumulation of the ongoing LNG Train 1 and 2 operation as well as LNG Train 3 operation plan in the Initial development plan and LNG Train 4 in the Future development plan.*				
Impact Duration	**Temporary**	**Short-Term**	**Long-Term**	**Permanent**	
	CO_2 emission from the Tangguh LNG operation activities will occur for ± 25 years from start of the operation phase, i.e during the LNG Plant operation.				
Impact Extent	**Local**	**Regional**	**Global**		
	CO_2 is an inert *gas and will be immediately dispersed and spread in the atmosphere following the global air circulation pattern.*				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Based on calculation, CO2 gas emission from LNG Train 1 and 2 operation in 2012 was 4.8 million tons per year. If CO_2 emission from LNG Train 1 and 2 is added with CO_2 emission from operation of LNG Train 3 to be estimated of 3.1 million tons per year, therefore the cumulative CO_2 emission from operation of the four Trains will be equal to 7.9 million tons per year. The Future development of LNG Train 4 is estimated to increase the amount of emission, similar to that of LNG Train 3, namely around 3.1 million tons per year. *Based on prediction using B2 scenario (medium population growth, medium economic growth and more diverse use of technology) referring to IPCC (2000), total CO_2 emission of 7.9 million tons per year contributing 0.05% compared with total global emission of CO_2 of 15,000 million tons per year. It should be noted that the comparison was based on the IPCC report of 2000 while LNG Train 3 is scheduled to operate in 2019 and LNG Train 4 is part of the future development plan.* *Based on nature of change able to be caused by CO2 emission, intensity of impact (contributing to 0.05% of global CO_2 emission), impact extent of global nature and duration of impact that is Long Term; the impact magnitude may be concluded to be in category of 'high'.*				
Receptor	**Low**	**Medium**	**High**		

Sensitivity	*Receptor of CO_2 emission is quite varied from several types of receptors (human and fauna) and various types of resources. Although the impact extent is global, however in the scope of this study, only the impact in Bintuni Bay was observed. Therefore, sensitivity of impact recipient is in category of 'medium'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	As the impact magnitude is 'medium' and receptor sensitivity is 'high', thus the impact severity is 'high'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Impact likelihood is categorized as 'high', since CO_2 gas will be emitted from the operation activities of LNG Train 1, 2, 3 and 4 that will proceed continuously over train operation for ± 25 years since the operation phase commenced.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Significance of impact is determined on the basis of impact severity toward impact likelihood. Impact severity is 'high' and impact likelihood is 'high' so that impact significance becomes 'major' and classified as significant impact.				

3.3.1.4 Noise

a. Increase of Noise Level

- Environmental Baseline

Baseline of noise level in the Tangguh LNG area and the vicinity was obtained through measurement of noise level both onshore and offshore. Measurement of noise level onshore represents noise level in the Tangguh LNG area (forest area and open area) and the nearest settlement outside the Tangguh LNG area.

In order to know the noise level, measurement was required during the day time (four times measurement per 5 seconds for 10 minutes) and at night (three times measurement per 5 seconds for 10 minutes) as stipulated in Minister for the Environment Decree No. 48 Year 1996 concerning Noise Level Standard. However, due to safety factor considerations, measurement was done three times only in daytime at onshore and offshore locations. Equivalent noise level (L_{eq}) was determined from the formula below (Equation 1) where f_i is Time Faction of noise level at specific measurement time interval and L_i is the median value of noise level at specific measurement time interval.

$$L_{eq} = 10\,log \sum_{i=1}^{n} (f_i 10^{\frac{L_i}{10}}) \qquad (1)$$

Equivalent noise level with three times daytime measurement cannot be compared with noise level standard in daytime and at night stipulated in Minister of the Environment Decree No. 48 Year 1996 concerning Noise level Standard. However, considering that peak activities at the onshore and offshore sampling locations occurred during the daytime, the equivalent noise level in the daytime can represent the worst condition of the sampling location. Equivalent noise level from the calculations were then compared with Minister of the Environment Decree No. 48 Year 1996 concerning Noise Level Standard.

From the calculation of equivalent noise level offshore (AQN-9, AQN-10, AQN-11 and AQN-12) as shown in **Figure III-31** and referring to Minister of the Environment Decree No. 48 Year 1996 concerning Noise Level Standard, overall noise level offshore was still below noise level standard specified for noise level of an industrial area (70 dBA).

In the onshore noise level measurement (AQN-1, AQN-2, AQN-4, AQN-6, AQN-7 and AQN-8), noise level in Tanah Merah Baru settlement area (AQN-7) and Tangguh LNG (AQN-4) exceeded noise level standard for settlement category (55 dBA). Noise level in the forest area (AQN-1 and AQN-2), open area in Tangguh LNG (AQN-6) and settlement area in Arguni (AQN-8) complied with the noise level standard according to Minister of the Environment Decree No. 48 Year 1996.

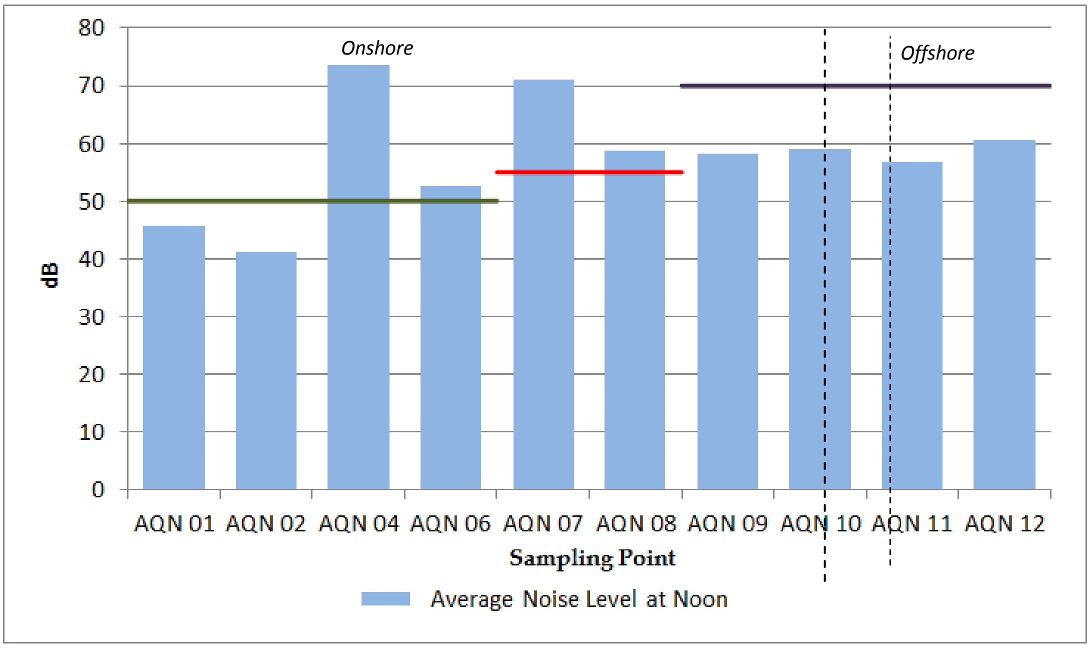


Figure III-31 Average Noise Level in Tangguh LNG

Measurement result of noise level at measuring point AQN-7 (Tanah Merah Baru settlement) during the sampling, besides affected by natural conditions (wind, animals and other natural conditions), was also affected by human activities, among others was the noise from grass cutters (mower) during noise level measurement.

Noise level measurement in the vicinity of LNG Train 1 and 2 indicated a value of 73.7 dBA. Noise level value at AQN-4 (open area planned as LNG Train-3 location) exceeded the noise level standard for industrial areas, i.e. 70

dBA. However, according to Minister of the Environment Decree No. 48 Year 1996 the noise level standard is stipulated to have +3 dBA tolerance so that noise level at AQN-04 cant be said to meet the noise level standard.

- **Impact Prediction**

The proposed Tangguh LNG Expansion Project activities and the supporting facilities potentially increase noise level in the Tangguh LNG area and the vicinity. In predicting increase of noise level due to the proposed Tangguh LNG Expansion Project activities, modeling was performed with considering the type of activities conducted, duration of activities and equipment used in construction and operation activities of the LNG Plant expansion and its supporting facilities. The impact of noise level to be able to affect environment at the surrounding project area was mostly due to activities during the construction phase.

The Tangguh LNG Expansion Project and its supporting facilities onshore include the following activities:

- Initial construction activities consists of tree cutting and initial land clearing with total area of around 125 ha; construction of BOF including dredging; construction of access road/haulage; improvement of shorebase (open storage area); combo dock enhancement; provision of 2,000 man camp and new fuel storage site in BOF for the construction activities;
- Future construction activities encompassing second phase of land clearing of ± 375 ha, construction of combined LNG – condensate jetty, LNG Plant, provision of 8.000 man camp, plant-utility area and office area.

The Tangguh LNG Expansion Project activities at offshore include offshore platform construction, production well drilling in each platform and installation of gas transmission pipeline from each offshore platform to the onshore receiving facility (ORF).

Noise level modeling focused on onshore facilities. The Tangguh LNG Expansion Project activities will take place from 2014 to 2018. Equipment used in construction activities of the Tangguh LNG Expansion Project consist of equipment for civil works and mechanical works.

Based on type of activity conducted, duration of activities and equipment used in LNG Train 3 construction and its supporting facilities, impact of noise level increase was predicted through eight scenarios according to activity group conducted simultaneously, i.e. scenario 2014, scenario semester 1 of 2015, scenario semester II of 2015, scenario semester 1 of 2016, scenario semester II of 2016, scenario semester 1 of 2017, scenario semester II of 2017, and scenario of 2018.

The scenario used for noise level modeling was the worst case scenario, i.e. when all equipment in the scenario of that year was used. Variations in actual noise level will depend on variation of activities, variation and number of equipment used. To understand the variations in noise level, modeling was also done by considering the number of equipment use of 50%, and 25% of all equipment. The modeling produced Leq contour obtained by combining noise stress level during construction activities, and ambient noise level in the absence of construction activities.

In BOF construction activities (the nearest facility to the settlement at Tanah Merah Baru) there is a possibility that construction works will need to be done in 24 hours a day. However, construction works that can cause relatively high noise level such as piling works for the first ± 6 months of the BOF construction schedule will be limited to a maximum of 14 hours per day. Ambient noise value used in daytime complied with results of environmental baseline measurement, while ambient noise value at night complied with the standard applied in Japan, Australia, EPA as well as WHO.

The use of ambient noise value standard at night-time according to the standard of ambient values applied in Japan, Australia, EPA as well as WHO was due to the fact that Indonesia does not have a night-time ambient noise standard. The night-time ambient noise value standard applied in Japan (*Japan Environment Agency Notification*, 1998) and Europe (WHO, 1999) was 40 dB, while the ambient noise value applied in Australia (*Australia Environment Protection Act*, 1997) was 35 dB. WHO and EPA stated a night-time ambient noise value standard of 45 dB. Therefore, the modeling used an intermediate value of night-time ambient noise, i.e. 40 dB.

In this modeling assumed distance reference of noise source was measured from the center point of the sound source. This is due to dimension of sound source is unknown. The modeling also took account of attenuation due to ground effect and attenuation due the presence of forest around the Tangguh LNG area.

Based on modeling of the LNG Plant Expansion activities and its supporting facilities toward noise level in the Tangguh LNG as shown in **Annex IV Modeling of Noise Dispersion from the Tangguh LNG Construction Activities**, the results were obtained as shown in **Figure III-32** and **Figure III-33**. The modeling results of eight scenarios are shown in **Table III-35**.

The modeling results of noise level modeling for the Tangguh LNG Expansion Project activities (development of LNG Train-3 and its supporting facilities) indicated that operation of 25% to 50% equipment in the activity scenario from 2014 to 2018 will increase noise levels which they were still within the noise level standard in accordance with Minister of the

Environment (MoE) Decree No. 48 Year 1996 concerning Noise level Standard.

One hundred percent equipment operation in the semester I 2015 to 2018 scenario may cause rising noise level at Tanah Merah Baru settlement exceeding the noise level standard for settlement areas, i.e.over 58 dB (The noise level tolerance from the MoE Decree No. 48 Year 1996 is 3 dBA).

Noise level increase will be highest in Tanah Merah Baru, occurring in scenario 2016 semester II with 100% equipment operation. In the scenario year 2016 semester II with 100% equipment operation resulting noise level in Tanah Merah Baru settlement reaching 61 dBA.

Table III-57 Modeling Results of Noise level in Development for the LNG Plant Expansion and its Supporting Facilities

Scenario	Equipment Used	Noise level towards the Affected Area (Tanah Merah Baru Settlement)		
		25%	50%	100%
2014	Dredging Vessel, Bulldozer, < 20 ton, Bulldozer, > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Crane below 30 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift.	57.5 dB	58 dB	58 dB
2015 semester I	Dredging Vessel, Bulldozer, < 20 ton, Bulldozer, > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Mixer truck, Water truck/fuel truck, Pile driving rig, Crane 100 to 120 ton, Crane 30 to 50 ton, Crane below 30 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift, Power generators.	58 dB	58 dB	59 dB
2015 semester II	Dredging Vessel, Bulldozer < 20 ton, Bulldozer > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Mixer truck, Water truck/fuel truck, Crane below 30 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift, Welding generators, Power generators	58 dB	58 dB	59 dB
2016 semester I	Bulldozer < 20 ton, Bulldozer > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Mixer truck, Water truck/fuel truck, Pile driving rig, Crane 100 to 120 ton, Crane 30 to 50 ton, Crane below 30 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift, Welding generators, Power generators	58 dB	58 dB	59 dB

Scenario	Equipment Used	Noise level towards the Affected Area (Tanah Merah Baru Settlement)		
		25%	50%	100%
2016 semester II	Bulldozer < 20 ton, Bulldozer > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Mixer truck, Water truck/fuel truck, Pile driving rig, Crane 30 to 50 ton, Crane below 30 ton, Flat bed trailer 30 to 50 ton, Fork lift, Welding generators, Power generators	58 dB	58 dB	61 dB
2017 semester I	Bulldozer < 20 ton, Bulldozer > 20 ton, Backhoe, Excavator, Wheel loader, Motor grader, Dump truck, Roller (tandem, tire, vibration), Compactor (plate, trench, d frog), Mixer truck, Water truck/fuel truck, Pile driving rig, Crane 30 to 50 ton, Crane below 30 ton, Flat bed trailer 30 to 50 ton, Welding generators, Power generators	58 dB	59 dB	60 dB
2017 semester II	Mixer truck, Water truck/fuel truck, Pile driving rig, Heavy lift crane 450 or 500 ton, Crane 150 ton, Crane 100 to 120 ton, Crane 30 to 50 ton, Crane below 30 ton, Prime mover and or self propelled transporter with power pack, Low bed trailer 60 to 100 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift, Welding generators, Power generators	58 dB	58 dB	59 dB
2018	Dredging Vessel, Mixer truck, Water truck/fuel truck, Pile driving rig, Ringer crane 1.200 to 1.500 ton, Heavy lift crane 800 ton, Heavy lift crane 450 or 500 ton, Crane 150 ton, Crane 100 to 120 ton, Crane 30 to 50 ton, Crane below 30 ton, Prime mover and or self propelled transporter with power pack, Low bed trailer 60 to 100 ton, Flat bed trailer 30 to 50 ton, Boom truck, Fork lift, Welding generators, Power generators	58 dB	58 dB	60 dB

Based on noise level modeling in scenario 2014 to scenario 2018, basically the increase of noise level may affect the community in Tanah Merah Baru settlement and wildlife as well as hepterofauna around the Tangguh LNG.

The impact of noise level on animals potentially cause to alarm and frighten animals. Reaction of alarm and fright may cause interruption of animal activities (Klein, 1971). Apart from reaction of alarm and fright to animals, noise level also cause affect hearing disturbance, physiology change, and behavioral change in animals (*Air and Noise Compliance*, 2012). Increase of noise level also potentially cause migration of some species (birds, mammals, reptiles, amphibians) due to increasing noise level. The impact of noise on wildlife may be seen in **Table III-53**. For insects, increase of noise level originating from construction activities will not much affect them.

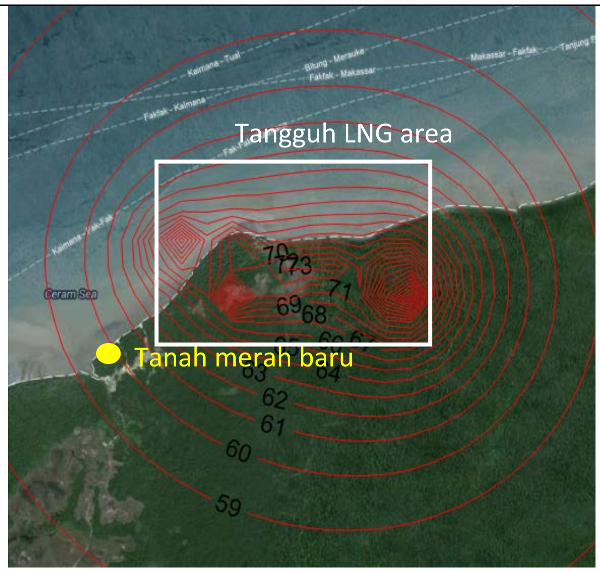
However, increase of higher frequency spectrum than 20 MHz may disturb insects.

Based on wildlife and herpetofauna data encountered at Tangguh LNG as shown in **sub-chapter 2.2.1.2** it was found that fauna species having difficulties in adapting to a new environment were among others land mammals such as *wallaby* (*Dorcopsis muelleri*), *Echymipera clara, Echymipera kalubu, Petaurus breviceps, and Strigocuscus gymnotis*, and particularly species protected by Government Regulation (PP) No. 7 /1999, IUCN, and CITES.

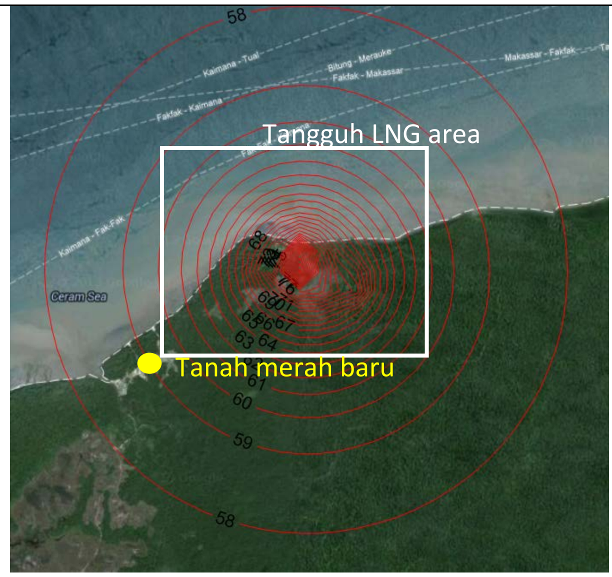
Table III-58 Noise Impact to Wildlife

Type of Impact	Primary Impact	Secondary Impact
Auditory (hearing)	Hearing disturbance	Change in relationship between predator and prey
	Shift in acceptable limit of hearing	Interference in mating
		Decrease of various functions
Physiology	Stress	Reduction of reproductive capacity
	Change in metabolism	Decreasing immunity
	Hormonal change	Decrease of various functions
Behavior	Signal masking	Change in relationship between predator and prey
	Avoidance Behavior	Decreasing population
		Migration and loss of habitat
		Interference in mating

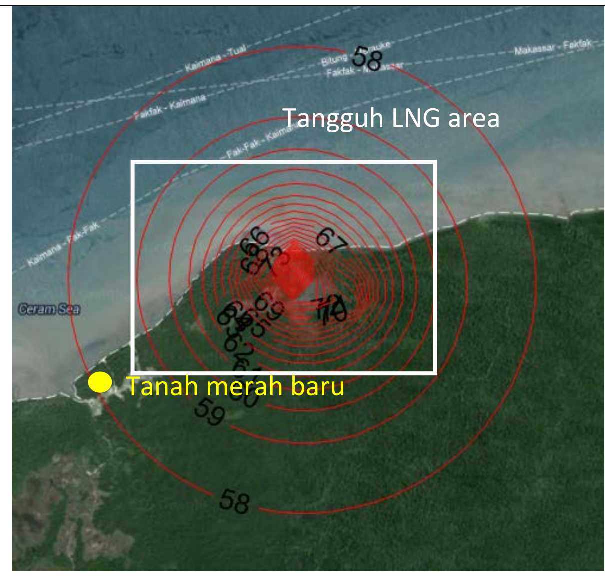
Source: *Air and Noise Compliance* (2012)



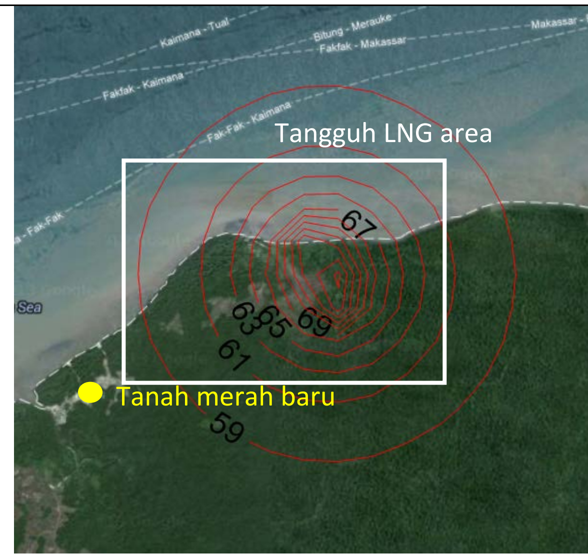
Scenario year 2014



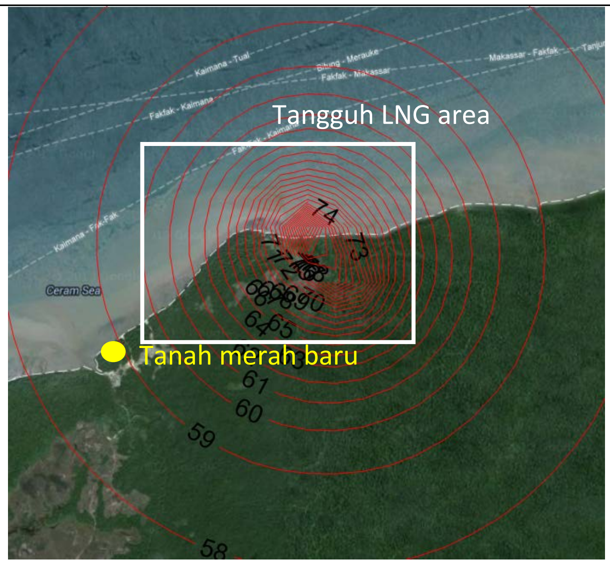
Scenario year 2015 semester I



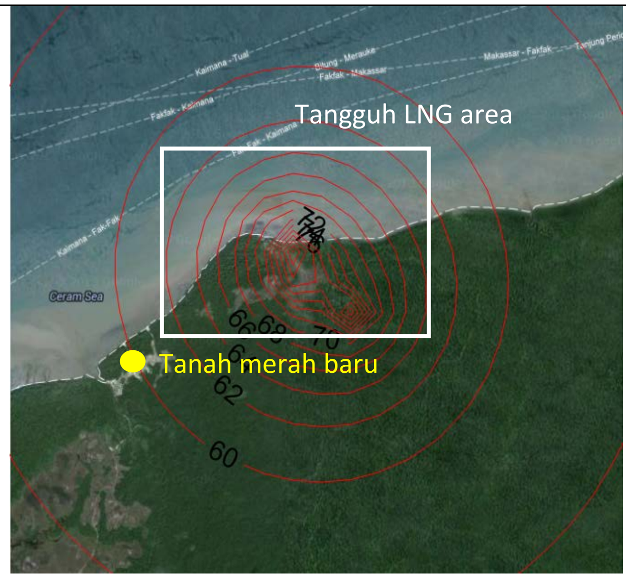
Scenario year 2015 semester II



Scenario year 2016 semester I

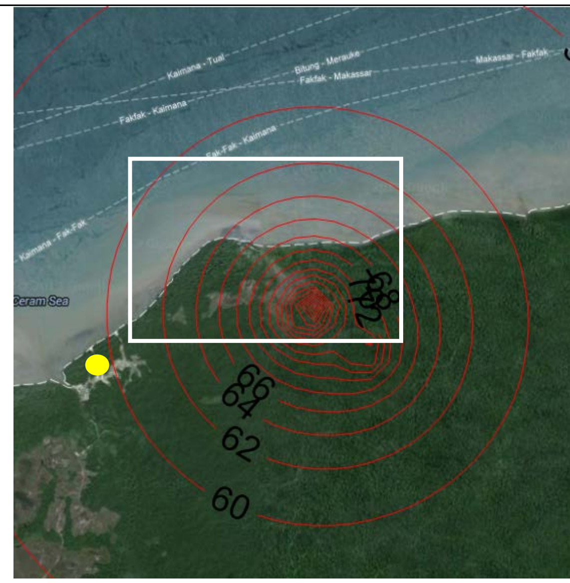


Scenario year 2016 semester II



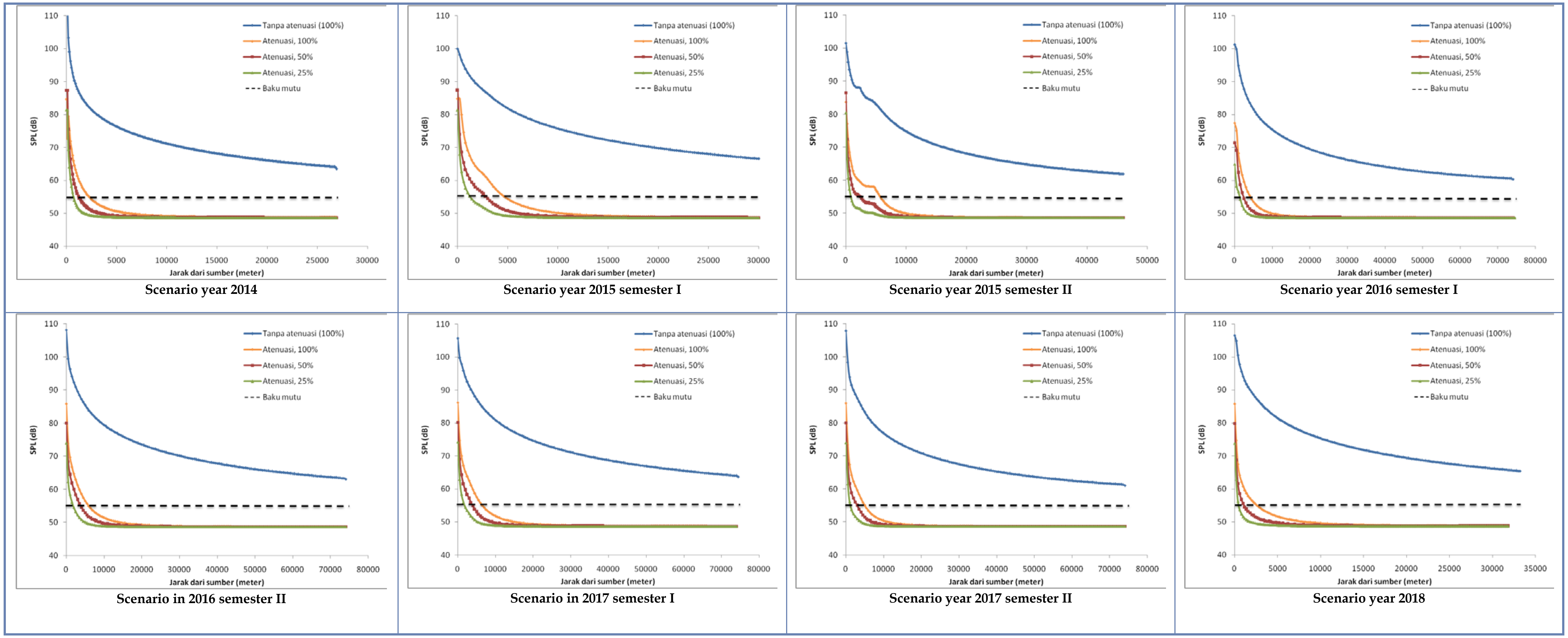
Scenario year 2017 semester I

Scenario year 2017 semester II



Scenario year 2018

Figure III-32 Modeling Results of Noise Level



Scenario year 2014 | Scenario year 2015 semester I | Scenario year 2015 semester II | Scenario year 2016 semester I

Scenario in 2016 semester II | Scenario in 2017 semester I | Scenario year 2017 semester II | Scenario year 2018

Figure III-33 Graph of Decreasing Sound Level toward Distance from the Source of Noise

- **Impact Evaluation**

  Based on baseline of noise at Tanah Merah Baru settlement, noise levels is used to reach 70 dBA as recorded. Therefore, it is estimated that noise level of up to 61 dBA as per modeling results of 2016 semester I can be tolerated.

  From the total area of Tangguh LNG of 3,266 ha, a total of ± 404 ha has been cleared (LNG Train 1 and 2 with area cleared of ± 365 ha, the perimeter fence of Tangguh LNG with area cleared of ± 39 ha) and the land clearing plan for the Tangguh LNG Expansion totally of ± 500 ha. So that after revegetation of ± 100 ha, forests unused by Tangguh LNG as well as its development to be ± 2,462 ha has function as a buffer zone. In addition, there is forest area outside the Tangguh LNG area that has function as habitat for similar species of wildlife.

  In terms of modeling results towards increasing noise level caused by construction activities of the LNG Plant Expansion and its supporting facilities also the presence of large forest area remaining after land clearing (± 2,462 ha), therefore the impact of noise on species distribution change and fauna diversity change is not considered as significant. However with the presence of protected wildlife, the impact magnitude is in category of 'medium'. Receptor sensitivity is also in the category of 'medium', since rare and protected wildlife habitats are also found outside the project area and adaptable to environmental change.

Table III-59 Impact Evaluation of Noise Level Increase in the Tangguh LNG Site (LNG Plant)

<table>
<tr><td>Impact Description</td><td colspan="5">Activities of land clearing and construction in the Tangguh LNG Expansion and its supporting facilities are not simultaneously conducted and dispersed over the entire area of the Tangguh LNG. The Tangguh LNG Expansion activities have potential to increase noise in the Tangguh LNG area and the vicinity . Based on noise level modeling through eight scenarios (scenario year 2014, scenario semester I year 2015, scenario semester II year 2015, scenario semester I year 2016, scenario semester II year 2016, scenario semester I year 2017, scenario semester II year 2017, and scenario 2018) using the worst condition approach, namely the scenario when 25%, 50% and 100% of equipment in the scenario for those years are used, it was known that Tangguh LNG Expansion activities had potential to raise noise level in the nearest settlement (Tanah Merah Baru) maximum up to 61 dBA in 100% equipment operation in semester II year 2016.

Rising noise levels besides affecting the settlement in Tanah Merah Baru, also have potential to cause impact on wildlife around the Tangguh LNG area.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Construction of land clearing and the Tangguh LNG Expansion and its supporting facilities are predicted to raise noise level around Tangguh LNG both settlements (Tanah Merah Baru) at distance of ± 4 km from the Tangguh LNG area and wildlife around Tangguh LNG. Increasing noise level may cause changes to distribution of species and fauna diversity.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Increasing noise level around Tangguh LNG is a direct impact of equipment operation during land clearing and construction of the Tangguh LNG Expansion facilities including LNG Train 3 and its supporting facilities.</td></tr>
</table>

Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Rising noise levels are estimated to continue during construction phase activities. Construction activities that will cause quite significant noise impact toward the nearest settlement to Tangguh LNG area are BOF construction activities. Highest noise level occurs during piling activities that will continue until maximum 14 hours for approximately the first 6 months of the BOF construction schedule. Other BOF construction activities besides piling *are estimated not to cause noise that will significantly affect settlement areas.* *Apart from that, the presence of land clearing activities that will proceed a maximum of 2 years, i.e. land clearing in the first year for the area required in the initial construction phase (*Early Work*) measuring ± 125 ha and the second year for the remaining land to be cleared in the future construction phase measuring ± 375 ha, Therefore, the duration of impact is in the category 'Short-term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Impact extent is local that will only affect the nearest settlement in Tanah Merah Baru and wildlife in the area of Tangguh LNG property.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Based on noise level modeling in Tangguh LNG and the vicinity, it was known that overall noise level in Tanah Merah Baru at 25% and 50% equipment operation in 2014 to 2018, met noise level standard in accordance with MoE Decree No. 48 of 1996 concerning Noise level Standard for settlements. *However, 100% equipment operation in scenario 2015 to 2018, produced increased noise level that was varied in Tanah Merah Baru and the vicinity, with highest noise level occurring in semester II of 2016 reaching 61 dBA. The rising noise level was considered* ***'medium'*** *because from results of environmental baseline noise level monitoring in Tanah Merah Baru, it was known that noise level in Tanah Merah Baru had reached 70 dBA (March 2013). While noise level of forest area within Tangguh LNG property was recorded at around 40 dBA. Increased noise level in forest area in relation to impact on wildlife was the influence on change ofspecies distribution and fauna diversity in which there were still protected wildlife, the impact magnitude was considered* ***'medium'***				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Human beings and animals are sensitive receptors towards increase of noise. *In terms of influence on wildlife, the habitat of rare and protected species commonly found outside the project area possessing adaptability to environmental change, the receptor sensitivitywas in 'medium' category.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact severity is determined from impact magnitude with receptor sensitivity. Impact magnitude is categorized as 'medium' and receptor sensitivity is categorized as 'medium', thus impact severity is categorized as 'high'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Increase of noise in the Tangguh LNG Expansion activities occurs several times in certain periods during construction activities, i.e. during land clearing performed in stages, and construction of LNG Train 3 and its supporting facilities, mainly during construction of BOF facility in close proximity to the settlement location, so that impact likelihood will occur once in each stage (in different space and time). Based on this, the impact likelihood is in category of 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	Critical
	Significance of impact is determined on the basis of impact severity toward impact likelihood. Impact severity is 'high' and impact likelihood is 'medium', therefore impact significance is categorized as 'major' and significant impact .				

3.3.1.5 Hydrology

a. Change in Creek Morphology

- Environmental Baseline

There are several large and small seasonal creeks (*ephemeral*) cross the Tangguh LNG area. Ephemeral creeks in the Tangguh LNG area are generally combined flows of several natural streams to join as one. The creeks are unnamed yet. For the purpose of the study, the creeks are designated the code 'S' and numbered in sequence. The sequence number is based on the catchment area, starting from the largest. **Figure III-34** shows distribution of ephemeral creeks around the Tangguh LNG area starting from 'S1' to 'S5'. Creeks 'S2', 'S3', 'S4' and 'S5' flowed to the north heading to the shore of Bintuni Bay with generally parallel flow pattern. Creek 'S1' flows to the west toward the Saengga River.

Light yellow color in **Figure III-34** indicates the proposed location to be built for the new Tangguh LNG Expansion facility.

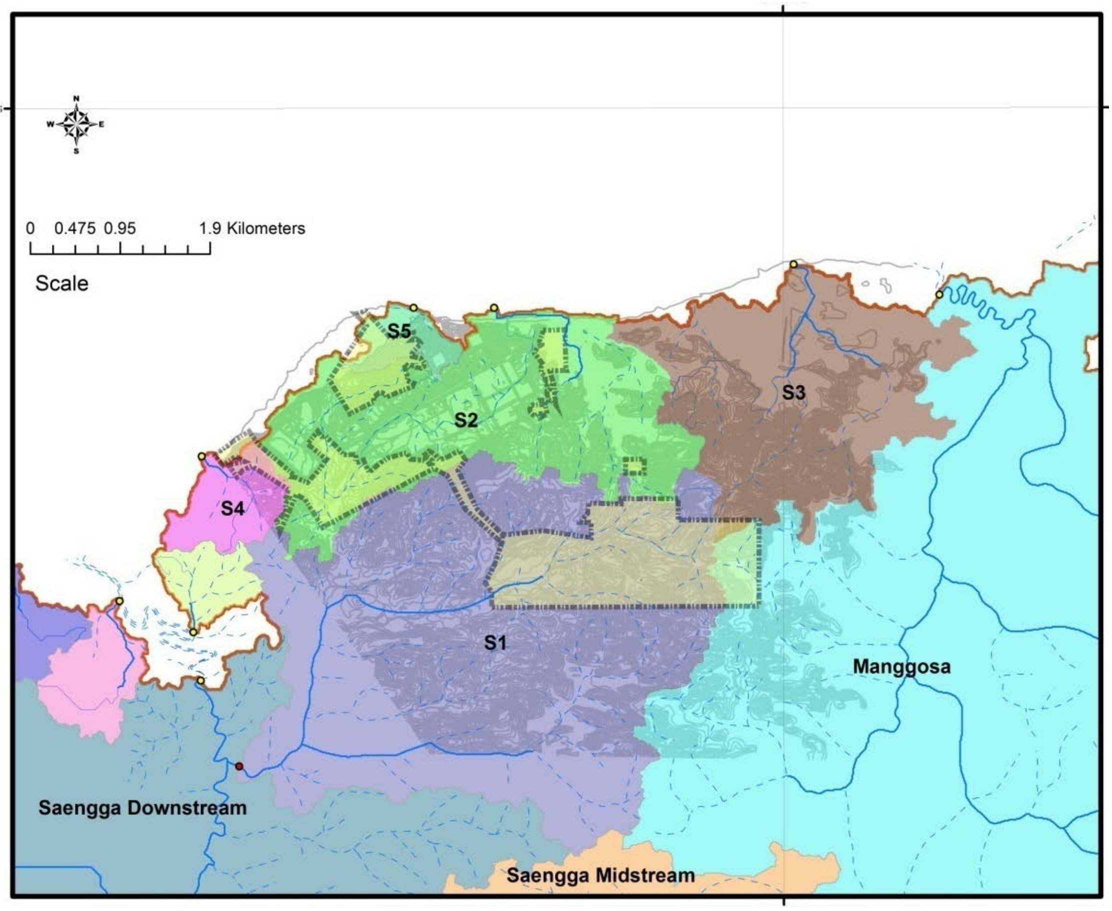


Figure III-34 Watersheds (DAS) in the Study Area

Creek morphology in this discussion is limited to the parameters: flow pattern, geometric form of flow section, channel bottom condition, as well as riparian flow condition. Only those creeks that will change in morphology due to the Tangguh LNG Expansion Project activities as discussed in this section.

Creek 'S1'

Figure III-35 illustrates flow pattern in 'S1'. Creek watershed (DAS) 'S1' possesses area is 1,482 ha with major flow length of 8,615 km, flowing to the West and joining with Downstream Saengga watershed. The flow pattern in 'S1' is dendritic-shaped. The geometric form of flow section 'S1' is generally trapezoidal with average width of 6.5 m and average depth of 0.4 m. Generally, the upstream of river is dry during the dry season with stone base. Relatively permanent flow begins from the middle watershed (DAS)downstream and with soil base.

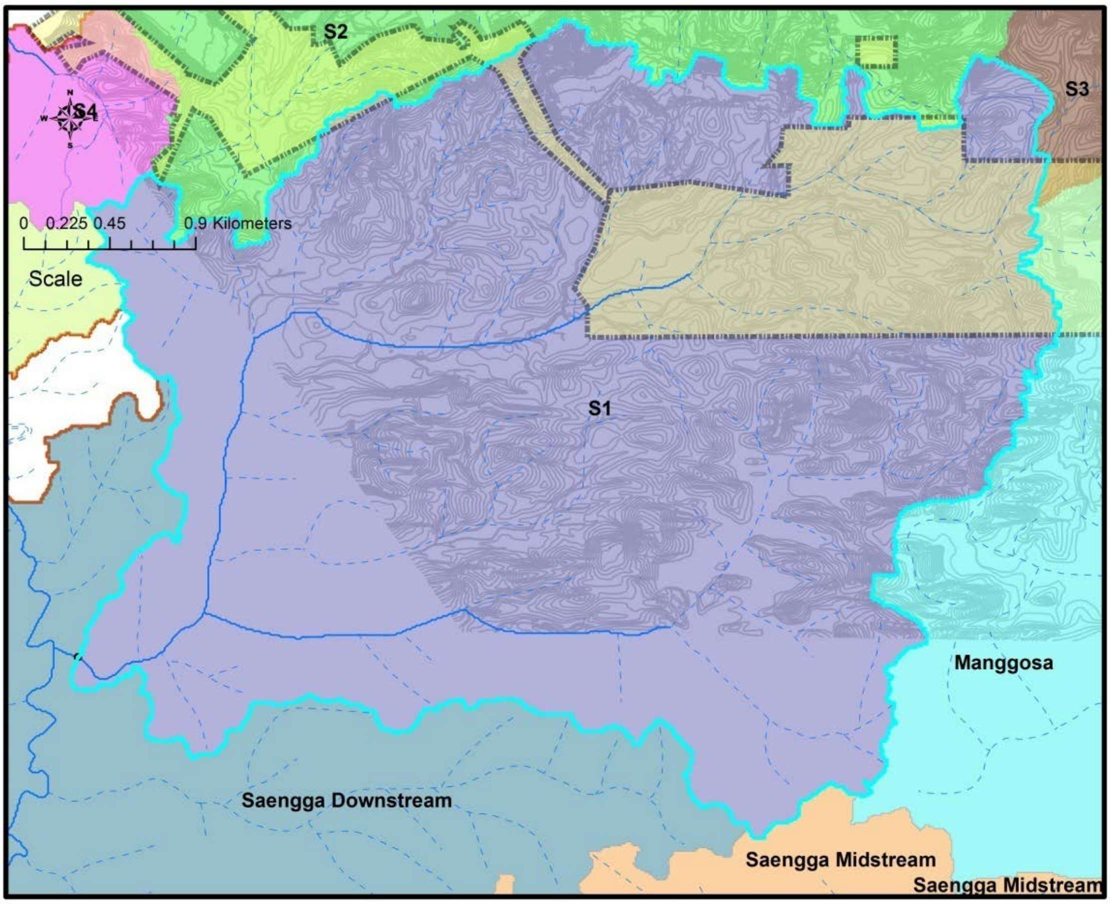


Figure III-35 River Watershed (DAS) 'S1' (bordered by green line)

Other Creeks

Figure III-36 illustrates flow patterns in other creeks. Creeks with likely change on their flow pattern are 'S4', 'S5' and 'S2'.

DAS 'S4' with an area of 96 ha with main creek flow of 1.60 km length, flowing to the North heading toward the waters of Bintuni Bay. Flow pattern at 'S4' is parallel shaped. The geometric shape of flow section 'S4' is generally trapezoidal with average width 1.30 m and average depth 0.13 m. The channel generally contains water from rainwater runoff and with soil base.

The area of DAS 'S5' is 53 ha with main flow length of 1.30 km, flowing to the North toward the waters of Bintuni Bay. The flow pattern in 'S5' is parallel. The geometric form of flow section 'S5' is generally trapezoidal with average width 0.90 m and average depth 0.10 m. Generally the channel only contains water from rainwater runoff with the channel bottom of soil.

DAS 'S2' covers an area of 660 ha with main flow length of 6.60 km, flowing North toward the sea. The flow pattern of 'S2' is parallel. Geometric form of flow section 'S2' is generally trapezoidal with average width 4.0 m and average depth 0.28 m. Generally the channel only fills with water from rainwater runoff and the channel bottom is soil.

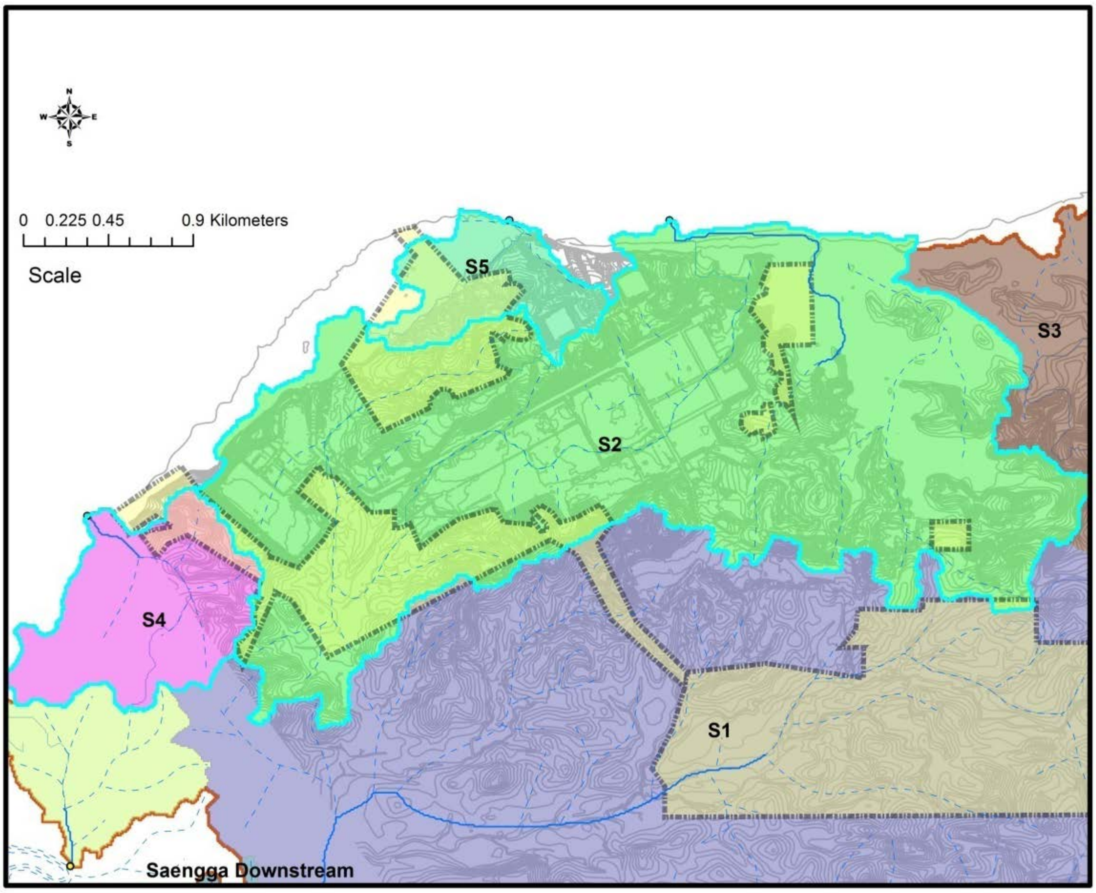


Figure III-36 Other River Watersheds (bordered by green line)

- **Impact Prediction**

Site preparation activities will cause change in creek morphology. In this discussion, site preparation activities are continuation of land clearing activities (clearing and cutting of vegetation). Thus site preparation activities encompass cut and fill, land grading (regulating gradient based on design slope), road and drainage construction , temporary storage of construction materials, and construction of direction kit (work barracks). All site preparation activities have potential to obstruct and divert creek flow.

DAS 'S1'

The area that will experience change in flow morphology due to altered landscape in DAS 'S1' is shown in **Figure III-35**. The Figure shows that natural flow from the area in the Northeast covering ± 83 ha will be obstructed, while in the East, landscape measuring ± 233 ha will change, similarly natural drainage flows in the area with total length ± 6,9 km will be replaced by artificial drainage channel.

DAS of Other Creeks

The areas that will experience change of flow morphology due to changes in landscape of DAS 'S4', 'S5' and 'S2' are shown in **Table III-55**.

In DAS 'S4', the landscape in the northeast that will experience change measures ± 11 ha. In the southwest part of DAS 'S5', landscape measuring 22 ha will be affected by physical facility development. Similarly, in DAS 'S2', areas to be affected by physical facility development covers approximately 121 ha, dispersed in the Southwest, North and East of area 'S2'.

From the description of predicted impact in DAS 'S1', 'S4', 'S5' and 'S2', locations to be cleared and built are generally in the upstream part of each catchment area. However, only 'S1' and 'S2' are predicted to be affected by the impact of change in flow morphology. In the Eastern part of 'S1', change in landscape will cause natural creeks flow to become artificial channels. In 'S2' in the Northwest and North, the landscape change will also alter the main ephemeral creek flow.

- **Impact Evaluation**

Site preparation activities will convert natural landscapes into physical facilities such as roads, administrative buildings, accommodation facilities (base camp), and other areas for project facilities. Change in landscape will cause change in natural drainage flows. **Table III-55** presents evaluation of impact toward change in creek morphology due to site preparation activities.

Table III-60 Impact Evaluation toward Change in Creek Morphology

Impact Description	*Site preparation activities will convert natural land into physical facilities of administrative buildings, accommodation facilities* (dormitory/base camp), *office building and other areas for project supporting facilities. This will result in disappearance of natural drainage flows to be replaced by drainage channels.*			
Impact Nature	**Negative**	**Positive**		

	Change in creek morphology may cause loss of natural drainage flows that will later be replaced by drainage trenches, so as to potentially increase flow rate. Higher flow rate may cause negative impact, namely increased channel bottom erosion and sedimentation due to higher TSS.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in creek morphology due to site preparation is a direct impact.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Duration of impact ranges from 9 months to 13 months, according to period of site preparation. It is estimated that after site preparation activities are completed, drainage ditches are able to replace the natural drainage flows that disappeared. Likewise, drainage flows severed by physical facility construction may be recovered by building culverts. The activity will proceed in relatively short period and is intermittent. Thus the Duration of Impact is 'Short-term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Change in creek morphology will occur mainly in creek watershed 'S1' and 'S2' located in Tangguh LNG area, so that impact extent is 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Impact Magnitude due to change in creek morphology may be evaluated using the Land Cover Index (ITL). The impact is low if ITL > 75%, medium if 30 % < ITL < 75% and high if ITL < 30% (Regulation of the Director General for Land Rehabilitation and Social Forestry on Guidelines for Monitoring and Evaluation of River Basins, No: P.04/V-Set/200, 05 March 2009). *Of the total river basin DAS area measuring around 1.482 ha, 233 ha land will change in form and gradient. The percentage of converted area is 16% (233 ha/1.482 ha) and located in the upper part of the DAS. Assuming that prior to construction, 'S1' was secondary forest, after construction ITL will become 84% (100%-16%) and in category of 'low' impact. Aside from that the upstream part of the DAS generally relatively dries drainage flow. Therefore, the impact magnitude may be categorized as 'small'.* *Similarly for land conversion in 'S5' and 'S2', of around 41% (22 ha/53 ha) and 18 % (121 ha/660 ha). Therefore, ITL for 'S5' and 'S2' are 59% (100%-41%) and 82%(100%-18%). With the same consideration as that of 'S1', we can categorize the impact magnitude at 'S2' and 'S5' as 'low'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	'S1', 'S4', 'S5' and 'S2' located in the Tangguh LNG area are resources affected by the impact of higher flow rate due to site preparation activities. Creek s S2', 'S4' and 'S5'flow to the north to Bintuni Bay waters and 'S1' flows to Saengga River, in which the water body is wider with larger discharge and influenced by condition of sea tides. Therefore, the receptor sensitivity is 'medium'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	The impact magnitude is categorized as 'low' and receptor sensitivity is categorized as 'medium', thus the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Impact likelihood is categorized as 'high' due to high rainfall and continuing throughout the year				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact significance is determined on the basis of impact severity and impact likelihood. Impact severity is categorized as medium and impact likelihood is categorized as 'high', thus the impact significance is categorized as 'moderate' and significant impact.				

b. Increase in Creek Flow Rate

- **Environmental Baseline**

  In terms of environmental baseline, ephemeral creek flow rate in the study area may be calculated using the Manning formula. **Table III-56** summarizes the results:

Table III-56 Creek Flow Rate around Tangguh LNG

No	Sub Watershed	Cross Section (m^2)	Perimeter (m)	Hydraulic Radius (m)	Velocity (m/sec)
1	'S5'	0.09	1.09	0.08	1.22
2	'S2'	1.11	4.55	0.24	1.24
3	'S4'	0.16	1.52	0.11	1.79
4	'S1'	2.49	7.27	0.34	1.54

From **Table III-56**, it shows maximum flow rate of ephemeral creek varies from 1.22 m/second to 1.79 m/second. The upstream river section generally has higher flow rate than the downstream section because the upstream part generally has steeper gradient than the downstream part.

- **Impact Prediction**

Impact of increase in creeks flow rate around the Tangguh LNG area is a derivative impact from:

- Changes in creek morphology;
- Increase in surface runoff; and
- Changes in drainage pattern.

This is due to land clearing activities, site preparation and cut and fill. Accumulation of the activities will cause changes in landscape and natural drainage flow pattern. Related to indicators of increase in creek flow rate, this is due to changes in river hydraulic parameters in four catchment areas, namely 'S1', 'S4', 'S5' and 'S2'. The Manning roughness coefficient will alter the condition from natural river (n=0.025) to artificial channel (n= 0.014). Therefore, the change in flow rate will be predicted as shown in **Table III-57**.

Table III-57 Changes in River Flow Rate in the Study Area

No	Sub Watershed	Cross Section (m^2)	Perimeter (m)	Hydraulic Radius (m)	Initial Velocity (m/dt)	Estimated Velocity (m/dt)
1	'S5'	0,09	1,09	0,08	1,22	2,17
2	'S2'	1,11	4,55	0,24	1,24	2,21
3	'S4'	0,16	1,52	0,11	1,79	3,20
4	'S1'	2,49	7,27	0,34	1,54	2,76

From **Table III-57** above, the facility development in former forest area will result flow rate increase in natural rivers.

- **Impact Evaluation**

  Development of facilities in the four river watersheds above are generally located in the upstream area of the rain catchment area. When flow from artificial channels are discharged to natural rivers, the increase in flow rate will aggravate scouring of river bed. The resistance limit of earth channel toward flow rate that will not cause scouring is 0.6 m/second (ASCE, 2000). When the new flow rate is nearly twice the previous flow rate, it may be concluded that change in creek flow rate in terms of impact magnitude is in category of 'high'. From the aspect of sensitivity, there will be potential for increase in riverbed scouring, however the duration of impact is temporary and the natural drainage flows will be replaced by artificial drainage channels, thus receptor sensitivity (resource) is categorized as 'low'.

  Based on the **matrix of impact severity**, for 'high' impact magnitude and 'low' sensitivity category, the impact severity is categorized as 'medium'.

  In terms of occurrence likelihood, increase in creek flow rate is likely to occur. Based on **matrix of impact significance**, with 'medium' impact severity category and 'high' likelihood, the impact of increase in creek flow rate is in 'moderate' category.

Table III-61 Increase in Creek Flow rate

Impact Description	*Site preparation activities will have a derivative impact of increase in creek flow rate caused by increase in surface runoff, change of drainage pattern and change in creek morphology.*				
Impact Nature	**Negative**	**Positive**			
	Increase in flow rate will aggravate scouring of creek beds generally of earth. The resistance of earth channel toward flow rate not causing scouring is 0.6 m/second (ASCE, 2000). Increase in flow rate will result in channel bed erosion.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Increase in creek flow rate is a secondary impact, thus it included in 'secondary impact' of site preparation activities				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Since the change occurring is permanent, the impact caused will also continue permanently				
Impact Extent	**Local**	**Regional**	**Global**		
	Impact extent will only occur in creek watershed 'S1', 'S4', 'S5' and 'S2' in the Tangguh LNG area, so that the impact extent is 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Impact Magnitude due to increase in creek flow rate may be evaluated using the river regime index (IRS). IRS is the maximum and minimum flow rate ratio. Impact is categorized as low if IRS < 50, medium if 50<IRS<120 and high if IRS>120 (Regulation of Director General for Land Rehabilitation and Social Forestry concerning Guidelines for Monitoring and Evaluation of River Basins, No: P.04/V-Set/200, 05 March 2009).				

	Based on calculation using the Manning equation, maximum creek flow rates in the proposed activity location in sub DAS S5, S2, S4, and S1 are respectively 1.22 m/second, 1.24 m/second, 1.79 m/second and 1.54 m/second. *'S1', 'S2' and 'S5' are intermittent creeks only carrying water in the wet season, while in the dry season they almost cease to flow. Maximum creek flow rate calculated using the rational formula varies with increased flow rate at 'S5' from 1.22 m/second to 2.17 m/second (discharge becomes 0.24 m³/second) that can reach ten times after land preparation activities. Flow rate at 'S2' increases from 1.24 m/second to 2.21 m/second (discharge will be 1.45 m³/second) and 'S1' from 1.54 m/second to 2.76 m/second (discharge will be 2.92 m³/second) may reach five to six times the present condition. Using IRS, the three rivers will have IRS value exceeding 120, thus may be categorized as 'high' impact.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	'S1', 'S4', 'S5' and 'S2' located in the Tangguh LNG area are environmental components receiving the impact of increased flow rate due to site preparation activities. Creek s S2', 'S4' and 'S5'flow north to the waters of Bintuni Bay and creek 'S1' flows to the Saengga River, a wider water body with greater discharge and affected by sea tides. Therefore, receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact magnitude is categorized as 'high' and receptor sensitivity is categorized as 'low', thus impact severity is 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Impact likelihood is 'high' as rainfall is relatively 'high' and continuous throughout the year.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact significance is determined on the basis of impact severity and impact likelihood. Impact severity is categorized as 'medium' and impact likelihood is categorized as 'high', thus the impact significance is categorized as 'moderate' and significant impact.				

c. Increase in Surface Runoff

- **Environmental Baseline**

From the aspect of environmental baseline, the maximum peak discharge of ephemeral river runoff in the study area can be calculated using the Rational method.

Rain intensity was calculated using the formula from Dr. Mononobe (Sosrodarsono and Takeda, 1983):

$$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{\frac{2}{3}}$$

I= Rainfall Intensity (mm/hour)

R_{24}= Maximum rainfall in 24 hours (mm)

t= Duration of rainfall (hours)

Maximum rainfall in 24 hours for the study area is 278 mm, taken from the study results of PT Calmarine Indonesia (September 2001): Minimum, Average, Maximum and Extreme Air Temperature and Rainfall Values Tanah Merah.

Based on the data and the equation of Dr. Mononobe, the rain intensity for various durations can be determined. The rain duration is calculated from time of concentration of each river watershed (DAS). **Table III-42** summarizes the calculation of time of concentration, intensity and peak discharge:

Table III-62 Peak Discharge of Rivers in the Study Area Estimated to Be Affected

No	Sub DAS	Area (ha)	Runoff Coefficient	Time of Concentration (minutes)	Rainfall Intensity (mm/hour)	Peak Discharge (m^3/sec)
1	'S5'	53	0.05	298	33.1	0.24
2	'S2'	660	0.05	905	15.8	1.45
3	'S4'	96	0.05	335	30.6	0.41
4	'S1'	1,482	0.05	1,061	14.2	2.92

Table III-63 shows maximum discharge of ephemeral creeks varying from 0.24 m^3/second to 2.92 m^3/second.

- **Impact Prediction**

Based on the development plan of project facilities, there will be change in landscape in four rain catchment areas, i.e. 'S1', 'S4', 'S5' and 'S2'. Therefore, there will be change in natural flow coefficient (c=0.05 for forest) to be industrial area (c= 0.9). Thus, predicted change of peak discharge is shown in **Table III-60.**

Table III-64 Change in Creek Peak Discharge in the Study Area

No	Sub DAS	Area (ha)	Area of the LNG Plant (ha)	Predicted Average Runoff Coefficient	Peak Discharge (m^3/sec)	Predicted Peak Discharge (m^3/sec)
1	'S5'	53	22	0.41	0.24	2.00
2	'S2'	660	121	0.21	1.45	6.07
3	'S4'	96	11	0.15	0.41	1.22
4	'S1'	1,482	233	0.18	2.92	10.52

From **Table III-60** above, the development of facilities in former forest area will result in increased peak discharge of natural rivers.

The impact of increased peak discharge can be evaluated by comparing coss section of the flow before and after the development of facilities.

Based on new values of peak discharge due to the facility development, there will be increase in the water level in existing channels. The calculation of the depths are presented in **Table III-61**.

Table III-65 Change in River Water Depth in the Study Area

No	Sub DAS	Width (m)	Depth (m)	Predicted Velocity (m/sec)	Predicted Peak Discharge (m^3/sec)	Cross Section (m^2)	Required Depth (m)
1	'S5'	0.89	0.10	2.17	2.00	0.92	1.04
2	'S2'	4.00	0.28	2.21	6.07	2.75	0.69
3	'S4'	1.26	0.13	3.20	1.22	0.38	0.30
4	'S1'	6.50	0.38	2.76	10.52	3.81	0.59

- **Impact Evaluation**

  From the calculation results in **Table III-66** above, increase in flow depth is largest in sub DAS 'S5' and 'S2', while in sub DAS 'S4' and 'S1' flow depth will slightly rise. Only in sub Basin 'S5' the increase will be relatively large. Unless runoff is properly managed, increase in flow depth would have an impact on likelihood of water inundation around the facility, therefore in terms of receptor sensitivity, it isclassified as 'medium'.

  Based on the matrix of impact severity, particularly for sub DAS 'S5' with 'medium' impact magnitude and 'medium' receptor sensitivity, so the impact severity is categorized as 'high'.

  In terms of likelihood of increase in creek flow rate this is almost certain to occur. Based on **matrix of significance of impact**, with 'high' impact severity and 'high' impact likelihood, the impact on increased surface runoff is in 'major' category.

Table III-67 Increased Surface Runoff

Impact Description	*Activities of land clearing, site preparation, cut and fill during the construction phase will increase the flow of surface runoff. Unless properly managed, increased surface runoff may cause soil erosion and raise total suspended solids (TSS) of the surrounding rivers in the Tangguh LNG area*				
Impact Nature	**Negative**	**Positive**			
	Water inundation may occur in the construction area if flow rate increases in surrounding small rivers as a result of increase in surface runoff that is larger than the accommodating capacity of small rivers.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Higher surface runoff is a direct impact of land clearing activities, site preparation, cut and fill.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	The impact can continue for around 9 months up to 13 months during land clearing activities, site preparation, cut and fill during the construction phase. After land stabilization and construction commence, the rise in surface runoff will be smaller. The activity proceeds in relatively short period and intermittently. Therefore the duration of impact is in category of ''Short Term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Land clearing, site preparation, cut and fill activities will cover the total area to maximum 500 ha of the 3.266 ha Tangguh LNG property. The activities will potentially give contribution of increased surface runoff, particularly in river basin 'S1', 'S2' and 'S3' located within the Tangguh LNG study area. It is estimated that the impact will continue until land stabilization is completed. However since the creek s are in Tangguh LNG area, it is estimated that there will be no impact outside the Tangguh LNG area. Thus the impact extent is in 'local' category.				

Impact Magnitude	Negligible	Low	Medium	High	
	Impact magnitude of increasing surface runoff may be evaluated using flow coefficient, which is the ratio between large surface flow and high rainfall. The impact is considered small if flow coefficient <0,25; medium if 0.25 < flow coefficient < 0.50 and high if flow coefficient >0.50 (Regulation of the Director General for Land Rehabilitation and Social Forestry concerning Guidelines for Monitoring and Evaluation of River Basins, No: P.04/V-Set/200, 05 March 2009). In the evaluation, the maximum flow coefficient is taken for each type of land use. • *'S1' will experience change in land cover of 233 ha from 1,482 ha of rain catchment area. Flow coefficient will change from 0.05 to 0.18.* • *'S5' will experience change in land cover of 22 ha from 53 ha rain catchment area. Flow coefficient will change from 0.05 to 0.41.* • *'S2' will experience change in land cover of 121 ha from 660 ha of rain catchment. Flow coefficient will change from 0.05 to 0.21.* *Therefore impact of surface flow is low (less than 0.25 for 'S1' and 'S2' and medium (between 0.25 and 0.50) for 'S5'. The change has taken into account size of catchment area, slope and land cover.* *In terms of change in flow coefficient, there will be quite significant change in discharge of 'S5' and 'S2'. This is indicated from larger creek flow depth for 'S5' of 0.1 m and S2 of 0.28 m. With the flow to larger water body, namely Bintuni Bay (for flow from 'S5' and 'S2') and the Saengga River for flow from 'S1', it is expected that no inundation will occur for long duration. In this case, the impact magnitude may be categorized as 'medium'.*				
Receptor Sensitivity	Low	Medium	High		
	'S1', 'S5' and 'S2' are environmental components receiving the impact of surface runoff due to activities of land clearing, site preparation, cut and fill. Related to the change in flow coefficient as described above and also possibility of water pools formed and higher TSS, receptor sensitivity is categorized as 'medium'. There is little influence of impact on Bintuni Bay waters as the flow destination of 'S2' and 'S5' and the Saengga River for 'S1', since the water bodies are wider with far larger flows than the three creek s and influenced by sea tides.				
Impact Severity	Slight	Low	Medium	High	Very High
	Impact magnitude is categorized as 'medium' and receptor sensitivity is categorized as 'medium', thus the impact severity is categorized as 'high'.				
Impact Likelihood	Very low	Low	Medium	High	
	Impact likelihood is categorized as 'high' since rainfall is relatively high, thus causing increase in surface runoff that may result in erosion and increased TSS.				
Impact Significance	Negligible	Minor	Moderate	Major	Critical
	Impact significance is determined on the basis of impact severity and impact likelihood. Impact severity is categorized as 'high' and impact likelihood is categorized as 'high', thus the impact significance is categorized as 'major' and significant impact.				

d. Change in Drainage Pattern

- **Environmental Baseline**

  In terms of environmental baseline, the natural drainage pattern in the study area is generally dendritic- shaped and parallel as presented in **Figure III-37**.

- **Impact Prediction**

  Based on the development plan of project facilities, the landscapes will change in four rain catchment areas: 'S1', 'S4', 'S5' and 'S2'. Therefore there will be a change of drainage flow patterns as shown in **Figure III-37**.

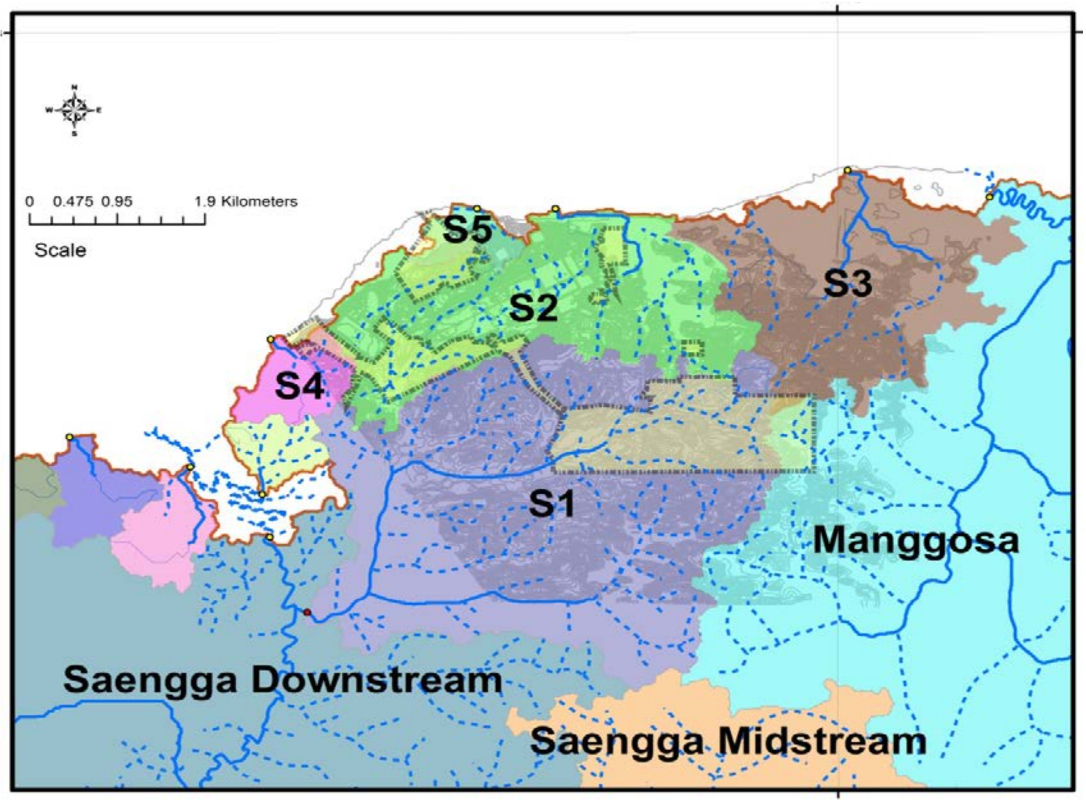


Figure III-37 Natural Flow Patterns of the Study Area

Based on **Figure III-37** above, development of physical facilities of the Tangguh LNG Expansion Project in the formerly forested region will result in changes of flow patterns in 'S1', 'S2' and 'S5'.

- **Impact Evaluation**

Change of drainage pattern can be evaluated by comparing change in percentage of natural area before and after the development of physical facilities for the Tangguh LNG Expansion Project. Calculation of changes in percentage are displayed in **Table III-68**.

Table III-69 Changes of Natural Areas in the Study Area in Percentage

No	Sub DAS	Area (ha)	Area in the LNG Plant (ha)	% change
1	'S5'	53	22	42
2	'S2'	660	121	18
3	'S4'	96	11	12
4	'S1'	1,482	233	16

Based on calculation results of **Table III-70** above, the highest percentage of landscape change is in sub DAS 'S5', while in sub DAS 'S4', 'S2' and 'S1' there will be an increase although less than 30% (minimum limit of green open space according to regulation). Only in sub DAS 'S5' the increase will be categorized as high. In this case the impact of change in drainage pattern has 'high' impact magnitude.

Impact severity can be categorized as 'medium', due to high impact magnitude and 'low' receptor sensitivity.

In terms of likelihood of occurrence, the change in river drainage pattern is almost certain to occur. Based on matrix of impact significance, with 'medium' impact severity and 'high' impact likelihood, change in drainage pattern is a 'moderate' impact.

Table III-71 Change in Drainage Pattern

Impact Description	*Change in drainage pattern is the impact of site preparation activities that can result in increased creek flow rate.*				
Impact Nature	**Negative**	**Positive**			
	Change in drainage pattern that may result in higher flow rate in creeks and cause negative impact with potential inundation formed in area to be cleared for construction of facilities will be built as part of the Tangguh LNG Expansion Project.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in drainage pattern is a direct impact of site preparation activities.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Natural drainage flows will change into drainage ditches. Therefore impact duration is categorized as 'permanent'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Change in river drainage pattern will occur, mainly in creek watersheds 'S1', 'S4', S5' and 'S2' located in Tangguh LNG area, so that the impact extent is 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Change in flow pattern is evaluated by comparing the change in percentage of natural areas before and after physical facility development in the Tangguh LNG Expansion Project. *Change in drainage pattern in 'S5' from the 53 ha DAS area, 22 ha to be a developed area related to the Tangguh LNG Plant Expansion or 42% larger than before site preparation activities, thus the impact magnitude is in 'high' category. For 'S2' , 660 ha of the DAS to be a developed area of 121 ha, and in 'S1'from DAS area of 1,482 ha, 233 ha to be a developed area so that the changes reach 16-18% of the initial value. In terms of the sufficient large quantity of natural area changes (42%) due to changes in drainage pattern from the site preparation activities in DAS S5, the impact magnitude is categorized as 'high'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	'S1', 'S4', 'S5' and 'S2' located in the Tangguh LNG area are resources that receive the impact of increased flow rate due to site preparation activities. Creeks S2', 'S4' and 'S5'flow north to the waters of Bintuni Bay and creek 'S1' flows to Saengga River, where the water bodies are wider with greater discharge and affected by condition of sea tide. Therefore, receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact magnitude is categorized as 'high' and receptor sensitivity is categorized as 'low', thus the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	The impact likelihood is categorized as 'high' since rainfall is relatively high and takes place throughout the year.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*Impact significance is determined on the basis of impact severity and impact likelihood. Impact severity is categorized as 'medium' and impact likelihood is categorized as 'high', thus the impact significance is categorized as 'moderate' and significant impact.*

3.3.1.6 Hydrogeology

Potential impacts related to the proposed option of groundwater use comprise the followings:

- Potential impacts on community wells at Tanah Merah and Saengga. These include very shallow excavated wells or less than 5 m and deeper wells installed for the communities by the Tangguh LNG to depth of 135 m as part of the Resettlement Project of Tanah Merah Village at the time;
- Potential seawater intrusion which could limit groundwater abstraction in adjacent areas or limit groundwater use in the Tangguh LNG site after post-operation; and
- Potential for land subsidence outside the Tangguh LNG site which could affect village infrastructures or drainage patterns.

Based on consultation and prior approval from Ministry of the Environment (MoE, the limitations were provided for the Tangguh LNG to continue the study on groundwater use option. These include the followings:

- Groundwater abstraction at the Tangguh LNG is restricted to aquifers deeper than 150 meter. Aquifers above 150 m will be protected by installation of steel casing and cemented in place.
- The optimum groundwater volume that can be abstracted will be determined based on pumping test results and modeling results as part of the groundwater study and not based on water demand of the Tangguh LNG. The pumping test will be witnessed by groundwater experts representingMinistry of the Environment.

The limitations will become the basis for developing a detailed design for the development of groundwater option at Tangguh LNG.

In connection with the proposed Tangguh LNG Expansion Project, the Tangguh LNG re-assessed the results of groundwater desktop study previously completed between 2001 to 2006. The desktop study assisted by groundwater experts of ENV in 2012 confirmed the findings of previous studies and recommended to proceed with the previous program with some amendments, which was further re-consulted with MoE and its groundwater experts. This was incorporated into the ANDAL-TOR of the Tangguh LNG that was approved by MoE on July 24th, 2013.

The results of study were intended to validate various groundwater desktop studies, that were completed between 2001 to 2012 in order to provide environmental baseline data as the basis for analyzing impacts in this AMDAL. Data of the study results will also be used to develop a detailed design as well as construction plan of all production wells that are required in the construction phase of the Tangguh LNG Expansion Project and future operation phase. Groundwater wells drilling to supply groundwater demand during construction and operation phase of the Tangguh LNG will only be executed when the results of the groundwater study made as part of this AMDAL indicate that the groundwater option is feasible and approved as part of the AMDAL approval process.

The desktop study also concluded that yield of each well was 12 L/sec. Thus, four production bored may be sufficient to provide the ultimate operational demand of the Tangguh LNG, i.e. 47.5 L/sec without causing significant impacts. The study at the time was based on groundwater abstraction in aquifer at depth of 150 m to 300 m.

Further modeling was undertaken to support impact assessment in this AMDAL study using latest information from the last eight years since previous modeling implementation with consideration of potential aquifer at depth of between 300 m to 400 m. The modeling results indicated that water demand during construction and operation phase can be fulfilled from four groundwater wells to be drilled and there would be minimal negative impacts towards community wells drawdown, seawater intrusion as well as land subsidence and would not require a particular treatment.

Impact prediction on community wells, seawater intrusion and land subsidence are described below:

a. Impact on Community Wells

- Environmental Baseline

  There are several shallow community wells with depths of less than 5 meters. Sampling was performed in 5 locations, i.e. 2 shallow wells at Tanah Merah and 3 shallow wells at Saengga.

  Three deep community wells were installed in 2006 which could potentially be impacted by long term groundwater abstraction at the Tangguh LNG. These are TMB1 at Tanah Merah at a position of approximately 2.5 km from the proposed groundwater production wells within Tangguh LNG site and S1 and S2 at Saengga, approximately 1 km further to the west of the TMB1 well.

  TMB1 well was drilled to 150 m deep and screens were installed to maximum depth of 135 m. At the time of construction, the water level was at a depth of 34.5 m and the submersible pump was set at depth of 78 m allowing drawdown of 43.5 m. The top of the screen was set at depth of 98 m, or 20 m below the pump intake.

Wells of S1 and S2 at Saengga were 30 m apart and both were constructed at depths of 135 m. At the time of construction, the depth of water level was 21 m and the pump was set at depth of 60 m allowing drawdown of 39 m. The top of the screen was set at depth 98 m or 38 m below the pump intake.

Over more than seven years operation, the depth of the pumps position in the community well have not been lowered, but it cannot be ascertained yet whether the well yield have decreased or increased.

Impact Prediction

The potential impact on the three community bore wells would be a decrease in well's yield due to drawdown, whereas the groundwater quality will not be affected. Impact on the community wells will be observed in the monitoring wells of 150 m deep within the Tangguh LNG area.

The shallow community wells (< 5 m deep) are recharged naturally and separated from the deeper sandstone layer/aquifer. Decrease in groundwater level and the yields will occur naturally due to the dry season and will not be influenced by production wells of the Tangguh LNG, thus these shallow wells will not be assessed further in the AMDAL.

Impact Evaluation

Based on the results of previous groundwater studies, including geophysical survey result, drilling of groundwater wells and pumping test that were conducted at the time of the community wells installation at Tanah Merah and Saengga villages as part of the Resettlement Project, the desktop study (ENV, 2012) concluded that:

- Hydraulic conductivity from pumping test results indicated an average of ± 3.5 m/day, transmissivity 70 m^2/day, with on the assumption that an aquifer thickness of 20 m at the depth between 150 m - 300 m;
- Storativity value of 0.001 was used for modeling, with re-calibration of the pumping test data for TW2 well (LAPI-ITB, 2004). The empirical relationship between storativity and aquifer thickness is given by the following equation :

  $$\text{Storativity} = 3 \times 10^{-6} \times \text{aquifer thickness}$$

- With the thickness of Steenkool Formation ± 300 m, indicated storativity value of 0.0009, it is the same the value used for modeling;
- The hydraulic parameter can be used to estimate potential yields (potential groundwater discharge) for each groundwater well with assuming drawdown up to 30 m in the aquifer and pumping period of 29 years (4 years construction phase and 25 years operation phase) by this equation:

$$Q = \frac{4\pi swT}{W(u)}$$

In which:

Q	=	yield (m³/day)
sw	=	drawdown (m)
T	=	transmissivity (m²/day)
W(u)	=	Well function

Value of W(u) are derived from tables of W(u)

$$u = \frac{r^2 S}{4Tt}$$

where, S = storativity (dimensionless)

r = diameter of bore well (m)

t = time (days)

The calculation confirms that the potential yield is 1,026 m^3/day, or ± 12 L/second, it is the same as the previous estimation based on groundwater abstraction in aquifer at depth of 150 m to 300 m that was identified based on slim hole drilling.

Should suitable aquifer be identified at depth of 300 m to 400 m, this will provide possibility to potentially increase pumping rate of each production well as long as potential impacts of the increased pumping rate are identified and the total groundwater abstraction from all production wells will be based on consideration in order to minimize potential impacts and not only prioritizing project water demand.

Evaluation of potential groundwater level drawdown related to the option of groundwater use in the Tangguh LNG was performed using numerical modeling updated from those developed in 2004/2005 by LAPI-ITB. The modeling developed by LAPI-ITB assumed water abstraction in the production well of 50 m^3/hour from aquifers at depth between 150 – 300 meter. The modeling used Visual Modflow V 2.8.1 software. ERM also conducted the same exercise in 2004 using Visual Modflow V 3.0.0.

Numerical modeling MODFLOW developed by LAPI-ITB and ERM was updated with the improved conceptual model (**Figure II-27**) that incorporated additional data inputs acquired since 2006, namely data of downhole-geophysical logging in 'Slimhole' drilled to depth of 300 m, resistivity traverses performed by ITB and several geotechnical studies also conducted in the Tangguh LNG site.

Most recent data indicated that aquifer distribution was actually more limited than previous estimates. The most recent data showed aquifer hydraulic parameters and new aquitard beneath the northwest of the

Tangguh LNG area. The latest modeling made as part of the groundwater study for this AMDAL study applied the FEFLOW software.

FEFLOW and MODFLOW are two groundwater modeling applications generally applied internationally. Both applications are used to solve the same groundwater equation using different numerical methods. The FEFLOW model described in this report uses the Finite Element code, whilst MODFLOW uses Finite Difference. For the latest modeling, the FEFLOW method was preferred compared to MODFLOW for the two principal reasons as follows:

- FEFLOW has great flexibility in the model grid, allowing a high density of nodes within small areas of interest, such as a wellfield, and low density nodes in other areas;
- FEFLOW can simulate solute transport and density driven flow within the same model code. MODFLOW can also achieve these, but requires additional application (MT3D and SeaWAT).

FEFLOW modeling has been used to a depth of 600 m to know the potential aquifer existence, to be usable at that depth with salinity level below 1,000 mg/L.

Numerical Model Design

Comprehensive description of FEFLOW numerical modeling is described in Annex IV.5 Numerical Modeling Report. The report elaborates the assumptions used and meticulous calibration as well as sensitivity analysis used by applying a series of hydraulic parameters to obtain representative estimates of drawdown in aquifer and change in salinity of the proposed groundwater abstraction rate.

The model domain is approximately 55 km x 29 km with a thickness of 600 m. The domain includes some recharge zones and discharge areas. This is discretized spatially into 499,565 elements and 275,532 nodes. The model has 19 vertical layers and 12 sections as explained in the conceptual model. A fine resolution mesh was used for area modeling encompassing 4 proposed groundwater production well locations to fulfil the Tangguh LNG water demand and three community wells at Tanah Merah and Saengga that were installed previously as part of the Resettlement Project, while grid discretization was gradually decreased towards the boundary of the model domain.

Conditions of constant head boundary (first type: Dirichelt) were assigned at the northern, western and southern edges of the model area; this showed seawater elevation and regional aquifer system. Along the eastern margin of the model domain, a variable constant head boundary was created to represent *Sungai Tegenarategen*, with variable decreasing elevation to the sea (see **Figure III-39**). A constant head was applied along the sandstone outcrop of the Steenkool Formation. The Head aimed to represent regional recharge area from the southern area of the model domain. Rivers were simulated with 3rd Cauchy limitation condition type.

Conceptual Hydrogeology Model indicates gently folded Steenkool sediments with sandstone outcrop to the south and southwest of the Tangguh LNG site. A correlation has been established for the Upper Steenkool aquifers down to depth of 150 m extending eastwards from the community wells at Saengga and Tanah Merah Baru across to the SHD-1 exploratory well at the Tangguh LNG site. The dip of the sediments is indicated to be, on average less than 1° which matches the dips extrapolated from the seismic profiles.

The highest potential impacts of community wells drawdown and to land subsidence outside the LNG site will occur if these aquifers are hydrogeologically connected and there are no faults act as barriers to groundwater flow. Therefore numerical modeling is based on the assumption that Steenkool Formation aquifers do not shift because of faults.For this reason, the drawdown and subsidence contours generated by the numerical model, tend to be conservatively higher in terms of potential impacts on community wells. Should fault barrier be identified in the future based on sustained groundwater abstraction and monitoring, it is likely that groundwater drawdown on the Tangguh LNG site will be higher than currently predicted and those at community well will be less. If identified, these fault will be incorporated into an updated numerical model at completion of the four-year construction period when more comprehensive data on monitoring of drawdown, land subsidence and salinity is available.

Hydraulic parameters (lateral hydraulic conductivity, vertical hydraulic conductivity, specific yield and specific storage capacity) used for each aquifer and aquitard in the groundwater numerical modeling are summarized in **Table III-65**.

Table III-65 Characteristic of Model Layer

Hydrostratigraphic Unit	Model Layer	Hydraulic Characteristic				Thickness (m)
		K_x & K_y (m/d)	K_z (m/d)	S_y	S_s (m^{-1})	
Alluvial Sediment	1	5.0	5.0	0.5	-	10
Upper Steenkool Formation – dominant clay	2	0.0086	0.0015	-	3.35×10^{-5}	30
Upper Steenkool Formation – dominant sand	3	4.0	0.4	-	5.05×10^{-6}	60
Upper Steenkool Formation – dominant clay	4	0.0004	0.00004	-	3.35×10^{-5}	55
	5	0.0004	0.00004	-	3.35×10^{-5}	55
	6	0.0004	0.00004	-	3.35×10^{-5}	55
Lower Steenkool Formation – dominant sand	7	4.0	0.4	-	5.05×10^{-6}	30

Hydrostratigraphic Unit	Model Layer	Hydraulic Characteristic				Thickness (m)
		K_x & K_y (m/d)	K_z (m/d)	S_y	S_s (m^{-1})	
Lower Steenkool Formation – dominant clay	8	0.0004	0.00004	-	3.35×10^{-5}	20
	9	0.0004	0.00004	-	3.35×10^{-5}	25
Lower Steenkool Formation – dominant sand	10*	4.0	0.4	-	5.05×10^{-6}	10
Lower Steenkool Formation – dominant clay	11	0.0004	0.00004	-	3.35×10^{-5}	30
	12	0.0004	0.00004	-	3.35×10^{-5}	30
	13	0.0004	0.00004	-	3.35×10^{-5}	30
Lower Steenkool Formation – dominant sand	14*	4.0	0.4	-	5.05×10^{-6}	10
Lower Steenkool Formation– dominant clay	15	0.0004	0.00004	-	3.35×10^{-5}	30
	16	0.0004	0.00004	-	3.35×10^{-5}	30
	17	0.0004	0.00004	-	3.35×10^{-5}	30
Lower Steenkool Formation – dominant sand	18*	4.0	0.4	-	5.05×10^{-6}	10
Lower Steenkool Formation– dominant clay	19	0.015	0.0015	-	3.35×10^{-5}	50

Note : K_x and K_y – lateral value of hydraulic conductivity
K_z – vertical hydraulic conductivity
S_y – specific yield (dimensionless)
S_s – specific storage
*unproven aquifer

Values of hydraulic conductivity of Layer 1 and Layer 3 of the modeling were based on:

- Hydraulic testing conducted in sand layer in alluvial deposit and perched aquifer of the Steenkool Formation by PT Hydrocore (2009) and PT Taka Hydrocore (2012) during monitoring and construction of several landfills in the Tangguh LNG site, and
- Values previously used by ERM (2004) and ITB (2005).

Values of hydraulic conductivity in the upper Steenkool Formation aquifer, used in the modeling were based on estimates obtained from pumping test toward this aquifer by ERM in 2006. The pumping test indicated that the aquifer layer in the formation possessed horizontal hydraulic conductivity between 1 and 15 m/day and generally around 4 m/day.

Storage capacity value was based on ERM recommendation that storage capacity of the upper Steenkool Formation aquifer can be estimated by multiplying aquifer thickness with estimating specific storage capacity from the modeling calibration, obtaining value of 3×10^{-6}. Based on this, storage capacity estimation between 5×10^{-6} and 3×10^{-5} were used in numerical model, respectively for layer dominated by sand and clay.

Hydraulic properties of the upper Steenkool Formation aquifer are not known. However, for modeling purposes, hydraulic properties of the aquifer were assumed to be the same as those of the upper Steenkool Formation aquifer. For this reason, values applied in the modeling were based on estimates obtained from the pumping test conducted by ERM in 2006 in the upper Steenkool Formation aquifer.

Aquitard hydraulic values used were those from laboratory hydraulic test results of four samples of undisturbed claystone obtained by ITP from the Steenkool Formation during geotechnical investigation for the new landfill and organic waste landfill.

Estimated Long Term value of rainwater recharge process is shown in **Table III-72**, the data was used as the basis of numerical modeling. MODFLOW modeling was formerly performed by ITB and ERM using recharge assumption of 20%. While FEFLOW modeling used assumption of smaller recharge to provide more balanced result.

Table III-73 Rainwater Recharge

Scenario	Type of Outcrop	Recharge (mm/year)	Recharge (% of annual rainfall)	Recharge (m/sec)
Basic assumption, Sensitivity Analysis 1, and Sensitivity Analysis 2	Alluvial, Steenkool Formation dominated by clay	150	4.6	4.1×10^{-4}
	Steenkool Formation dominated by sand	94	2.9	2.6×10^{-4}

Groundwater abstraction considered in this modeling includes community wells in the upper Steenkool aquifer (known as WWS-1, WWS-2, WWTMB-1) also from four groundwater production wells proposed to be drilled in the lower Steenkool aquifer at the Tangguh LNG site. Estimated volume of groundwater demand during construction and operation phase of the Tangguh LNG used for modeling purposes is shown in **Figure III-38**.

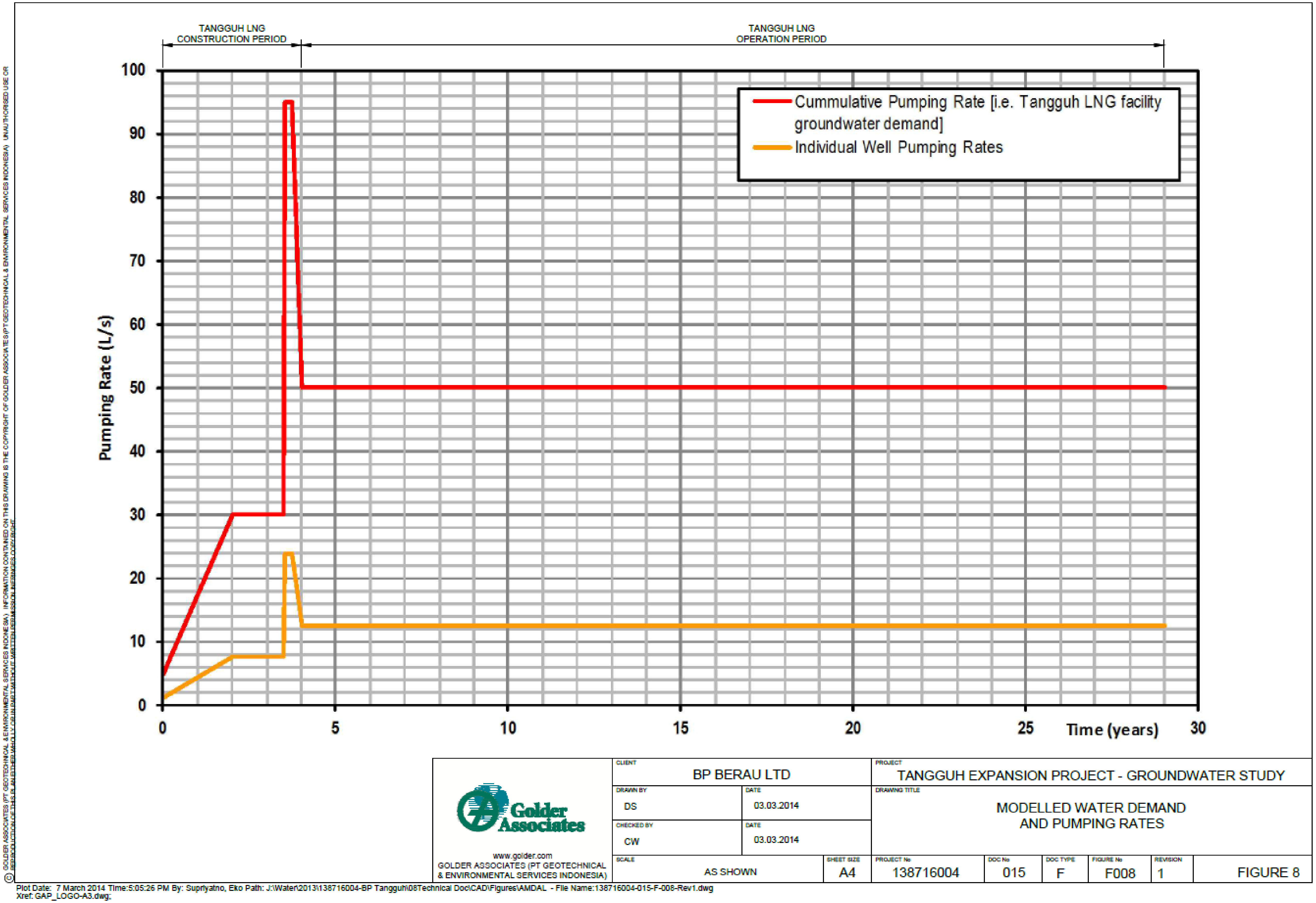


Figure III-38 Modeling of Water Demand and Pumping Rates

Based on the current project plan, average groundwater demand during the construction phase is estimated to be 32 L/second and increasing to 50 L/second in the operation phase. Short-term water demand for hydrotest were also considered in the modeling although hydrotest water demand would be able or not be able to be fulfilled from groundwater source depending on capacity of production well to be determined based on pumping test results in PW1 well. Modeling results indicated the acceptable drawdown value during short term groundwater abstraction rate for the hydrotest water demand. FEFLOW modeling indicated that groundwater abstraction with higher pumping rate than initial planned will not cause significant negative impact on community groundwater wells, potential seawater intrusion and land subsidence. Groundwater well capacity will particularly be determined by well design.

Table III-74 Details of Pump Well used in Numerical Modeling

Well ID	Easting Coordinate (mE)	Northing Coordinate (mN)	Depth of Screen (m bgs)	Duration of Pumping	Pumping rate (L/second)
Provisional Production Wells Location	626,020 627,140 625,530 628,915	9,729,360 9,728,975 9,726,750 9,726,540	265 to 295 340 to 350	2 years	Starting at 5 and increasing to 30
				18 months	30
				100 days	95
				100 days	Starting at 95 and decreasing to 50
				25 years	50
WWS-1	289,451	9,726,729	98 to 110 117 to 120	Continuously 8 hours per day	3
WWS-2	289,502	9,726,729	101 to 122	Continuously 8 hours per day	3
WWTMB-1	290,491	9,728,077	98 to 110 122 to 125	Continuously 8 hours per day	3

Drawdown contour was modeled for the upper Steenkool aquifer used for community wells in Tanah Merah Baru and Saengga villages, and for the lower Steenkool aquifer to be used for the four proposed groundwater production wells in the Tangguh LNG site. The modeling results indicated that groundwater drawdown occurring in the upper Steenkool aquifer was the combined impact of groundwater abstraction for community demand fulfilment and water flow into the lower Steenkool aquifer, which the water level will decrease in connection with the proposed groundwater abstraction for the Tangguh LNG activities. The impact assessment will be made at measurement point above depth of 150 m, monitoring well will be drilled at the location near the proposed well PW-3 at the boundary fence of the

Tangguh LNG property, near Tanah Merah Baru village, which the largest accumulated drawdown is predicted to occur.

Modeling results are shown in the form of ratio of drawdown contour to time unit – plot of drawdown in the upper and lower Steenkool Formation aquifer. **Figure III-39** shows maximum drawdown occurring in the lower Steenkool aquifer after 29 years (4 years construction phase and 25 years operation phase), which is estimated to be around 15.2 m in PW2.

The drawdown contour in the upper Steenkool Formation related to groundwater abstraction by the community themselves and combined abstraction (by the community and the Tangguh LNG) are shown in **Figure III-40** and **Figure III-41**.

Figure III-42 shows that total drawdown in the upper Steenkool Formation in the Tangguh LNG property near the proposed monitoring well location 150 m away from well PW-3 is 0.165 m, which it is around 0.050 m of the value is likely due to the proposed groundwater abstraction in the Tangguh LNG from the lower Steenkool Formation aquifer. Estimated groundwater drawdown from modeling is assumed to possess accuracy of 0.005 m.

The largest land subsidence occurring in the property boundary fence of the Tangguh LNG, north of PW-3, near Tanah Merah Baru is greatly related to groundwater abstraction by the community. Estimated groundwater drawdown is 0.29 m which 0.050 m originates from groundwater abstraction by the Tangguh LNG.

Modeling results indicated that possible total groundwater drawdown of around 0.57 m (at Tanah Merah Baru village) to 0.6 m (at Kampong Saengga) will likely occur in community wells originating from the upper Steenkool Formation aquifer. Around 0.52 m of total groundwater drawdown is due to water utilization by the community in Tanah Merah Baru village and the remainder of around 0.050 m is estimated to be related to the proposed water abstraction to fulfil the Tangguh LNG water demand.

Estimated drawdown in the lower Steenkool Formation in location PW-2 is shown in **Figure III-43**.

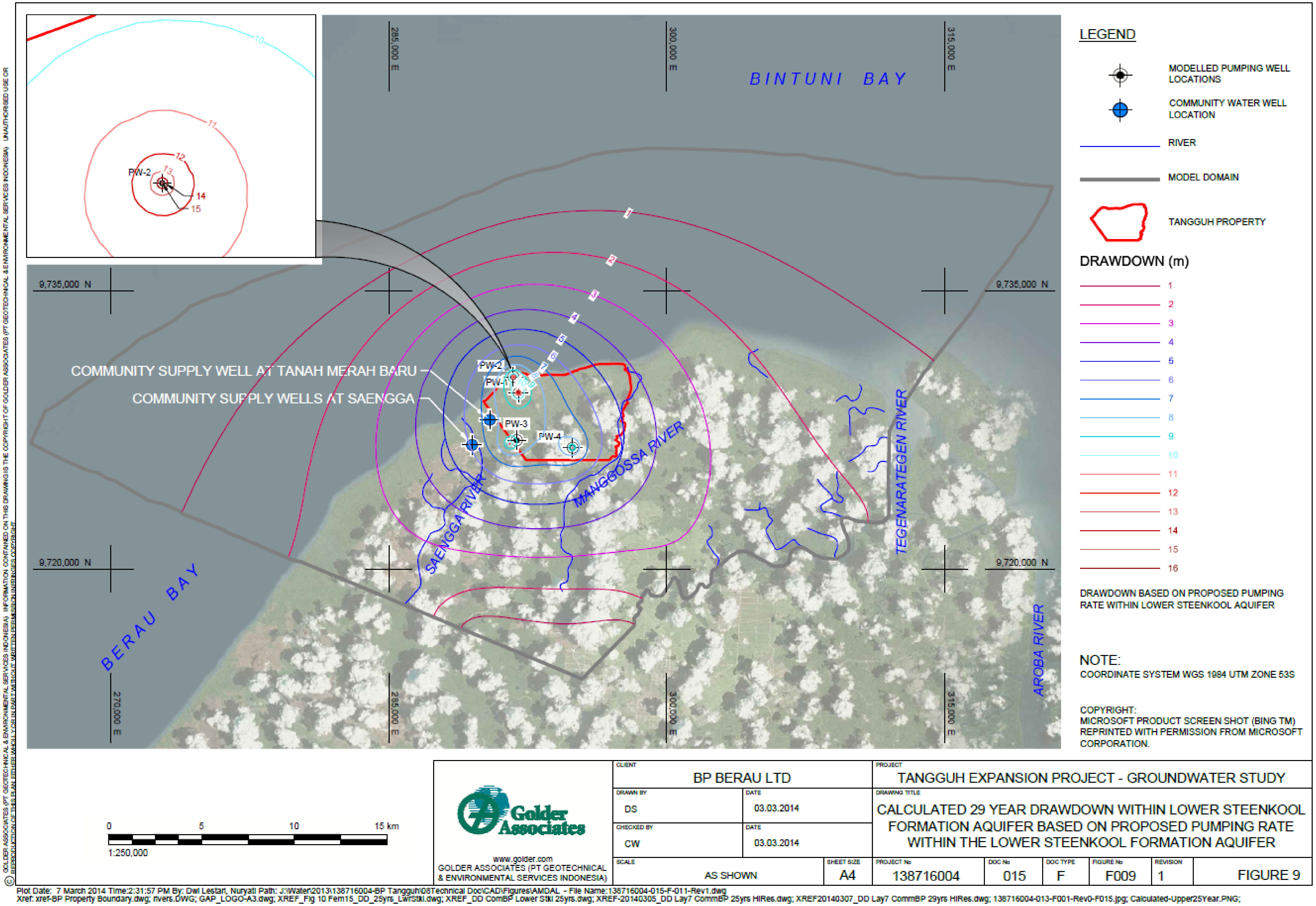
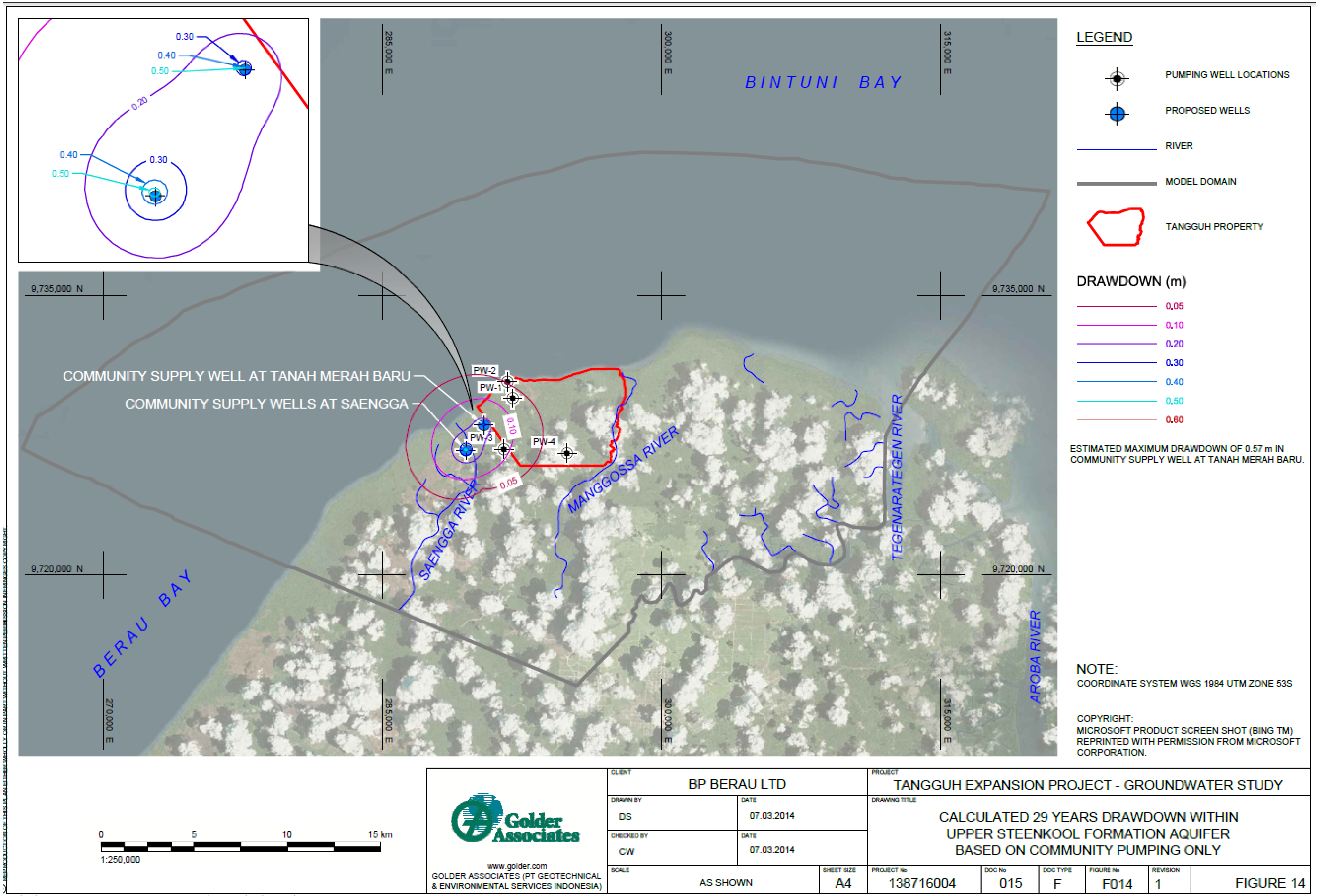


Figure III-39 Modeling of Water Table for 29 Years in the Lower Steenkool Formation Aquifer based on Proposed Pumping Rate



Plot Date: 7 March 2014 Time:3:50:50 PM By: Dwi Lestari, Nuryati Path: J:\Water\2013\138716004-BP Tangguh\08Technical Doc\CAD\Figures\AMDAL - File Name:138716004-015-F-016-Rev1.dwg
Xref: xref-BP Property Boundary.dwg; rivers.DWG; GAP LOGO-A3.dwg; XREF FIG 14 Fem15 SWI 25yrs LwrStkl.dwg; XREF Salinity Base ComBP Lay7 25yrs.dwg; XREF DD ComOnly Upper Stkl 25yrs.dwg; XREF-20140307 DD Lay3 Comm 29yrs HiRes.dwg; 138716004-013-F001-Rev0-F015.jpg; Calculated-Upper25Year.PNG;

Figure III-40 Modeling of Water Table for 29 Year in the Upper Steenkool Formation Aquifer based on Community Wells Pumping at Tanah Merah Baru and Saengga

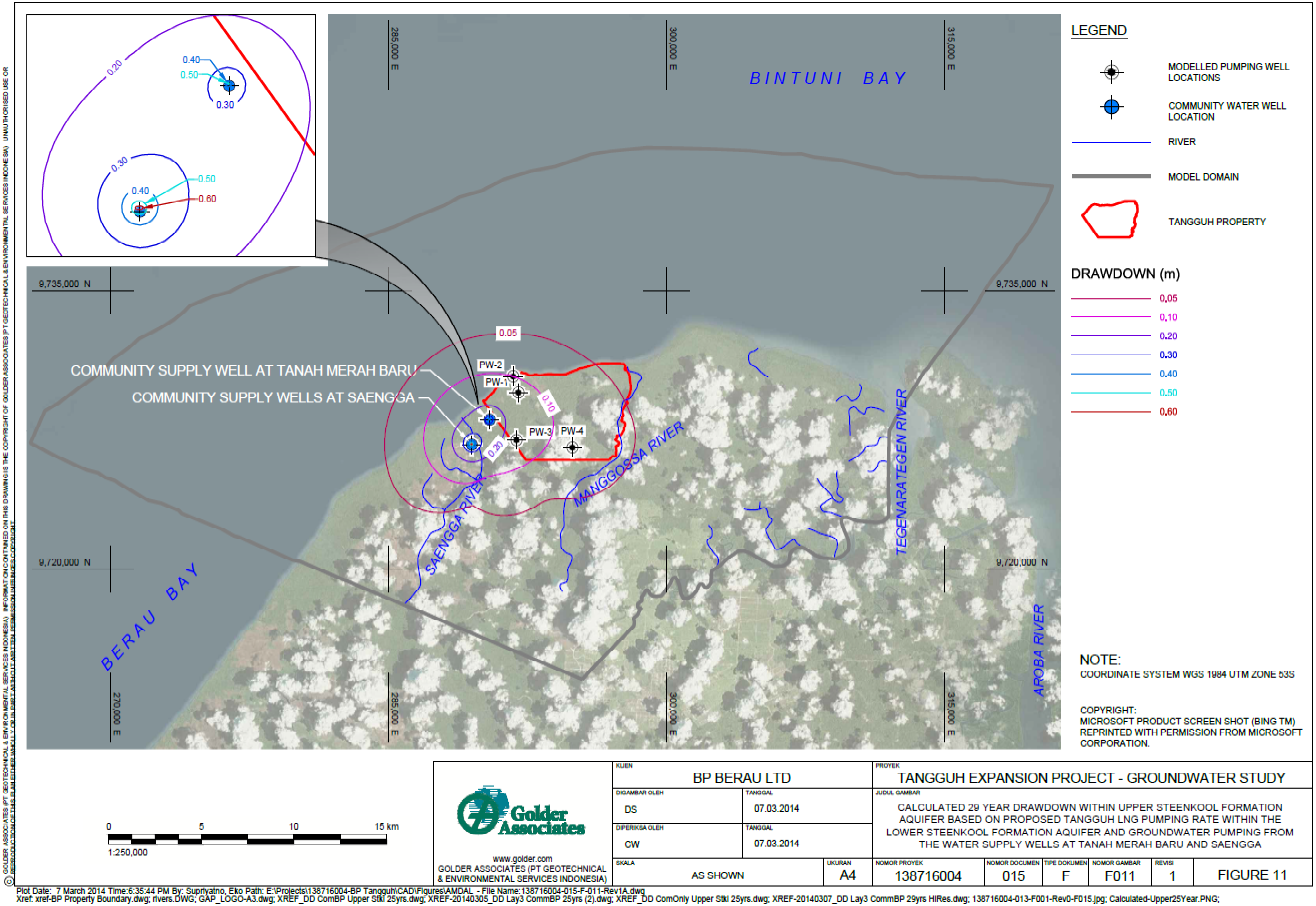


Figure III-41 Modeling of Water Table for 29 Year in the Upper Steenkool Formation Aquifer based on Pumping of Community Wells and Proposed Groundwater at the Tangguh LNG

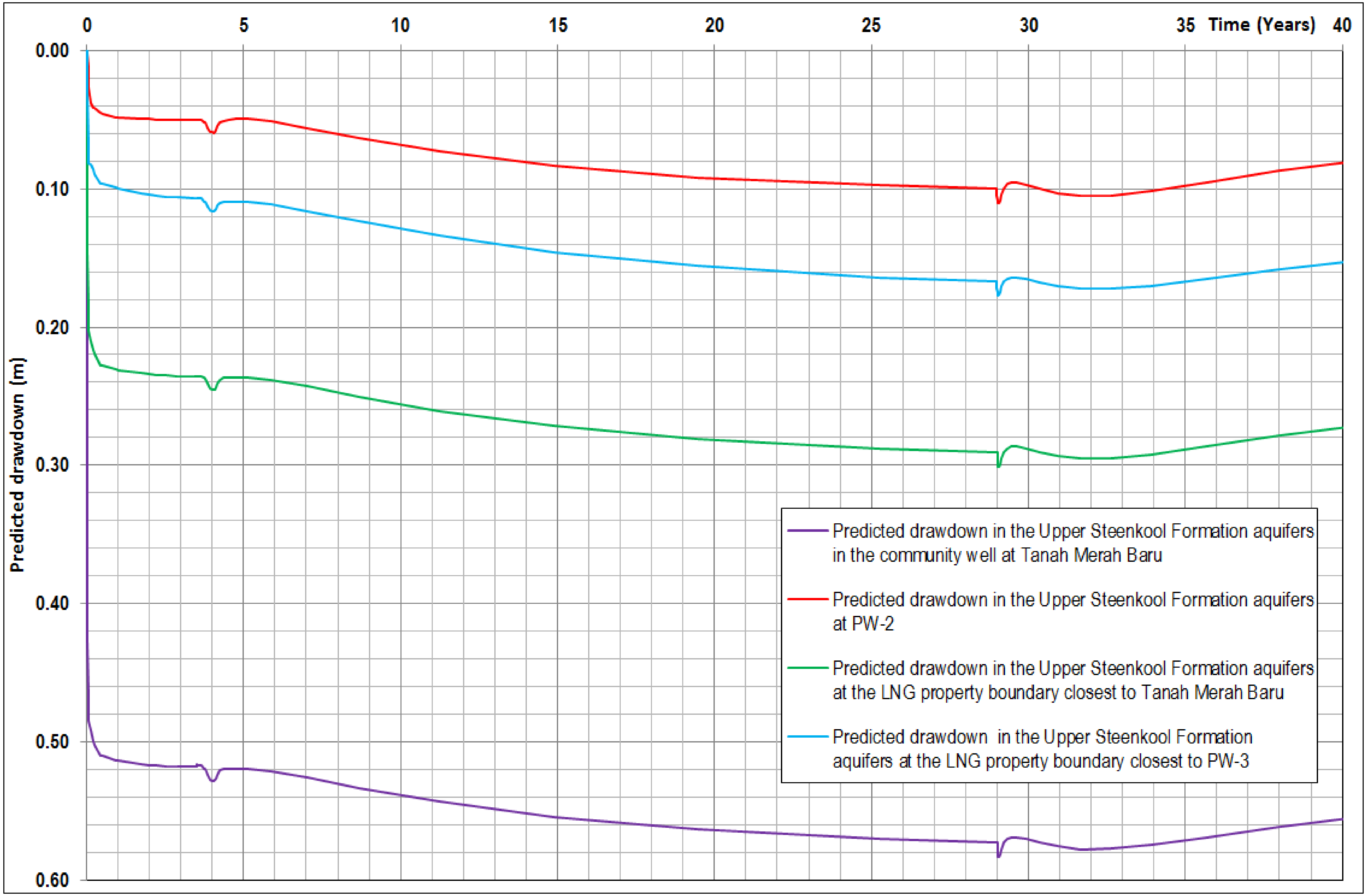


Figure III-42 Predicted Drawdown and Rebound of Water Level in Upper Steenkool Formation Aquifer at PW-2, Community Well at Tanah Merah Baru, at the Boundary Area of the Tangguh LNG nearest to PW-3 and the Boundary Area of the Tangguh nearest to Tanah Merah Baru Village

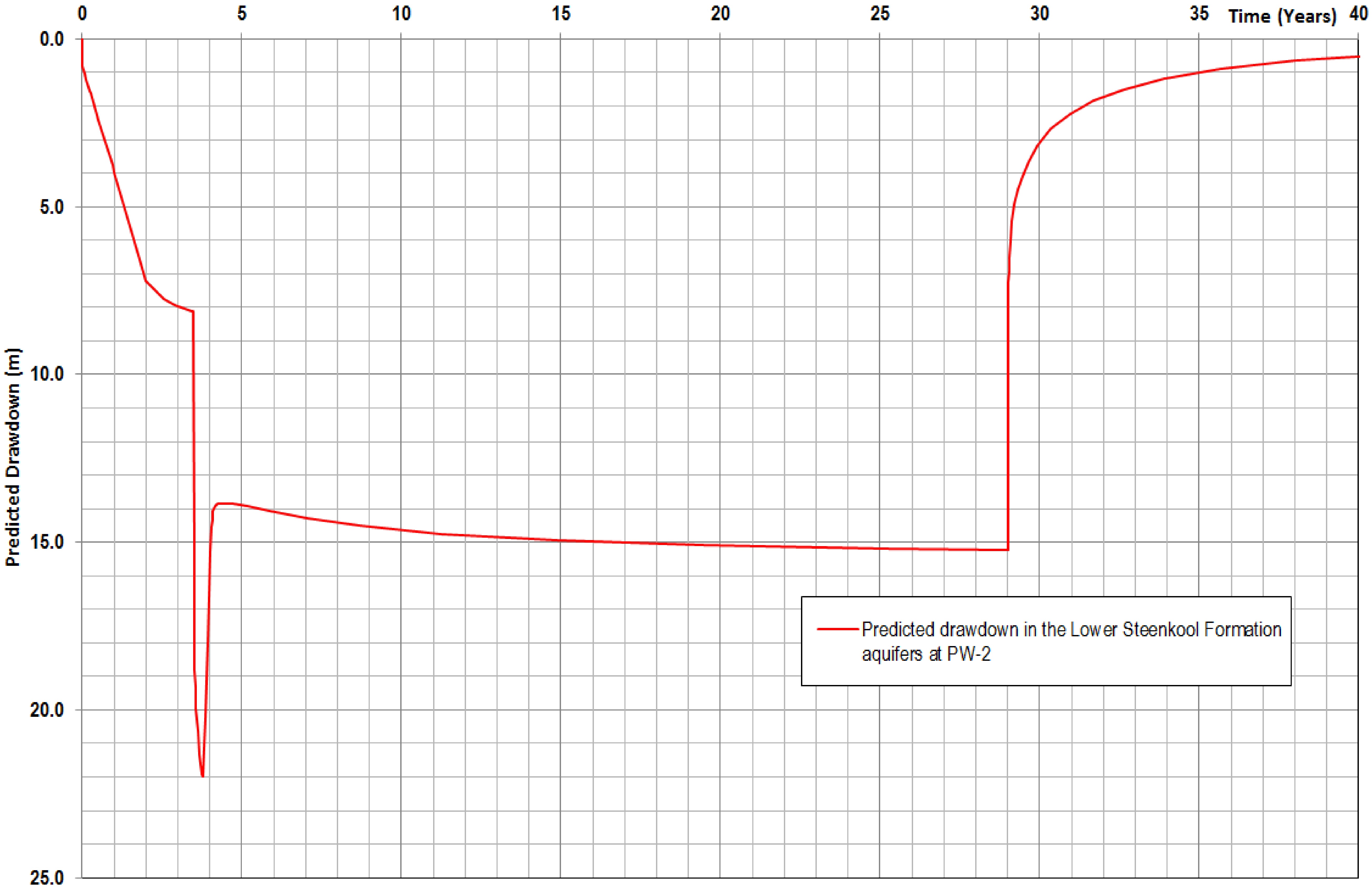


Figure III-43 Predicted Drawdown and Rebound of Water Level in Lower Steenkool Formation Aquifer at PW-2

Table III-75 Impact Evaluation on Community Wells (Drawdown/Decrease in Shallow Groundwater Level)

Impact Description	*The impact of decreasing available water supply for the population of Tanah Merah Baru and Saengga due to groundwater abstraction activities for Tangguh LNG demand.* *There are seven community shallow wells with depth <5 m (five wells in Saengga and two wells in Tanah Merah Baru), and three wells of depth <150 m (one well in Tanah Merah Baru and two wells in Saengga).* *The groundwater supply option proposed is designed with considering the results of a series of* desk-top studies *on groundwater conducted by the Tangguh LNG between 2002 to 2011, and based on Groundwater Pumping Test in 2006 approved by Ministry of the Environment, for the Tangguh LNG.* *Study results recommended that to minimize potential impact on community wells, groundwater abstraction in the Tangguh LNG area should be limited to aquifers deeper than 150 m. Aquifers with depth over 150 m are protected by installing cemented steel* casing. *The groundwater abstraction option proposed for the Tangguh LNG Expansion will be designed on the basis of this condition.*				
Impact Nature	**Negative**	**Positive**			
	Potential for drawdown in three deep wells with depth <150 m (one well found in Tanah Merah Baru and two wells in Saengga).				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The potential for community well drawdown is due to groundwater abstraction from four proposed production wells with depth between 150 m - 400 m to fulfil Tangguh LNG water demand. The potential impact is a combined impact of groundwater abstraction to fulfil community water demand in Tanah Merah Baruvillage (1well) and Saengga village (2 wells), and from four proposed production wells in the Tangguh LNG site.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	Groundwater drawdown in three community wells in Tanah Merah Baru and Saengga may occur during the construction phase of the Tangguh LNG Expansion Project (around 4 years) and throughout the operation phase of the Tangguh LNG train (around ±25 years since the operation phase commenced) when the groundwater option is used. *Rate of drawdown will decrease as time progresses. The impact of drawdown on the Tangguh LNG activities will not continue if the option of groundwater utilization for the Tangguh LNG activities is no longer used or when the Tangguh LNG operational activities terminate. The impact of drawdown is reversible and the water level will rebound after groundwater abstraction ceases.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Impact potential is limited to community groundwater wells in Tanah Merah Baru and Saengga village, so that impact extent is 'local'.				
Impact	**Negligible**	**Low**	**Medium**	**High**	

<table>
<tr><td rowspan="2">Magnitude</td><td colspan="5">Three deep wells were drilled in 2006 with potential to be affected due to long-term groundwater abstraction in Tangguh LNG, namely well TMB1 in Tanah Merah at position of approximately 2.5 km from the planned location of the groundwater production well in the Tangguh LNG and well S1 and S2 in Saengga, located approximately 1 km west of well TMB1.

Well TMB1 was drilled to depth of 150 m. During construction, the water level was at depth 34.5 m and submersible pump installed at depth 78 m with possible drawdown of 43.5 m.
Wells S1 and S2 in Saengga were drilled to depth of 135 m. At the time of construction, the water level was 21 m deep and pump installed at depth of 60 m with possible drawdown of 39 m.

For over seven years of being used, the pump position depths in the community wells were never lowered, however it cannot yet be ascertained whether the water volume in the wells decreased or increased.

Modeling results showed that total drawdown in the upper Steenkool Formation in the Tangguh LNG property area near the planned monitoring well location at distance of 150 m from well PW-3 was 0.165 m, in which around 0.050 m of the figure is likely due to planned groundwater abstraction in Tangguh LNG from the lower Steenkool Formation aquifer. Estimated drawdown from modeling is assumed to possess accuracy of 0.005 m.</td></tr>
<tr><td colspan="5">Largest land subsidence occurring in the Tangguh LNG property boundary fence north of PW-3 near Tanah Merah Baru is greatly related to groundwater abstraction by the community. Estimated drawdown is 0.29 m in which 0.050 m is derived from groundwater abstraction by the Tangguh LNG.

Modeling results show that possible total drawdown will be around 0.57 m (in kampong Tanah Merah Baru) to 0.6 m (in Kampong Saengga) , likely to occur in community groundwater wells originating from the upper Steenkool Formation aquifer. Around 0.52 m of total drawdown is due to water utilization by the community of Kampong Tanah Merah Baru and the remainder of around 0.050 m is estimated to be related to water abstraction plan to meet the water demand of the Tangguh LNG.

The well in Tanah Merah Baru obtains water from the confined aquifer in the Steenkool Formation to depth of 135 m, and the well in Saengga from the confined aquifer in the Steenkool formation to depth of around 120 m. The four planned groundwater production wells of the Tangguh LNG will abstract water from the confined aquifer in the Steenkool Formation at depth of between 150 m – 400 m. Groundwater movement from community wells to production wells will be very slow due to the relatively thick claystone layer with low permeability, separating two confined aquifer systems . The presence of claystone will protect community wells from the impact of drawdown. This was proven by modeling results.

Traditional community wells that are very shallow, generally have depths of less than 5 m, utilizing unconfined aquifer. Recharge into the wells will be of local nature (according to data of groundwater quality taken during environmental baseline survey), and affected by groundwater abstraction from confined aquifer deeper than 150 m in the Tangguh LNG area.</td></tr>
<tr><td rowspan="2">Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">The community utilizes rainwater and very shallow bore wells, in which during the dry season the water volume may lower. The community depends on wells with depth < 150m only during the dry season.

Groundwater abstraction from depths over 150 m will prevent lowering of groundwater supply in three community wells made by the Tangguh LNG in Tanah Merah Baru dan Saengga with screen installed at depth of between 80 m and 135 m. Shallow community wells of depth less than 5 m will not be affected by impact. Thus, the overall category of Receptor Sensitivity is ‘medium’.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Slight</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">Since the impact magnitude is ‘small’ and receptor sensitivity is in ‘medium’ category, the impact severity is in category of ‘medium’.</td></tr>
<tr><td>Impact</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
</table>

Likelihood	*The presence of relatively thick claystone layer between the aquifer used as water source for community well and aquifer planned to be used for Tangguh LNG groundwater production well, will protect community wells from the impact of groundwater drawdown. This was proven by modelling results. Thus, the impact likelihood is small.* *Community wells with depth <5 m recharges from unconfined aquifer in which there is* recharge *during the wet season and is unconnected with deeper aquifer. Thus, the impact will not likely occur.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since the impact severity is in 'medium' category and impact likelihood is 'very low', the impact significance is categorized as 'minor' and is an insignificant impact.				

b. Impact of Seawater Intrusion

Environmental Baseline

If a suitable source of groundwater supply is confirmed with groundwater demand of each proposed production well yields of ± 50 L/second, then further evaluation of groundwater salinities in the range of 300 m to 600 m depth should be considered particularly as groundwater abstraction is planned from the layer between 300 m and 400 m depth. This would assist in defining the position of the seawater interface offshore at different depth in the Steenkool sandstone layer and also beneath the Tangguh LNG area. The salinity data gathered from the sandstone layer at depths of 300 m to 400 m will assist in calibrating the SP salinity interpretation previously conducted by the the Tangguh LNG and proposed to be updated as part of this study.

Groundwater flow in confined aquifer in the Tangguh LNG site occurs due to the factor of pressure toward the shore from onshore recharge location. In the confined aquifer, groundwater is predicted to move through the shoreline and flow in diffused manner (upward leakage) through aquitard layer with low permeability or through local fault structure. The transition location of fresh groundwater to saline groundwater at distance of 2 km offshore is considered feasible for the purpose of analyzing potential saline water intrusion into four proposed groundwater production wells at the Tangguh LNG.

There is no data of groundwater salinity in the Steenkool Formation to depth of 30 m apart from what is shown in the hydrogeological section (Figure II-27) and as well as interpretation of groundwater salinity to a depth of 300 m based on geophysical logging in slim hole drilling SHD-1. Initial assessment has been made indicated that groundwater salinities to a depth of 600 m, which is the lowest part of numerical modeling, is less than 1,000 mg/L. Numerical modeling described in this chapter was shown salinities based on groundwater flow and water balance, and this is shown in the section and in the map. The numerical modeling uses the assumption that fresh water–saline water interface in the lower Steenkool Formation aquifer is located around 2 km at the sea.

Transient modeling was initially conducted to define stable condition of the salt water wedge in the Steenkool Formation. Representative condition of seawater mass concentration boundary (i.e. 35,000 mg/L) was determined at regional waters of the model domain in the uppermost layer to allow lateral and vertical migration through the upper Steenkool Formation. To illustrate the saline water interface with non-saline (fresh) water, mass concentration boundary was applied at location about 2 km offshore in the layer below the upper Steenkool Formation that is dominated by clay (below layer 7).

Impact Prediction

The groundwater abstraction to fulfil the Tangguh LNG water demand is predicted to cause seawater intrusion or a lateral landward migration of the seawater interface

Impact Evaluation

FEFLOW modeling was conducted to allow sufficient time for saline water (interface) to achieve a stable condition. To assist the simulation, constant head boundary with water level +24 m MSL was used for all layers below Layer 7 along the south side of the model domain.

Based on logical estimation in the interface position of saline water and confined aquifer, aquifer parameters and aquitard characteristics, modeling results predicted virtually that there was no lateral movement of saline groundwater toward the proposed wellfield location in the confined aquifer. Modeling results also virtually predicted that there was no flow beneath seawater from the bay toward the confined aquifer underneath.

Prediction of salinity change in the lower Steenkool Formation at PW-2 (i.e. well was installed and modelled nearest to the Bintuni Bay) that caused by the proposed groundwater abstraction to fulfil the Tangguh LNG water demand is less than 10 mg/L; this is the only well (actual and used for the modeling purposes) which the increase in salinity could occur in the upper and lower Steenkool Formation aquifer after a period of 29 years (4 years construction phase and 25 years operation phase) of groundwater abstraction to fulfil the Tangguh LNG water demand.

The Salinity Contour Map shown in **Figure III-44** below is for the Layer 7 that is the zone with targeted aquifer.

Cross section of the salinity interface after groundwater abstraction for 29 years (4 years construction phase and 25 years operation phase) is shown in **Figure III-45**.

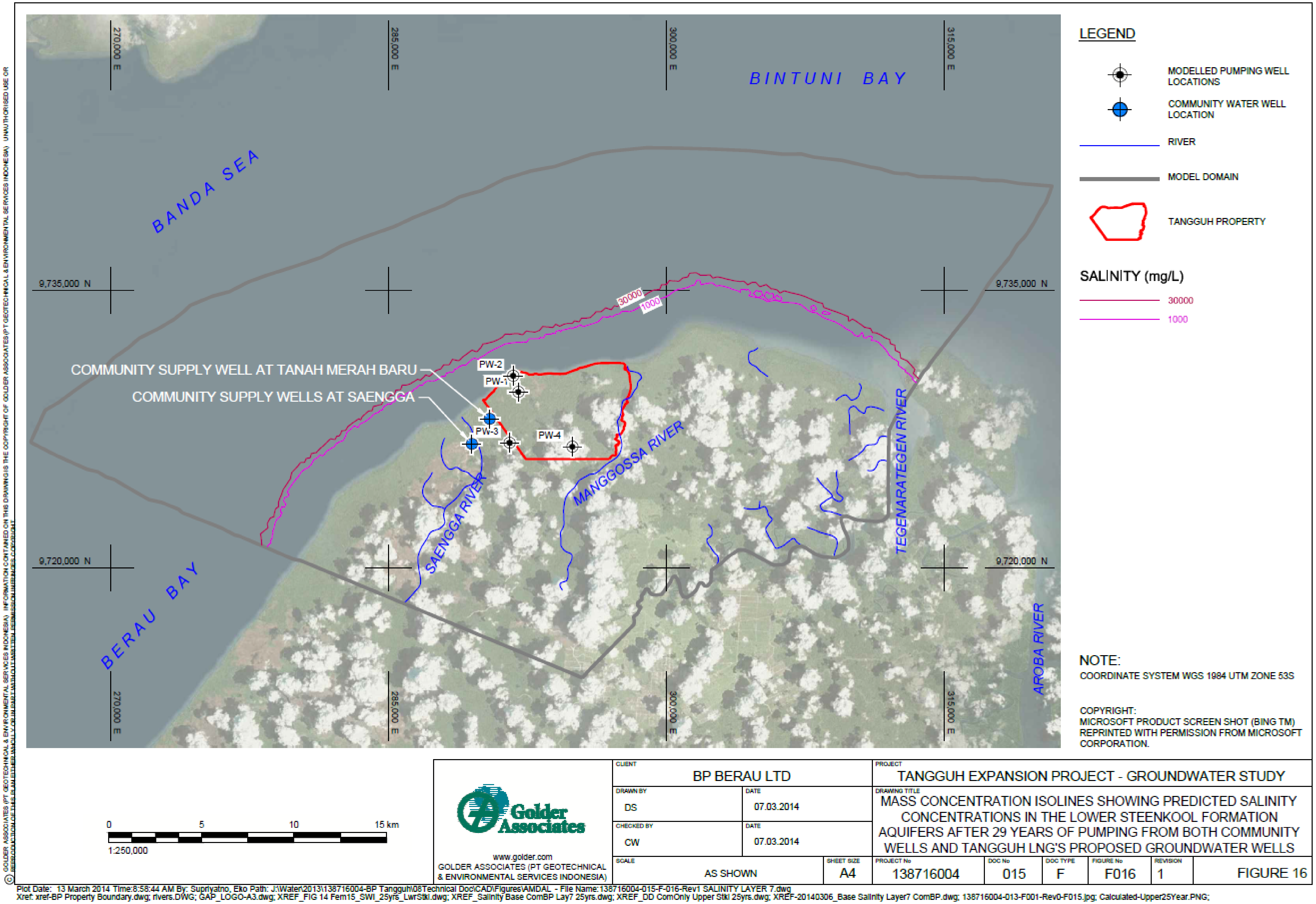


Figure III-44 Mass Concentration Isolines showing Predicted Salinity Concentrations in Steenkool Formation Aquifer after 29 years of Pumping from Community Wells and the Proposed Groundwater Wells of the Tangguh LNG

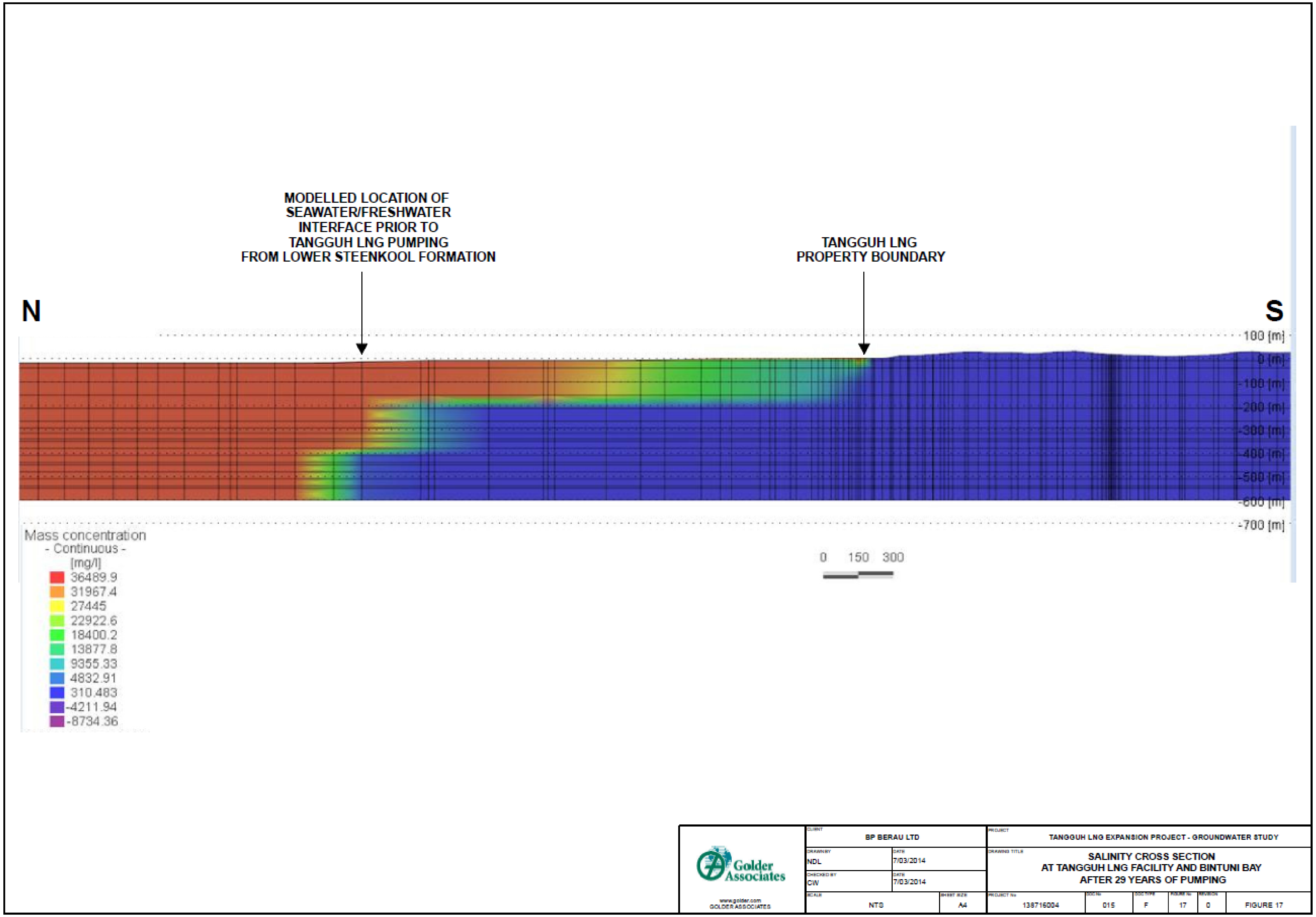


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Figure III-45 Salinity Cross Section at the Tangguh LNG Facility and Bintuni Bay after 29 years of Pumping

Table III-76 Impact Evaluation of Seawater Intrusion

<table>
<tr><td>Impact Description</td><td colspan="5">Impact of seawater intrusion on groundwater production wells in Tangguh LNG.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Potential decrease of groundwater salinity in groundwater production wells with quality standard of salinity refers to PP No. 82/2001.

The impact might occur when groundwater is excessively abstracted from the 4 proposed groundwater production wells of the Tangguh LNG that will cause intrusion from the saline aquifer in Bintuni Bay into groundwater production wells. Seawater intrusion is horizontal and limited to individual sandstone layer.

FEFLOW modeling evaluated the current position of seawater interface below Bintuni Bay and its landward movement based on total groundwater abstraction volume and groundwater production well location. Discharge of groundwater abstraction will be evaluated to minimize seawater intrusion into production wells and will be based on optimal pumping rate of pumping test and modeling as part of the groundwater study, rather than on total water volume required by the Tangguh LNG Expansion Project. If water requirement for the project is larger than permissible pumping discharge, the deficit will be augmented by sea water desalination.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">If seawater intrusion occurs, this will only occur after a long period of time and will initially be identified in monitoring well planned to be drilled until depth 400 m, near the coast north of the groundwater production well.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short-term</td><td>Long-term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">Increase of salinity may occur in the upper and lower part of the Steenkool Formation aquifer after a period of 29 years (4 years construction phase and 25 years operation phase) groundwater abstraction to fulfil water demand of the Tangguh LNG.

If seawater intrusion occurs, this will only be seen several years after groundwater abstraction commences to fulfil water demand during the construction and operation phase of the Tangguh LNG. This will immediately prompt mitigation measures in the form of decreasing volume of groundwater abstraction from groundwater production well near the coast and possibility of making additional groundwater production well in further location to land to the south of the coast.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">In general, only groundwater production wells near the coast might be impacted. After groundwater abstracted from production wells located in coastal areas decreases, salinity value is expected to return to the previous level.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Interpretation based on current existing data from hydrogeological cross section and geophysical log indicate that groundwater salinity at depth up to 600 m, used as modeling basis is less than 1,000 mg/L.

Numeric modeling made as part of the AMDAL, assumes that interface between seawater in the lower steenkool formation is located 2 km offshore.

Predicted change in salinity in the lower Steenkool Formation in PW-2 (the well made and modeled nearest to Bintuni Bay) due to groundwater abstraction plan to fulfil water demand of the Tangguh LNG is less than 10 mg/L.

Groundwater salinity will return to its former level after groundwater abstraction from the production well on the coast is reduced, and assuming there is no other groundwater abstraction in or near the Tangguh LNG area.

Monitoring of groundwater quality in monitoring well on the coast will give early warning of the presence of seawater intrusion in groundwater production wells enabling enough time to perform management measures. Management consists of reducing abstraction from production wells in the north and relying more on groundwater production wells in the south near the surrounding fence of the Tangguh LNG property border. Initial numerical modeling is planned to be calibrated upon completion of the construction phase, by using field testing toward wellfield abstraction and drawdown to provide more accurate prediction and control of seawater movement/migration. Thus, the impact magnitude is in category of 'low'.</td></tr>
</table>

Receptor Sensitivity	**Low**	**Medium**	**High**		
	Currently there are no other projects near the Tangguh LNG location abstracting groundwater aquifer in the Steenkool Formation, however for the purpose of impact evaluation in the AMDAL , the possibility of several other projects including those in the oil and gas and petrochemicals field will likely be developed around the Tangguh LNG area. When the projects use groundwater in their activities, this will accelerate aquifer salinity in the steenkool formation due to groundwater abstraction in the area around the Tangguh LNG. Future use of groundwater after Tangguh LNG shutdown might be limited, if the source of existing groundwater supply has been impacted by seawater intrusion. Therefore, receptor sensitivity is categorized as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude is 'low' and receptor sensitivity is 'medium' category, the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Seawater interface in several Steenkol formation sandstone aquifers below Bintuni Bay will move to the south in the direction of proposed groundwater well site, in which the velocity and amount of water movement will vary depending on depth and nature of each sandstone aquifer. Impact likelihood is 'medium' in which increased salinity value may occur in several deeper sandstone near the coast, which will later require modification toward groundwater extraction discharge as well as production well sites as part of the impact prevention plan.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since the impact severity is in 'medium' category and impact likelihood is 'medium', the impact significance is in category of 'minor-moderate' and is a significant impact.				

c. Land Subsidence Impact

<u>Environmental Baseline</u>

Large-scale groundwater abstraction over an extended period can cause land subsidence depending on the hydraulic interconnectivity between deeper groundwater aquifers and the near surface sedimentsand the geotechnical properties of the near surface sediments. The extent of land subsidence in mm or a few cm is generally considered an insignificant impact. Greater land subsidence will cause physical disturbance of the land surface and higher impact can change the surface drainage pattern or cause damage to infrastructures such as roads, pipelines networks, liquid storage tanks and other structures.

Currently, a considerable volume of geotechnical data has been collected for the shallow near surface sediments on the Tangguh LNG area and considerably more additional data will be collected during the Tangguh LNG Expansion.

The previous geotechnical contractor, Calmarine, reported these sediments were predominantly claystone layers which become rock through the lithification process, as observed in the coastal cliff outcrop in the Tangguh LNG area. The Calmarine report indicated that the claystone layers dating from the Miocene of the Steenkool Formation have been compacted and consolidated over the past 1.5 million years of geological time and were therefore unlikely to undergo further dewatering process and settlement. Comprehensive laboratory testing has been undertaken on the claystones including water content, bulk wet and dry densities, specific gravities, plastic and liquid limits, grain size analysis, unconfined compressions; UU triaxial compressions; CD direct shear and consolidations.

Impact Prediction

Land subsidence occurs below the ground surface due to change in effective pore water pressure both in confined aquifer and confined aquitard in the upper and lower Steenkool Formation. The reduced aquifer pore pressure due to groundwater abstraction effectively raises effective pressure of soil layer thus cause land subsidence.

Compression of soil layer is calculated with combined elasticity and consolidation theories by applying the following formula:

$$\rho_{ult} = \Delta\sigma'_v\left(\frac{D}{E'_0}\right) \quad (1)$$

Where: ρ_{ult} = soil subsidence or ultimate compression

$\Delta\sigma'_v$ = increase of vertical effective stress

E'_0 = soil stiffness in one-dimensional compression

D = thickness of soil layer

Coefficient of compressibility volume (m_v) is generally related to and used for settlement of fine-grained soils such as clay and silt, and illustrates soil compression, per unit of original thickness, due to unit increase in pressure is

m_v = volumetric change / increase in pressure unit

Stiffness of fine-grained soils is thus derived from m_v and total subsidence is calculated with the following formula:

$$\rho_{ult} = m_v \Delta\sigma'_v D \quad (2)$$

Stiffness of coarse- grained soils (sandy) with direct use of E'_0.

E'_0 is inversely proportional to mv (coefficient of compressibility volume) and used in Equation (1) since compression occurs in both fine- grained and coarse -grained soils.

Assuming no change has occurred in the unit weight of soil, change in effective pressure $\Delta\sigma'_v$ is equal to reduced water pore pressure $\Delta i = \gamma_w s$ (in which $\gamma_w s$ is the unit weight of water and s is subsidence). Thus, equation (1) may be re-written as:

$$\rho_{ult} = \gamma_w s\left(\frac{D}{E'_0}\right) \quad (3)$$

Compression in permeable aquifer is considered to develop in conjunction with subsidence; while compression in aquitard occurs gradually from time to time depending on consolidation parameter of aquitard. Compression in aquitard at time *t* after drawdown may be estimated from:

$$\rho_t = R\rho_{ult} \quad (4)$$

Where R is the average degree of consolidation determined from time factor T_v and suitable drainage condition and distribution of reduced water pores. Time factor is calculated from:

$$T_v = c_v\left(\frac{t}{h^2}\right) \quad (5)$$

Where h is maximum drainage path length for vertical drainage in aquitard and c_v is the coefficient of consolidation that can be expressed in aquitard characteristic as:

$$c_v = k_v\left(\frac{E_0'}{\gamma_w}\right) \quad (6)$$

Where k_v is the vertical permeability of aquitard.

Thus, total soil subsidence is the total compression in all aquifer and aquitard layers.

$$\rho_{total} = (\rho_{ult})_{all\,aquifers} + (\rho_t)_{all\,aquitards} \quad (7)$$

The following methodology has been adopted for analysis of land subsidence related to the proposed groundwater abstraction to fulfil water demand in the Tangguh LNG:

- Developing rationalized soil profile for the Tangguh LNG site including all aquifers and aquitard layers based on conceptual groundwater modeling;
- Establishing parameters (including E_0' and mv) for each soil layer required to calculate land subsidence;
- Adopt drawdown (change in pore pressure) from groundwater modeling for aquifer in upper and lower Steenkool Formation to develop profile of change in effective pressure distribution for each soil layer;
- Calculate land subsidence using Equation (7) for change produced in effective pressure at main locations including in wells and within and around the border fence of the Tangguh LNG property.

Impact Evaluation

Geotechnical model profile was used for modeling of land subsidence based on conceptual modeling of groundwater and calculation of geotechnical parameters for over-consolidated soils as shown in **Table III-77**.

Table III-78 Geotechnical Model and Parameters

Layer	Layer	Bottom Depth	Thickness	K_x K_y	K_z	E_0'	c_v
		m bgs	m	m/d	m/d	MPa	m²/year
Alluvial Deposit	1	10	10	5.0	5.0	10	-
Upper Steenkool formation – dominant clay	2	40	30	8.6×10^{-3}	8.6×10^{-4}	90	18
Upper Steenkool Formation – dominant sand	3	100	60	4.0	0.4	320	-
Upper Steenkool Formation – dominant clay	4	155	55	4.0×10^{-4}	4.0×10^{-5}	300	12
	5	210	55	4.0×10^{-4}	4.0×10^{-5}	310	
	6	265	55	4.0×10^{-4}	4.0×10^{-5}	410	
Lower Steenkool Formation – dominant sand	7	295	30	4.0	0.4	1,280	-
Lower Steenkool Formation – dominant clay	8	315	20	4.0×10^{-4}	4.0×10^{-5}	420	8
	9	340	25	4.0×10^{-4}	4.0×10^{-5}	450	

Note: x,y indicate *denote* property in lateral direction and index z for *denote* property in vertical direction

It is predicted that land subsidence of 4.0 cm will occur in the Tangguh LNG property boundary, in the area near the location of well PW-3, as shown in **Figure III-46**. This prediction is considered a conservative value based on limited hydraulic interconnection between aquifer and also based on consolidation properties of Steenkool claystones.

Groundwater abstraction will cease at the end of the operating period (year-29) and geotechnical data indicates that aquifer will be overconsolidated and will rebound after groundwater abstraction has been ceased. Modeling was conducted for 40 years and the results show that subsidence will rebound from 4 cm to 2.5 cm in PW-3 in year 40.

The potential impact analysis of land subsidence was particularly aimed at areas outside the Tangguh LNG site particularly community settlements around the Project site.

Figure III-47 shows locations in the Tangguh LNG area used for the land subsidence analysis with effective emphasis of drawdown interpolation from conceptual modeling of groundwater as shown in **Table III-7**.

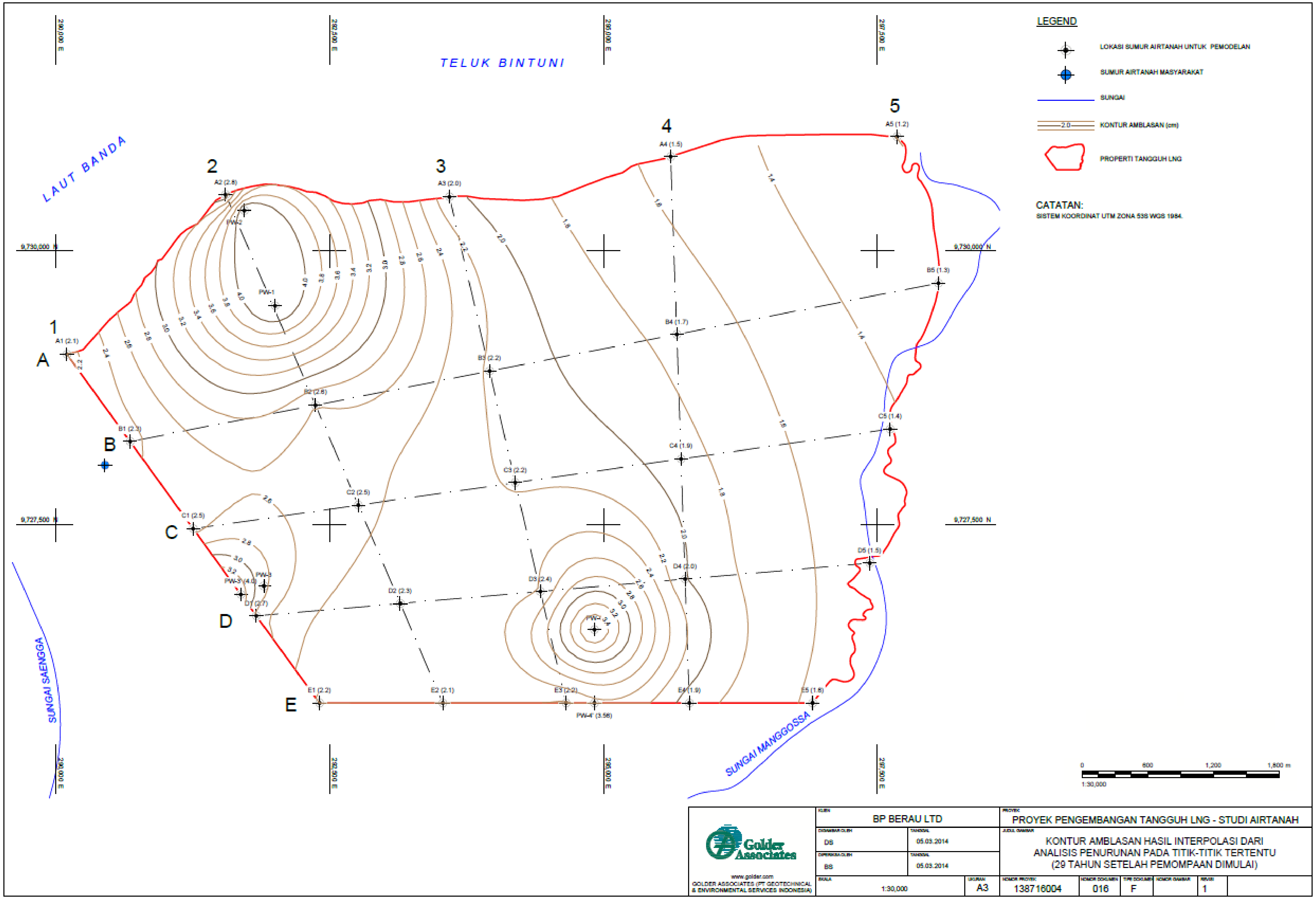


Figure III-46 Subsidence Contour from Interpolation of Subsidence Analysis at Specific Points (29 Years after Pumping Commenced

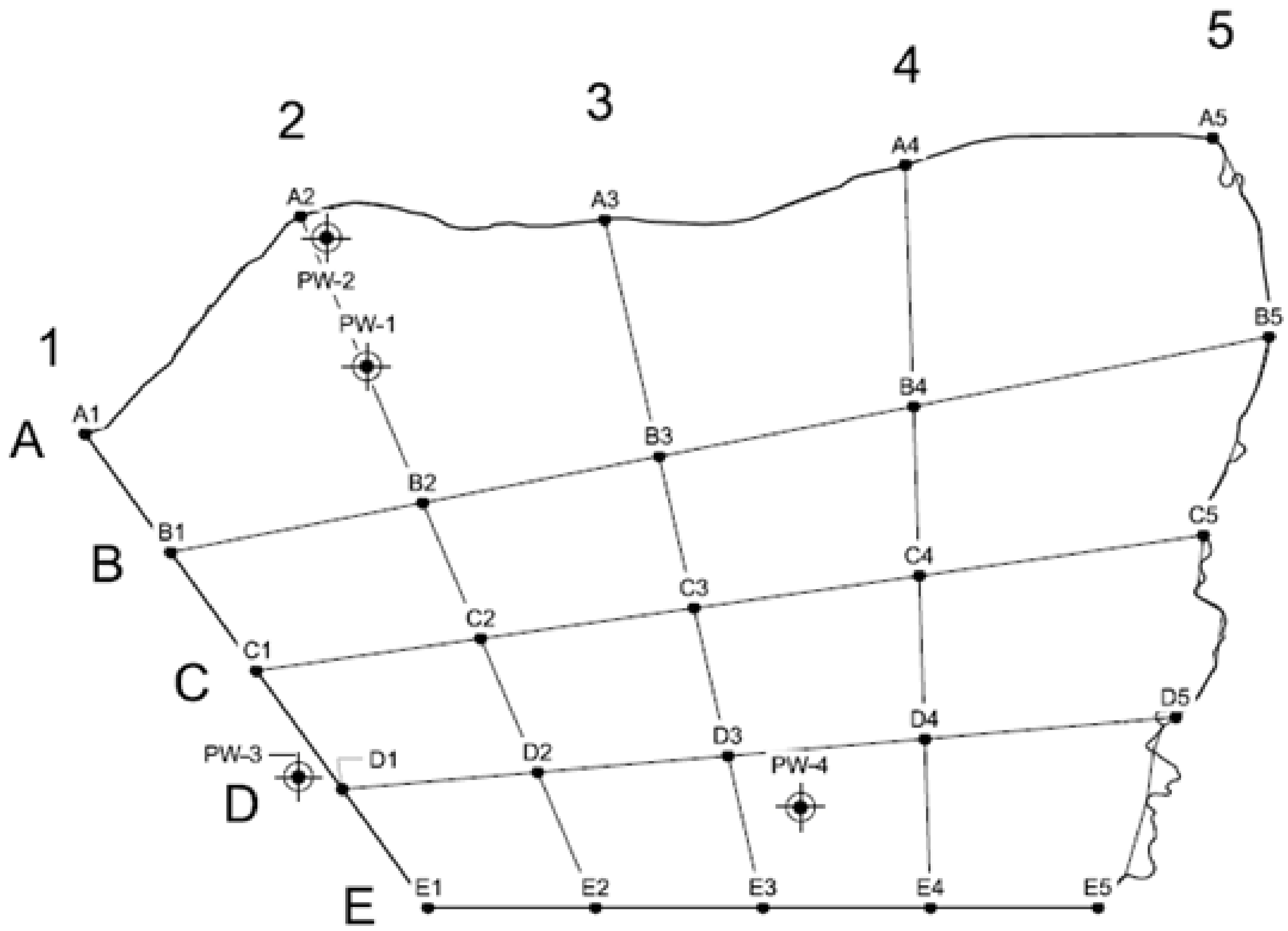


Figure III-47 Locations used for the Subsidence Analysis

Table III-79 Predicted Drawdown and Land Subsidence

Point	Coordinate *Easting* (m)	Coordinate *Northing* (m)	Drawdown in Layer 3 (m)	Drawdown in Layer 7 (m)	Subsidence after 4 years (cm)	Subsidence after 29 years (cm)
A1	290099	9729057	0.18	7.1	0.7	2.1
A2	291548	9730515	0.10	9.8	1.0	2.8
A3	293593	9730495	0.08	7.1	0.7	2.0
A4	295614	9730862	0.06	5.3	0.5	1.5
A5	297680	9731044	0.04	4.2	0.4	1.2
B1	290676	9728260	0.28	7.8	0.8	2.3
B2	292369	9728592	0.15	8.9	0.9	2.6
B3	293959	9728904	0.10	7.5	0.7	2.2
B4	295669	9729239	0.07	6.0	0.6	1.7
B5	298058	9729707	0.05	4.4	0.4	1.3
C1	291252	9727464	0.20	8.5	0.9	2.5
C2	292759	9727679	0.14	8.4	0.8	2.5
C3	294194	9727884	0.10	7.5	0.8	2.2
C4	295708	9728101	0.08	6.5	0.6	1.9
C5	297617	9728374	0.06	4.9	0.5	1.4
D1	291829	9726667	0.16	9.2	0.9	2.7
D2	293143	9726780	0.12	7.9	0.8	2.3
D3	294423	9726891	0.09	8.3	0.8	2.4
D4	295745	9727004	0.08	7.0	0.7	2.0
D5	297430	9727149	0.06	5.2	0.5	1.5
E1	292405	9725871	0.11	7.4	0.7	2.2
E2	293531	9725871	0.09	7.1	0.7	2.1
E3	294657	9725871	0.08	7.5	0.7	2.2
E4	295783	9725871	0.07	6.6	0.6	1.9
E5	296909	9725871	0.06	5.5	0.5	1.6
PW 1	292000	9729500	0.13	15.0	1.5	4.3
PW 2	291720	9730370	0.10	15.0	1.5	4.3
PW 3	291897	9726940	0.17	14.0	1.4	4.0
PW 4	294916	9726542	0.09	13.0	1.3	3.7

Note : 1) Layer 3 is the upper Steenkool Aquifer and Layer 7 lower Steenkool Aquifer
2) 29 years (4 years construction phase and 25 years operation phase)

Analysis of soil subsidence including compression between aquifers (layer 3 and 7) and between aquitard directly in contact with the aquifer (layer 2, 4-6 and 8-9).

Predicted subsidence after groundwater abstraction for 29 years (4 years construction phase and 25 years operation phase) at certain points caused by drawdown in the upper and lower Steenkool aquifer are also shown in **Table III-80**. Degree of average consolidation is around 90% at the end of pumping (29 years). Plot of periodic land subsidence at specific locations around the property fence boundary of the Tangguh LNG is shown in **Figure III-48**.

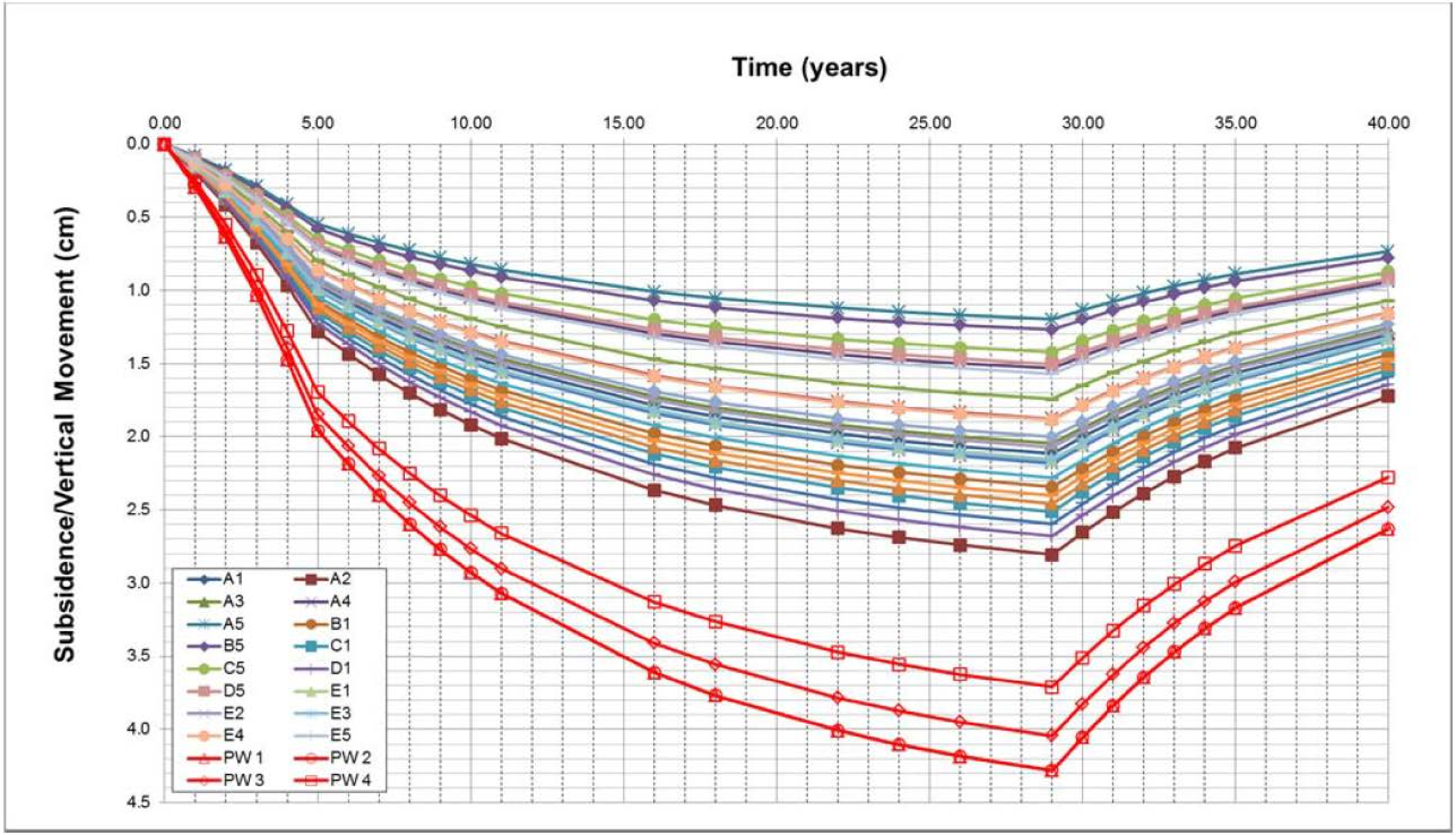


Figure III-48 Subsidence Contour Lines (cm)

Table III-81 Impact Evaluation of Soil Subsidence

Impact Description	*Soil subsidence as a result of groundwater abstraction from production wells in Tangguh LNG.*				
Impact Nature	**Negative**	**Positive**			
	Land subsidence occurring outside the Tangguh LNG location, related to project activities are considered a negative impact. Land subsidence can occur when bonds between sediments near the soil surface are very weak when dewatering takes place. However from the series of desk-top studies *conducted by the Tangguh LNG between 2002 to 2011, and limitations provided based on previous consultation with MoE in which groundwater abstraction was only permitted at depths of over 150 m, this will reduce the possibility of land subsidence.*				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Impact directly occurring is related to groundwater abstraction in the four production wells proposed in the Tangguh LNG site.				
Impact Duration	**Temporary**	**Short-term**	**Long-term**	**Permanent**	
	The land subsidence process occurs slowly over an extended period of time and is irreversible. Around 30% of subsidence occurs in the 4 years construction phase, in which average degree of consolidation considers all aquitards affected by the impact of groundwater utilization is around 90 % after the end of groundwater utilization (29 years). Groundwater abstraction will cease at the end of the operation period (year 29) and geotechnical data indicates that aquifer is over consolidated *and will partially rebound after groundwater abstraction ceases.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent is limited to the area influenced by groundwater production well drawdown and more specifically in areas nearest to the groundwater production wells. Land subsidence outside the Tangguh LNG area will be far lower than inside the Tangguh LNG area.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Previous geotechnical study indicates that surface sediment in the Tangguh LNG area is dominated by claystone layer that has become rock through a process of lithification, as observed in the coastal reef outcrop in the Tangguh LNG area. Geotechnical characteristics of claystone *in steenkool formation indicate claystone properties with very low permeability, which can maintain water content reduction and not vulnerable to subsidence and compression.* *Modeling of land subsidence was based on results of numeric modeling of drawdown. Estimated subsidence occurring for 29 year along the perimeter fence of Tangguh LNG after the start of water utilization ranges from 1.2 cm to 2.8 cm and up to 4 cm in PW-3 near the west border, which is the planned subsidence monitoring location. Maximum subsidence from calculation is 4.3 cm at well locations PW-1 and PW-2. Estimated subsidence during the well operating period (29 years) is less than the maximum estimated limit of 5 cm for Tangguh LNG facility border. Modeling was done for 40 years and the results indicate that soil subsidence will rebound from 4 cm to 2.5 cm in PW-3 in year 40.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Claystone geotechnical properties on the surface and near surface indicate that claystone is not vulnerable to compaction and settlement. This ensures that potential impact of subsidence in the settlement area around the Tangguh LNG location is small. Thus , receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude is categorized as 'low' and receptor sensitivity is categorized as 'low' category, thus impact severity is categorized as 'slight'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	There is very slight possibility of land subsidence outside the Tangguh LNG site, so that impact likelihood is 'very low'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since impact severity is categorized as 'slight' and impact likelihood is categorized as 'very low', thus the impact significance is categorized as 'negligible' and is an insignificant impact.				

3.3.1.7 Soil

a. Increase in Soil Erosion

- **Environmental Baseline**

Soil Map Units

Based on soil observation made within the borders of the proposed Tangguh LNG Expansion Project area, *Landforms* in the project area can be grouped into three Soil Map Units (SPT). In the three SPTs, four soil orders are encountered, i.e. *entisols*, *inceptisols*, *ultisols* and *spodosols*. The soil types are found in associations. The distribution of SPT is presented in **Figure III-49**.

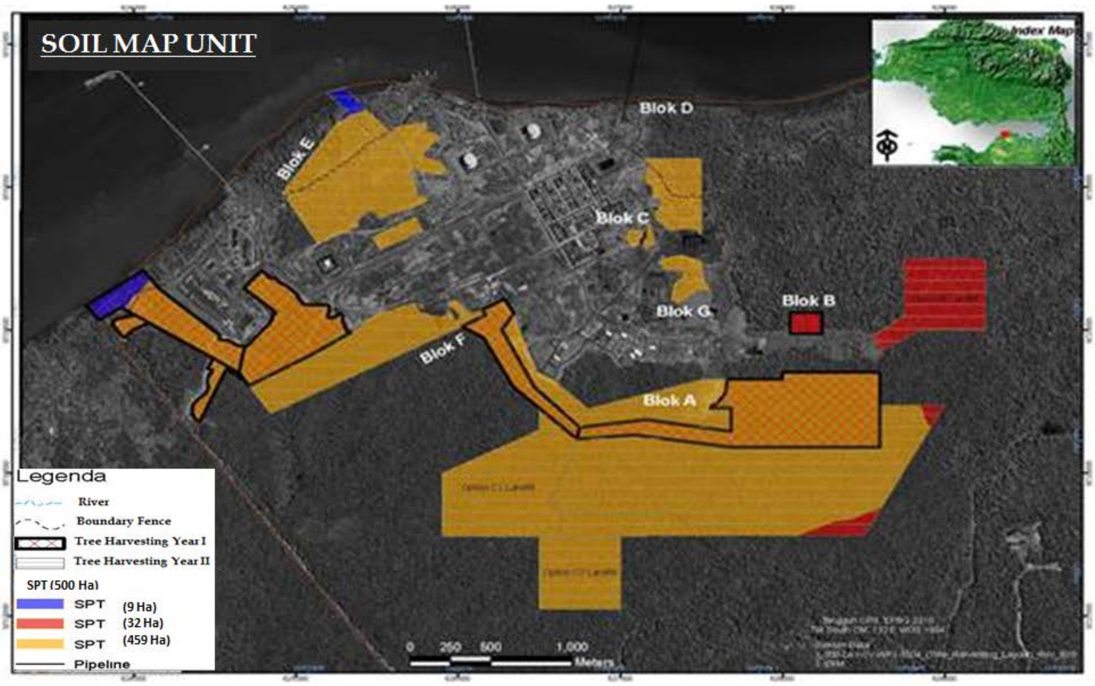


Figure III-49 Soil Map Units in Location of the Proposed Tangguh LNG Expansion

The characteristics of three soil map units (SPT) found in the proposed Tangguh LNG Expansion location are shown in **Table III-82**:

Table III-83 Soil Map Unit Characteristics in Areas to be Cleared for the Tangguh LNG Expansion

SPT	Type of Soil		Landform	Gradient (%)	Main Material	Land Area to be Cleared	
	Ordo	USDA Representative Great Group				Ha	%
1	*Entisols*	*Hydraquent* and *Quartzipsamment*	Tidal swamp and coastal reef	< 2	*Aluvium Marin*	9	1.8
2	*Ultisols and Inceptisols Association*	*Hapludults and Dystropepts*	Mild slope	8-25	Conglomerate Complex and Mudstone	32	6.4

SPT	Type of Soil		Landform	Gradient (%)	Main Material	Land Area to be Cleared	
	Ordo	USDA Representative Great Group				Ha	%
3	*Ultisols and Spodosols Association*	*Hapludult, Humuldt and Ortods*	Incised terrace	3 -16	Conglomerate Complex and Mudstone	459	91.8
Total Land Area to Be Cleared						**500.0**	**100.0**

Soil Physical Properties

Soil physical properties observed in the field and laboratory consist of: texture, structure, effective depth, particle size class in root zone (0-20 cm), condition of rock on the soil surface, slope and rock condition in the soil, drainage class, flood and seasonal inundation.

Observation of land physical parameters is required to identify potential erosion. Soils such as SPT 1 has slightly different textural variation between mangrove swamp landform and coastal shoal. In swamp area, mangrove generally has fine soil texture on the upper surface and several cm below coarse texture (sand)become found, while SPT 1 as a coastal shoal of the soil surface has coarse texture (sand). SPT 2 and SPT 3 have finer texture than SPT 1. Ultisols soil in SPT 2 and SPT 3 have higher clay content than inceptisol and spodosols in the same SPT. Soils containing much clay are more resistant to erosion.

Soil structure in SPT 1 is unformed since soils in the SPT is classified as recent soil. SPT 2 and 3 are generally of loose structure on the upper layer (ranging 0-5 cm), and lumpy in the lower layer (range of 5-20 cm) except for lower layer spodosols (ranging 5-20 cm) generally flaky – untextured. Firmness of structure is generally found in the lower layer. Soils with firm structure such as ultisols in SPT 2 and SPT 3 are more resilient to erosion compared with inceptisols and spodosols.

Surface rocks are not encountered in all SPT except for *spodosols* that have lost their topsoil (organic matter). Surface rocks in spodosols are encountered in small amount (< 5%). Effective depth (soil solum) in all SPT is found over 100 cm except for *inceptisols* in block E, effective depth of about 30 cm due to the presence of pan layer as accumulation of clay and iron fractions.

Soil color in each block varies from brown, yellowish brown, reddish yellow and gley. Soil color indicates the drainage conditions in soils. Brown to reddish/yellowish soil generally indicates a good drainage, while gley colored soils indicate poor drainage. Drainage is one of the soil properties observed based on velocity of water flow from a soil plot, both as run off and as seepage into the soil.

- **Environmental Baseline of Soil Erosion**

Potential erosion in the area can be illustrated per soil map unit represented by one of the dominant soil types. Soil sampling are in two categories, namely primary dry forest and secondary dry forest in the proposed project location in the Tangguh LNG area. The primary dry forest and secondary dry forest illustrates the current general condition that will be cleared for the Tangguh LNG Expansion activities. Soil physical characteristics related with erosion are shown in **Table III-74**.

The results of potential erosion prediction in the proposed Tangguh LNG Expansion area is very low (see **Table III-84**), namely for SPT 1 which is tidal swamp and coastal shoal (mangrove forest), soil erosion ranges between $2x10^{-4}$ to $4x10^{-3}$ ton/ha/year; in SPT 2, consisting of mild slopes covered by primary forest, secondary forest and shrubs, the potential erosion ranges between $2x10^{-3}$ to 0.04 ton/ha/year; while in SPT 3, that was composed of incised terrace covered by primary forest, secondary forest and shrubs, the potential erosion ranges between $6x10^{-4}$ to 0.01 ton/ha/year. Very low erosion is due to the soil being tightly covered by existing vegetation so that it can adequately resist to erosion. Based on the data, in general it might be said that currently the soil erosion rate in the project area is very low.

Table III-85 Soil Physical Characteristics Related to Erosion

Soil Map Unit	Dominant Soil Type	Organic Material (%)	Texture		Permeability cm/hour		Structure		Soil Erodibility Value (K)	Slope	Effective Depth/ Solum (cm)	Soil Depth Factor
		a	Class	M	cm/hour	v		b				
SPT 1	*Hydraquent* and *Quartzipsamment*	1.0	Coarse (sand-sandy clay)	812.1	Quick (coastal shoal) and slow (mangrove swamp)	2	Unstructured	4	0.11 (low)	< 2 %	>100 cm	0.9-1.0
SPT 2	*Hapludults*	2.6	Fine (silty clay)	5465.6	Medium-obstructed	5	Lumpy	4	0.74 (very high)	8 - 16 %	> 100 cm	0.8
SPT 3	*Hapludults*	3.6	Slightly coarse (sandy clay)	5116.3	Medium	4	Lumpy	4	0.55 (high)	2 - 4 %	> 100 cm	0.8

Source: Results of data analysis. 2013

Table III-86 Environmental Baseline of Soil Erosion Rate in Each Soil Map Unit on Areas to be Cleared for the Tangguh LNG Expansion Project Activities

Baseline		Natural Factor			Land Cover (C)			Conservation (P)			Potential Erosion (ton/ha/year)			Erosion Hazard Level			Maximum Tolerated Erosion*	
Soil Map Unit	**Dominant Soil Type**	**R**	**K**	**LS**	**Primary Forest**	**Secondary Forest**	**Shrub**	**Without**	**Without**	**Without**	**Primary Forest**	**Secondary Forest**	**Shrub**	**Primary Forest**	**Secondar y Forest**	**Shrub**	**mm/yr**	**ton/ha/year BD=1.30**
SPT1	*Hydraquents* and *Quartzipsamment*	891	0.21	1	0.001	0.005	0.02	0.001	0.001	0.001	$2x10^{-4}$	$9x10^{-4}$	$4x10^{-3}$	**SR**	**SR**	**SR**	**3**	**72**
SPT2	*Hapludults*	891	0.74	3.21	0.001	0.005	0.02	0.001	0.001	0.001	$2x10^{-3}$	0.01	0.04	**SR**	**SR**	**SR**	**2**	**42**
SPT3	*Hapludults*	891	0.55	1.30	0.001	0.005	0.02	0.001	0.001	0.001	$6x10^{-4}$	$3x10^{-3}$	0,01	**SR**	**SR**	**SR**	**2**	**57**

* According to Hammer 1980 (in Arsyad, 2000)

Table III-87 Predicted Erosion and Erosion Hazard Level on Land to be Cleared in Each Soil Map Unit for the Tangguh LNG Expansion Project

Baseline		Natural Factor			Land Cover (C)		Conservation (P)		Potential Erosion (ton/ha/year)		Erosion Hazard Level		Maximum Tolerated Erosion*	
Soil Map Unit	**Dominant Soil Type**	R	**K**	**LS**	**Cleared Land**	**Soil Cover**	**Cleared Land**	**Soil Cover**	**Cleared Land**	**Soil Cover**	**Cleared Land**	**Soil Cover**	mm/yr	ton/ha/year BD=1.30
SPT1	*Hydraquents* and *Quartzipsamment*	891	0.21	1	1	0.1	0.8	0.03	150	0.6	S	SR	**3**	**72**
SPT2	*Hapludults*	891	0.74	1	1	0.1	0.8	0.03	527	2.0	SB	SR	**2**	**42**
SPT3	*Hapludults*	891	0.55	1	1	0.1	0.8	0.03	392	1.5	B	SR	**2**	**57**

* According to Hammer 1980 (in Arsyad, 2000)

Note: SR = Very Low,R = Low, S = Medium, B = Heavy, SB = Very Heavy

Impact Prediction

Land clearing activities are predicted to affect the magnitude of potential erosion. Erosion occurs if the top soil is vulnerable towards rain water and surface run-off so that the soil particles will move and be transported to other places. Erosion is calculated toward soil map unit, each represented by the dominant soil type. The approach made to predict the amount of erosion during construction used the scenario with the following assumptions:

1. When land clearing is conducted, gradual loss of land cover occurs in each cleared land. Thus the amount of potential erosion for each bare land without vegetation in each type of SPT, will proceed for maximum three months.
2. In each land cleared, cover crops will be immediately planted and potential erosion prediction will be based on fully land covered by cover crops after three months as bare land.

Land area to be cleared for the Tangguh LNG Expansion is maximum 500 ha. There are three options of proposed landfill location to be considered, namely Option B with area of 27.87 ha, Option C1 with area of 47.45 ha and Option C2 with area of 27.87 ha. For the soil erosion calculation, Option B is excluded, which if the option is selected, the amount of erosion caused will be considered separately. In erosion prediction, options C1 and C2 are included and taken into account in the document, although later only one option will be selected. Land clearing area in the first year and second years in each SPT as well as period of bare land and afterwards covered by soil cover crops are shown in **Table III-77.**

Overall land clearing will be conducted in stages associated with land clearing activities, in the first year with area of 127.25 ha, including 6.18 ha in SPT 1, 4.50 ha in SPT 2 and 116.57 ha in SPT 3. In the second year, if landfill Option C1 is selected, land to be cleared will be 331.12 ha; consisting of 1.30 ha in SPT 1, 4.30 ha in SPT 2, and 325.52 ha in SPT 3. In the second year, if landfill Option C2 is selected, land to be cleared will be 309.11 ha; encompassing 1.30 ha in SPT 1, 4.30 ha in SPT 2, and 303.51 ha in SPT 3.

Table III-77 Land Clearing Area in the First and Second Year according to Soil Map Unit in the Tangguh LNG Area

Soil Map Unit	Year -1		Year -2			
			Landfill Option C1		Landfill Option C2	
	Bare Land until 3 Months	Land Covered by Cover Crops in Period until Construction	Bare Land until 3 Months	Land Covered by Cover Crops in Period until Construction	Bare Land until 3 Month	Land Covered by Cover Crops in Period until Construction
SPT 1	6.18	6.18	1.30	1.30	1.30	1.30
SPT 2	4.50	4.50	4.30	4.30	4.30	4.30
SPT 3	116.57	116.57	325.52	325.52	303.51	303.51
Total	**127.25**	**127.25**	**331.12**	**331.12**	**309.11**	**309.11**

In every land to be cleared, land cover will completely disappear over approximately three months period, afterward cover crops will be planted. When land is covered with cover crops**,** so that the potential erosion will decrease to lowest level in all SPTs, with the following description:

Based on the soil physical properties for each SPT and natural factors, consisting of (1) rainfall erosivity factor (R), (2) soil erodibility factor (K), (3) slope length factor (L) and (4) slope gradient factor (S); and non-natural factors consisting of (5) land coverage factor (C), and (6) conservation factor (P) on land to be cleared and using the USLE (Universal Soil Loss Equation), potential erosion and erosion hazard level are obtained on the project site as shown in **Table III-78.** Erosion hazard level refers to the criteria shown in **Table III-78**.

Table III-78 Erosion Hazard Level Based on Thickness of Soil Solum and Erosion Hazard (Maximum Erosion)

Thickness of Solum (cm)	Maximum erosion (ton/ha/year)				
	< 15	15 – 60	60 – 180	180– 480	> 480
> 90	SR	S	S	B	SB
60 – 90	R	B	B	SB	SB
30 – 60	S	SB	SB	SB	SB
< 30	B	SB	SB	SB	SB

Note: SR = Very Low, R = Low, S = Medium, B = Heavy, SB = Very Heavy
Source: Ministry of Forestry, 1986

<u>Potential Erosion in Soil Map Unit 1 (SPT 1)</u>

Based on erosion estimates as shown in **Table III-76**, potential erosion in SPT 1 without cover crops (cleared land) is 150 ton/ha/year with erosion hazard level of medium (S) that will take place for three months with erosion rate of 12.5 tons/ha/month; the potential erosion in SPT 1 with land cover following cover crops planting is 0.6 ton/ha/year, with very low (SR) erosion hazard level , that will take place for period until the commencement of construction with erosion rate of 0.05 ton/ha/month.

With soil bulk density of 1.22 tons/m^3 for SPT 1 (see **Table II-16** in Sub-chapter 2.1.6.2 Soil Physical Properties), the loss of soil layer due to erosion for SPT 1 is 1.02 mm/month in cleared land condition for about three months, and will be 0.004 mm/month for the following months upon the presence of land cover through the planting of cover crops.

<u>Potential Erosion in Soil Map Unit 2 (SPT 2)</u>

Potential erosion for SPT 2 without land cover is 527 ton/ha/year with very heavy erosion hazard level (SB) that will take place for three months with erosion rate of 43.9 tons/ha/month; and upon the presence of land cover through planting of cover crops, the potential erosion decreases to 2 tons/ha/year , in very low (SR) category that will last for a period until the commencement of construction with erosion rate of 0.16 tons/ha/month.

With average bulk density of soil of 1.18 ton/m^3 for SPT 2 (see **Table II-16** in Sub-chapter 2.1.6.2 Soil Physical properties), so that the loss of soil layer for SPT 2 is 3.7 mm/month in condition of cleared land that will continue for three months, and will be 0.014 mm/month for the following months upon the presence of land cover through planting of cover crops.

Potential Erosion in Soil Map Unit 3 (SPT 3)

Potential erosion for SPT 3 without land cover is 392 tons/ha/year, in category of heavy (B) erosion hazard level that will take place for approximately three months with erosion rate of 32.7 tons/ha/month; and upon the presence of land cover through planting of cover crops, the potential erosion decreases until 1.5 tons/ha/year , or very low (SR) category that will further take place in a period up to the commencement of construction with erosion rate of 0.12 tons/ha/month.

With average bulk density of soil of 1.35 ton/m^3 for SPT 3 (see **Table II-16** in Sub-chapter 2.1.6.2 Soil Physical Properties), the soil layer loss for SPT 3 is 2.4 mm/month in condition of cleared land for about three months, and will be 0.009 mm/month for the following months upon the presence of land cover through the planting of cover crops.

Soil Particles Transported in the First Year

According to the first year land clearing plan of 127.25 ha, with land clearing plan in SPT 1 is 6.18 ha, in SPT 2 is 4.50 ha and in SPT 3 is 116.57 ha. Overall, simultaneously the cleared land will be free of vegetation without land cover, and subsequently will be planted with cover crops. On this basis, the rate of soil particles transported in the first three months will be 4.087 tons/month. In the following period of time, after land is covered by cover crops, the rate of soil particles transported will be 15 tons/month (**Table III-79**).

Soil Particles Transported in the Second Year

- *Landfill Option C1*

In the second year, if landfill Option C1 is selected, total land to be cleared is 331.12 ha, among others land to be cleared is 1.30 ha in SPT 1, 4.30 ha in SPT 2 and 325.52 ha in SPT 3. Similar to the first year, land already cleared will be a fully bare land without vegetation for three months and afterwards will be planted with cover crops. As shown in **Table III-80** the rate of transported soil particles in the first three months will be 10.850 tons/month. In the following period, after the land is completely covered by cover crops, the rate of soil particle transported will be 40 tons/month.

- *Landfill Option C2*

In the second year, if landfill Option C2 is selected, total land to be cleared is 309.11 ha, among others land to be cleared is 1.30 ha in SPT 1, 4.30 ha in SPT 2 and 303.51 ha in SPT 3. Similar to the first year, land already cleared will be fully bare land without vegetation for three months and afterwards will be planted with cover crops. As shown in **Table III-80** the rate of transported soil particle in the first three months will be 10.130 ton/month. In the following period, after the land is completely covered by cover crops the rate of soil particle transported will be 37 tons/month.

From the above calculation, there is no conspicuous difference in soil particles transported between landfill Option C1 and Option C2. Accordingly, further calculation of transported soil particles will use the maximum value of one of the two options.

Soil Particles Transported Further upon Completion of Land Clearing in the Second Year

From the data of **Table III-79** and **Table III-80**, the rate of transported soil particles in the following months after the completion of land clearing in the second year is 15 tons/month from land clearing in the first year and 40 tons/month from land clearing in second year, so that the total will be 55 tons/month.

Transportation Media of Soil Particles Produced from Erosion

As described in the hydrology section (Sub-chapter 2.1.4), several large and small ephemeral creeks are crossing the Tangguh LNG area. Ephemeral creeks in the Tangguh LNG area are generally combined flows of several natural ditches joined into one flow. Ephemeral creeks around the area of Tangguh LNG are S1, S2, S3, S4 and S5 (see **Figure III-34** in Sub-chapter 3.3.1.5 Hydrology). Creeks of S2, S3, S4 and S5 flow to the north heading to the shores of Bintuni Bay waters with generally parallel flow pattern. Creek S1 flows to the west heading to the Saengga River. **Figure III-50** shows the location of SPT and Creek watershed in the Tangguh LNG Expansion Project site, based on this figure, the land area to be cleared in each SPT is calculated and to be determined to enter Creek watershed S1, S2, S4 or S5. Results of soil erosion, unless control efforts are applied , will flow through surface runoff and enter creeks S1, S2, S4 and S5 with details of total soil particles transported and entering each creek watershed shown in **Table III-81**.

In the first year, the total soil particles transported in the initial three months of land clearing will be 4,097 tons/month, a total of 2,169 tons/month or around 53% will enter S1 creek watershed, which if there is no control on erosion impact (through drainage management and sediment trap), hence the total amount will enter the Saengga River and end up in Bintuni Bay waters. A total of 1,551 tons/month or around 38% will enter creek watershed of S2 flowing north to enter the marine waters of Bintuni Bay. A further 367 tons/month or 9 % (if no drainage management applied or sediment trap built) will enter creek watershed of S4 flowing to the north and enter the waters of Bintuni Bay. Total soil transported in the following months of the first year after land cleared is covered by cover crops is 15 tons/month, much lower compared to the first three months when the land was without vegetation.

In the second year, similar to the first year, the total soil particles transported in the initial three months of land clearing will be 10,850 tons/month, a total of 7,265 tons/month or around 67% will enter creek watershed S1. A total of 2.884 tons/month or around 27% will enter creek watershed S2 and a further 701 tons/month or 6% will enter creek watershed S5. Total soil transported in the following months of the second year after the land cleared is planted with *cover crops* will be 40 tons/month, much lower than the first three months when the land was without vegetation, which will be distributed to three creek s, i.e. S1 (27 tons/month), S2 (11 tons/month) and S5 (2 tons/month).

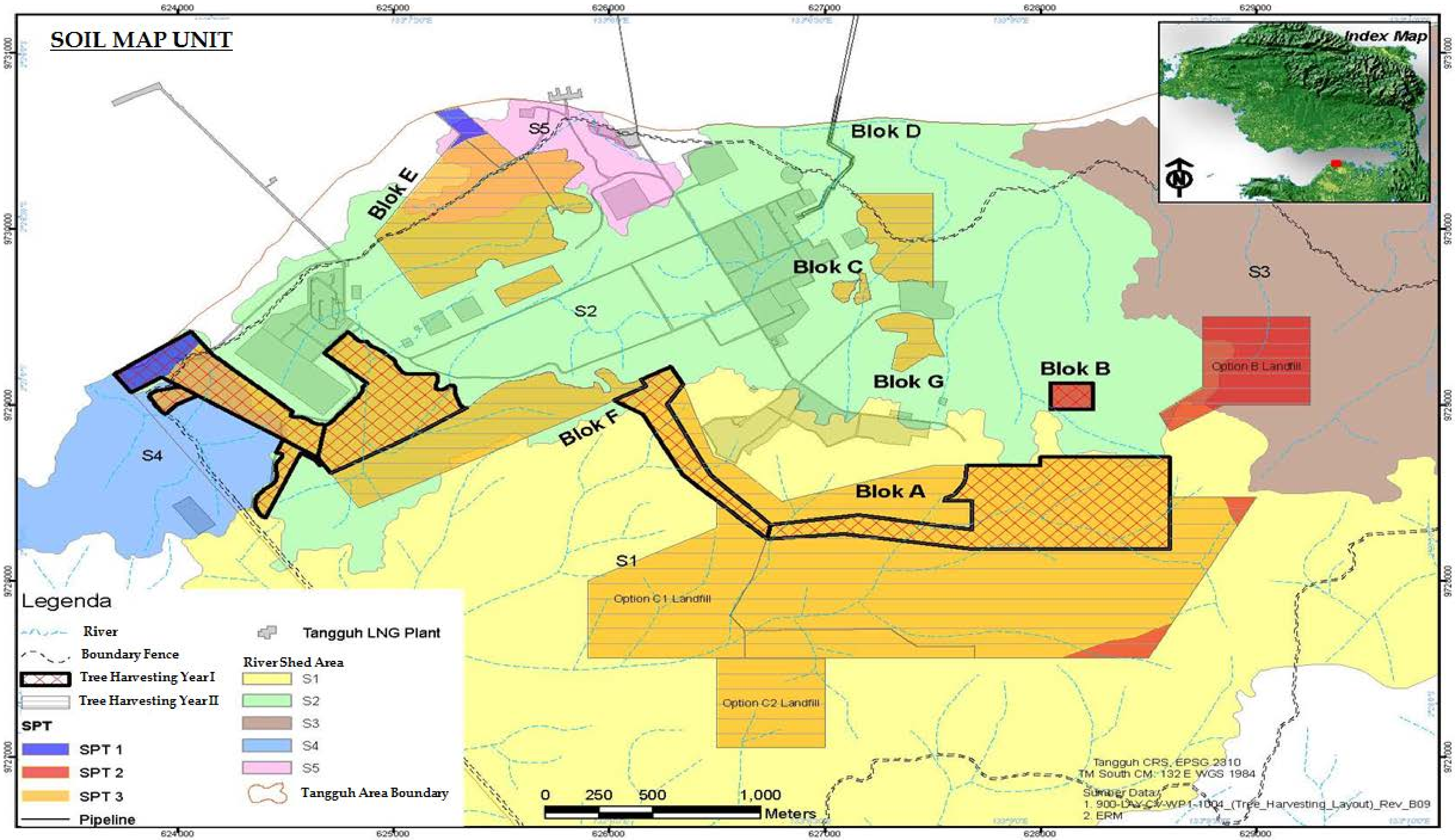


Figure III-50 Location of Soil Map Units (SPT), Land Clearing Plan, and Creeks Watershed

Table III-88 Soil Particles Rate due to Erosion Transported in the First Year

Soil Map Unit	Bare Land until Three Months			Land Covered by Cover Crops in Time Period until Construction		
	Erosion Rate (ton/ha/month)	Area Cleared (ha)	Total Soil particles Transported (ton/month)	Rate of Erosion (ton/ha/month)	Area Cleared (ha)	Total Soil Particles Transported (ton/month)
SPT 1	12.5	6.18	77.2	0.05	6.18	0.3
SPT 2	43.9	4.50	197.5	0.16	4.50	0.7
SPT3	32.7	116.57	3,811.9	0.12	116.57	14.0
Total			**4,087**			**15**

Table III-89 Soil Particles Rate due to Erosion Transported in the Second Year

Soil Map Unit	Bare Land until Three Months			Land Covered by Cover Crops in Time Period until Construction		
	Erosion Rate (ton/ha/month)	Area Cleared (ha)	Total Soil particles Transported (ton/month)	Rate of Erosion (ton/ha/month)	Area Cleared (ha)	Total Soil particles Transported (ton/month)
Landfill Option C1						
SPT 1	12.5	1.30	16.2	0.05	1.30	0.06
SPT 2	43.9	4.30	188.8	0.16	4.30	0.7
SPT3	32.7	325.52	10,644.5	0.12	325.52	39.1
Total			**10,850**			**40**
Landfill Option C2						
SPT 1	12.5	1.30	16.2	0.05	1.30	0.06
SPT 2	43.9	4.30	188.8	0.16	4.30	0.7
SPT3	32.7	303.51	9,924.8	0.12	303.51	36.4
Total			**10,130**			**37**

Table III-90 **Estimated Amount of Soil Transported to Each Sub-Watershed at the Project site in the First, Second, and Following Years**

Soil Map Unit	Land Cover	Sub - Watershed at the Project site												Total
		S1			S2			S4			S5			
		Area (Ha)	Ton/Ha/ Month	Ton/ Month	Area (Ha)	Ton/Ha/ Month	Ton/ Month	Area (Ha)	Ton/Ha/ Month	Ton/ Month	Area (Ha)	Ton/Ha/ Month	Ton/ Month	
First Year														
SPT-1	Bare Land, for Three Months	0	12.5	0	6.18	12.5	77.2	0	12.5	0	0	12.5	0	
	Land Covered by *Cover Crops*, furthermore	0	0.05	0	6.18	0.05	0.3	0	0.05	0	0	0.05	0	
SPT-2	Bare Land, for Three Months	0	43.9	0	4.50	43.9	197.5	0	43.9	0	0	43.9	0	
	Land Covered by *Cover Crops*,	0	0.16	0	4.50	0.16	0.7	0	0.16	0	0	0.16		
SPT-3	Bare Land, for Three Months	66.33	32.7	2,169.0	39.03	32.7	1,276.3	11.21	32.7	366.6	0	32.7	0	
	Land Covered by *Cover Crops*, furthermore	66.33	0.12	8.0	39.03	0.12	4.7	11.21	0.12	1.3	0	0.12	0	
Soil Particles Transported in the First Three Months				**2,169**			**1,551**			**367**			**0**	**4,087**
Soil Particles Transported in the following Months				**8**			**6**			**1**			**0**	**15**
Second Year (Calculated using Option C1, with Maximum Transported Particles)														
SPT-1	Bare Land, for Three Months	0	12.5	0	0	12.5	0	0	12.5	0	1.30	12.5	16.2	
	Land Covered by *Cover Crops*, Furthermore	0	0.05	0	0	0.05	0	0	0.05	0	1.30	0.05	0.06	
SPT-2	Bare Land, for Three Months	4.30	43.9	188.8	0	43.9	0	0	43.9	0	0	43.9	0	
	Land Covered by *Cover Crops*, Furthermore	4.30	0.16	0.7	0	0.16	0	0	0.16	0	0	0.16	0	
SPT-3	Bare Land, for Three Months	216.40	32.7	7,076.3	88.19	32.7	2,883.8	0	32.7	0	20.93	32.7	684.4	
	Land Covered by *Cover Crops*, Furthermore	216.40	0.12	26.0	88.19	0.12	10.6	0	0.12	0	20.93	0.12	2.5	
Soil particles Transported in the First Three Months				**7,265**			**2,884**			**0**			**701**	**10,850**
Soil particles Transported in the Following Months				**27**			**11**			**0**			**2**	**40**
Third Year and Furthermore														
SPT-1	Land Covered by *Cover Crops*, Furthermore	0	0.05	0	6.18	0.05	0.3	0	0.05	0	1.30	0.05	0.06	
SPT-2	Land Covered by *Cover Crops*, Furthermore	0	0.16	0	4.50	0.16	0.7	0	0.16	0	0	0.16	0	
SPT-3	Land Covered by *Cover Crops*, Furthermore	282.73	0.12	33.9	127.22	0.12	15.3	11.21	0.12	1.3	20.93	0.12	2.5	
Soil Particles Transported				**34**			**17**			**1**			**3**	**55**

In the third year and following, after cleared land is covered with cover crops, total soil particles transported will be 55 tons/month that will be distributed to creek flow in the project site area with total soil particles entering creek S1 of 34 tons/month, S2 of 17 tons/month, S4 of 1 ton/month and S5 of 3 tons/month.

Impact Evaluation

Estimated potential erosion as found in **Table III-76** indicates that erosion cause a negative impact, namely loss of surface soil layer at very heavy level (SB) to very low (SR) according to soil map unit (SPT) and type of land cover.

Potential soil erosion upon commencement of land clearingas a bare land will be very heavy (SB) to heavy (B), that is predicted to take place for about three months, then with efforts of cover crops planting on the cleared lands, erosion will decrease to be very low (SR) in all SPTs until to be ready for the construction phase. Based on this, soil erosion is local that only occured on cleared lands and in a short period of time. Soil particles from erosion will enter creeks S1, S2, S4 and S5 as sediment load that can raise the total suspended solids (TSS) content both in creeks and water bodies as the final recipient of sediment load unless erosion in the creeks are properly controlled. Creek S1 that flows to the Saengga River will receive the highest sediment load compared with other creeks (53% in the first year and 67% in the second year) of the total soil particles transported due to erosion in the first three months of land clearing compared with other creeks. All soil particles due to erosion, unless erosion control is applied through drainage management and sediment traps, will be carried to the waters of Bintuni Bay. Therefore the dispersion of derivative impact from soil erosion is local.

Sensitivity of direct receptors of soil erosion. i.e. the creeks in the project site, since the creeks are ephemeral that are sensitive to incoming sediment, so that receptor sensitivity is categorized as 'medium'.

With good management of soil particles from erosion (sediment), the influence of increased soil erosion toward quality of Saengga River waters and Bintuni Bay waters is relatively small, since water bodies have much greater flow than the creeks with relatively high TSS content at present.

Table III-91 Increase in Soil Erosion due to Land Clearing Activities in the proposed Tangguh LNG Expansion Area

Impact Description	*Increased erosion may occur due to higher surface runoff that can erode soil surface layers through which water passes. This is the consequence of the following activities:* • *Additional land clearing, with estimated increase of soil erosion of maximum around 500 ha;* • *Cut and fill with total volume of around 6 million m³ for the Tangguh LNG Expansion; and* • *Site Preparation.*				
Impact Nature	**Negative**	**Positive**			
	Increased erosion (eroding of soil surface layers) is a negative impact that can occur from land clearing activities, cut and fill, and site preparation				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**

<table>
<tr><td></td><td colspan="5">Increased erosion (erosion of soil surface) is a 'derivative impact' of higher surface runoff caused by land clearing activities, cut and fill, and site preparation.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short-term</td><td>Long-term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">The entire construction phase will take place for approximately 4 years, however, land clearing will be conducted for three months on land without vegetation cover, and afterwards planting cover crops that will proceed until the site is ready for construction.

Besides replanting efforts with cover crops for land cleared but not directly used, a drainage system will be made simultaneously in disturbed areas and others. The impact will only be during land clearing, cut and fill and site preparation in the construction phase, so that the duration of impact is categorized as 'short-term'.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Increased erosion will occur in the Tangguh LNG area to be cleared and in creeks found in the Tangguh LNG area (particularly S1, S2, S4 and S5) and unless the impact is properly managed it will affect the quality of the Saengga and Bintuni Bay waters around the Tangguh LNG , so that the dispersion of extent is 'local'.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Potential soil erosion is predicted using the USLE formula for each soil map unit (SPT) found in the location planned to be cleared for the Tangguh LNG Expansion. Land area to be cleared for the Tangguh LNG Expansion is maximum 500 ha composed of 9 ha in SPT 1, 32 ha in SPT 2 and 459 ha in SPT 3. Results of prediction indicate potential erosion at the start of land clearing (first three months) with condition of bare land in SPT 1, SPT 2 and SPT 3 respectively of 12.5 tons/ha/ month, 43.9 tons/ha/month and 32.7 tons/ha/month. In terms of erosion hazard level for SPT 1 in the first three months it is medium (S), however for SPT 2 in category of very heavy (SB) and SPT 3 in category of heavy (B).

As time progresses in the following month, planting will be done on cleared land with cover crops so that erosion potential decreases in all SPT and erosion hazard level is very low (SR) i.e. for SPT 1 it will become 0.05 tons/ha/month; for SPT 2 will be 0.16 tons/ha/month; and for SPT 3 will be 0.12 tons/ha/month.

Based on area of land to be cleared in the first year measuring 127.25 ha and from calculation results, in the first year in which land is completely cleared of vegetation for three months, the rate of soil particle transport is 4.087 tons/month and in the following months after the land is covered by cover crops, rate of soil particles from erosion, which are transported becomes 15 tons/month. In the second year, if landfill Option C1 is selected, total land area to be cleared is 331.12 ha, rate of soil particles transported will be 10.850 tons/month (maximum transported soil particles) when the land is completely cleared for three months and becomes 40 tons/month in the following months after the land is covered by cover crops. The rate of soil particles transported after land clearing in the first and second years are completed and after all lands are completely covered by cover crops will be 55 tons/month that will proceed in the following years.

Product of soil erosion will enter creeks S1, S2, S4 and S5. Of the total soil particles transported in the first year; in the first three months after land clearing, of a total 4.087 tons/month, the majority or 2.169 tons/month will enter creek S1 (total 53%) and flow to Saengga River and eventually into the Bintuni Bay. A total of 1.551 tons/month or around 38% will enter creek watershed S2 and a further 367tons/month or 9% will enter creek watershed S5. Total soil particles transported in the following months will be 15 tons/month, far lower compared with the first three months when the land was without vegetation.

In the second year, similar to the first year, of total soil particles transported in the first three months of land clearing of 10.850 ton/month, 7.265 tons/month or around 67% will enter creek watershed S1. Some 2.884 tons/month or around 27% will enter creek watershed S2 and the remaining 701 tons/month or 6% will enter creek watershed S5. Total soil transported in the following months of the second year after land cleared is planted with cover crops will be 40 tons/month, far lower than during the first three months when the land was without vegetation, which will be distributed to three creeks, i.e. S1 (27 tons/month), S2 (11 tons/month) and S5 (2 tons/month).</td></tr>
</table>

	In the third year and further after land cleared is covered by cover crops , total soil particles transported will be 55 tons/month, distributed to creek flow in the project site with total soil particles entering creek S1 of 34 tons/month , S2 of 17 tons /month, S4 of 1 ton/month and S5 of 3 tons/month. *Based on the nature of change that can be caused by erosion potential, intensity of impact, local Impact extent , and short-term duration of impact ; the impact magnitude may be concluded to be 'medium'.* *A total of 5.982 tons/month or 35% will enter creek S2 that flows north and enters the waters of the Bintuni Bay, the remaining 1.691 tons/month or 10% will enter creek watershed `S4 and S5 that flow north and enter Bintuni Bay waters. Total soil particles transported in the following months, i.e. 62 ton/month, far lower compared with the first three months when the land was without vegetation.* *Based on the nature of change that can be caused by potential erosion, intensity of impact, local Impact extent, and short-term duration of impact; the impact magnitude may be concluded as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Direct receptors of soil erosion are creeks in the project site within Tangguh LNG property borders, since creek s are ephemeral *that are sensitive to incoming sediment, so that the receptor of impact is in 'medium' category. The waters of the Saengga River as the estuary of S1 and Bintuni Bay waters as estuary of S2, S4 and S5 already have relatively high TSS content, thus the influence of higher TSS in the water bodies is not too significant if increased erosion is managed properly.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	
	Impact severity is categorized as 'high' since the impact magnitude is 'medium' and receptor sensitivity is 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Likelihood of increased soil erosion is high, due to relatively high number of rain days throughout the year.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact severity and impact likelihood are both categorized as 'high', so that impact significance is 'major' and significant impact.				

3.3.1.8 Surface Water Quality

a. Increase inTotal Suspended Solids (TSS)

- **Environmental Baseline**

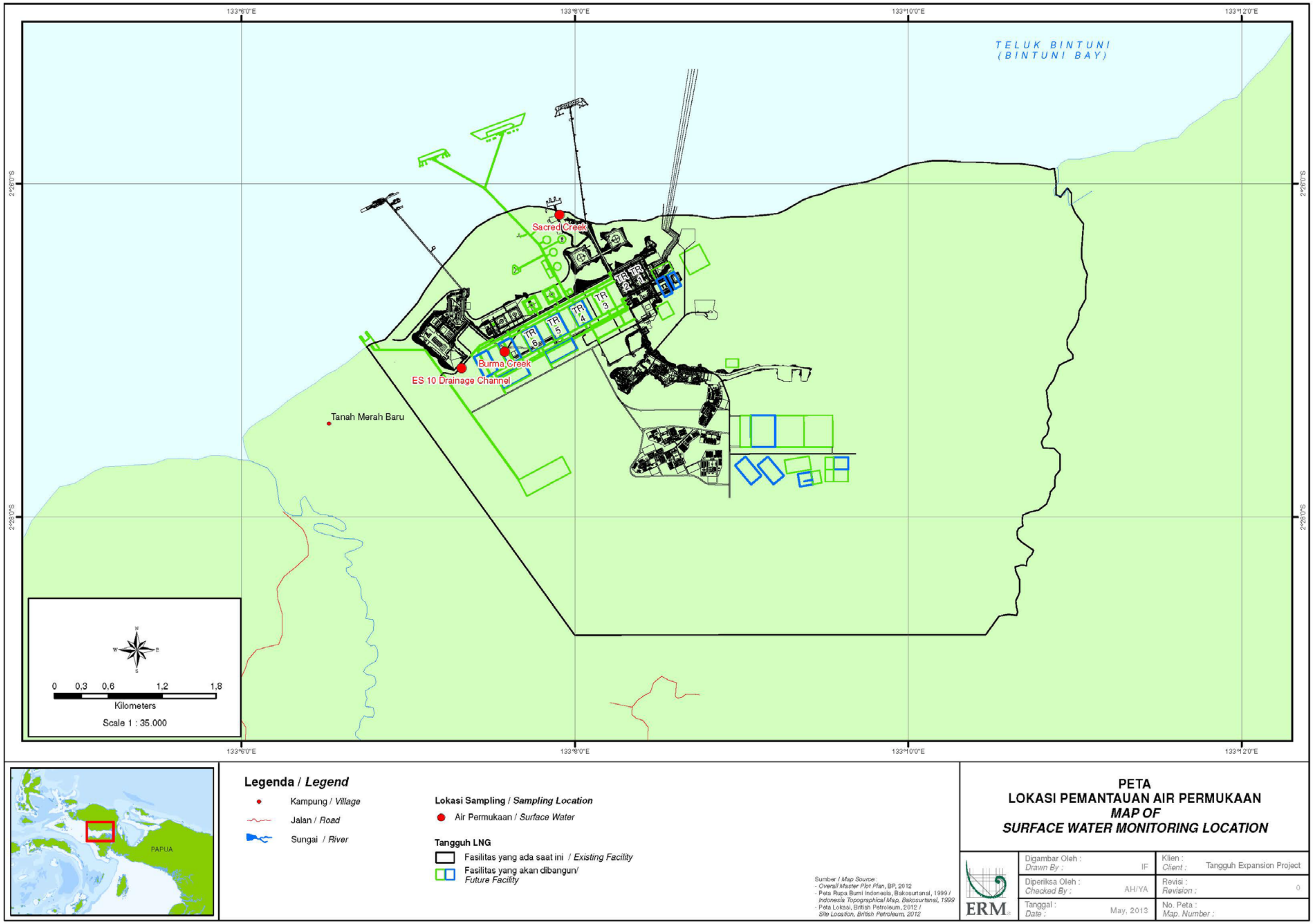
During Tangguh LNG operation, surface water quality sampling was conducted in three locations in the Tangguh LNG area, identified as natural small rivers (**Map III-1**). The surface water quality monitoring was performed in the period from October-December 2010 and January-September 2011.

Water quality monitoring of natural small rivers was able to illustrate the environmental baseline condition in the current operation site of the Tangguh LNG. Results of monitoring indicated that total suspended solids (TSS) content in the Tangguh LNG area that was cleared in the period October – December 2010 ranged between 2 – 103 mg/L and period from January – September 2011 between 2 – 75 mg/L as shown in **Table III-83** At specific times, TSS content, mainly after rainfall exceeded Class II water quality standard in accordance with Government Regulation No 82 Year 2011 that stipulates the acceptable limit of TSS at 50 mg/L.

Table III-83 Results of Water Quality Monitoring

Parameter	Unit	GoI Regulation No. 82/2001 Class II	2010		2011	
			Min	Max	Min	Max
pH	-	6 - 9	6,58	7,87	6,51	8,88
Dissolved Residue, TDS	mg/L	1000	206	1.048	106	1.066
Total Suspended Solids, TSS	mg/L	50	2	103	2	75

Results of TSS monitoring in Saengga River, in sampling location SW-1 in the dry season 2012 (months of July - August) and wet season year 2013 (months of March - April) indicated TSS contents of respectively 51 mg/L and 129 mg/L. The sufficiently high TSS content in the wet season indicated the amount of sediment material carried by rainwater runoff to water bodies through tributaries of the Saengga River. Quality Standard for TSS was 50 mg/L based on GoI Regulation No. 82 Year 2001 for water quality Class II.



Map III-1 Monitoring Locations of Creek Water Quality and Drainage Channels in the Tangguh LNG area

TSS content in nearshore waters were periodically monitored once a week by the Tangguh LNG at intake water for desalination water that is at location of Jetty 1. Results of monitoring during 2011 (47 monitoring data) are shown in **Figure III-51**. Based on results of monitoring, in the dry season TSS content ranged between 32 mg/L to 267 mg/L with average value of 102 mg/L, while in the wet season ranged between 28 mg/L to 369 mg/L with average value 139 mg/L. From 47 monitoring data of TSS, a total of 27 data or 57% monitoring results of TSS exceeded quality standard for mangrove, i.e. the quality standard requirements of TSS parameter is ≤ 80 mg/L. This indicated that concentrations of TSS were naturally quite high at nearshore.

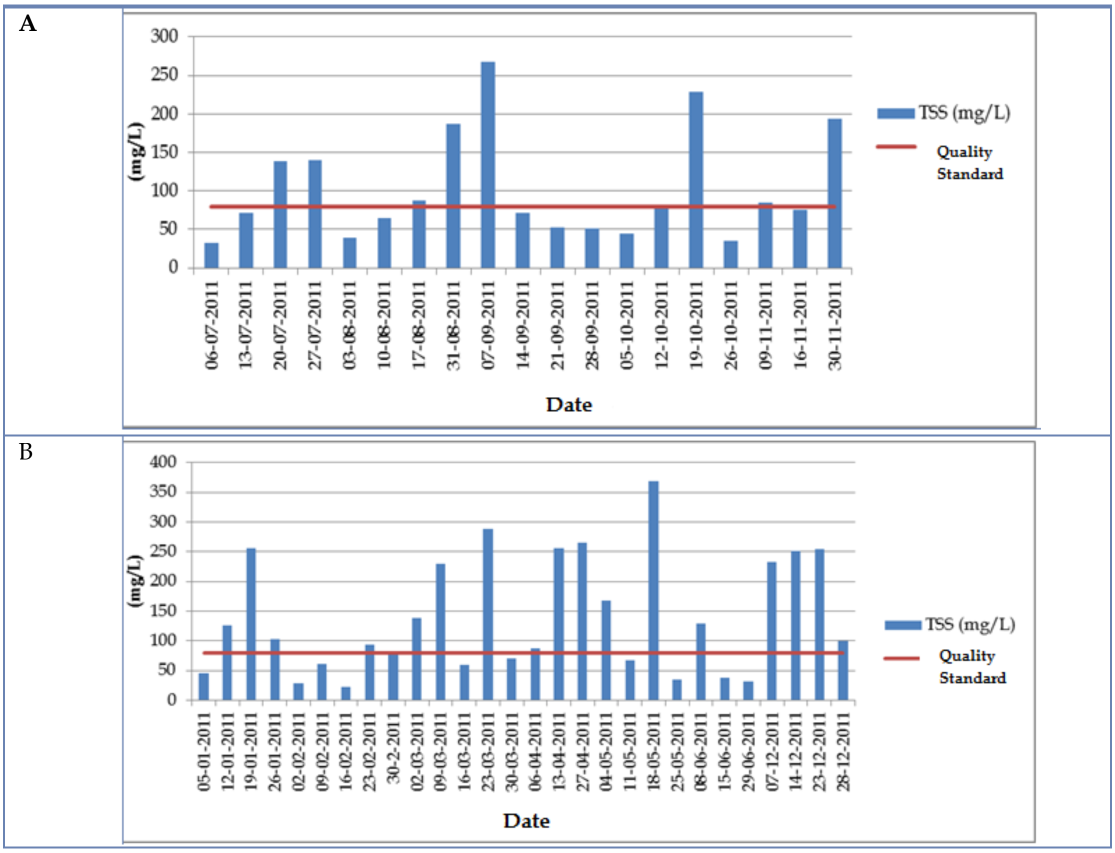


Figure III-51 Graph of TSS Concentration at Intake Water, Jetty 1 during 2011. (A) Dry season, (B) Wet season

- **Impact Prediction**

  Increase of TSS content in creeks at the Tangguh LNG project site and nearshore waters around the Tangguh LNG was a derivative impact of increase in soil erosion. Increase in soil erosion was due to increase in surface water runoff caused by land clearing, cut and fill and site preparation activities.

The amount of potential soil erosion was estimated using the USLE (Universal Soil Loss Equation) as described in detail in Sub-chapter 3.3.1.7. As described in the Hydrology section (Sub-chapter 3.3.1.5), several large and small ephemeral creeks cross the Tangguh LNG area. Ephemeral creeks in the Tangguh LNG area consist of S1, S2, S3, S4 and S5. Creek S1 flows to the west heading to the Saengga River, while creeks S2, S3, S4 and S5 flow north to the shores of Bintuni Bay waters.

In accordance with the proposed land clearing locations in each soil map unit (SPT) and creek watershed locations as shown in **Figure III-34** (Sub-chapter 3.3.1.7, Increased Soil erosion)**;** soil particles caused by erosion will enter creeks S1, S2, S4 and S5 through surface runoff. Based on the Einstein-Brown formula (Vanoni, 1975) soil particles that will become "floating sediments" are particles with size of <60 μ. Results of texture fraction analysis for each SPT with size of <60 μ are shown in **Table III-84** (see complete texture fraction analysis in **Table II-16**, Sub-chapter 2.1.6.2)**.** Therefore based on results of the calculation, transported particles of predicted erosion to be "floating sediments" and enter each creek in the first year, second year, and following years are shown in **Table III-85.**

Table III-84 Percentage of Soil Texture Fractions <60 μ for Soil Map Unit (SPT) in the Tangguh LNG area

Sampling Location		Texture Fraction (%)						Total (%)
		Sand Fraction	Silt Fraction			Clay Fraction		
		50-100 μ	20-50 μ	10-20 μ	2-10 μ	0,05-2 μ	<0,05 μ	
SPT-1	F-9	19.8	19.1	3.8	2.1	18.2	4.8	67.8
SPT-2	F-1	25.4	24.2	13.5	4.3	12.2	3.8	83.4
	F-2	13.7	32.2	20	0.8	14.8	6.2	87.7
	F-8	28.1	29.9	17.9	2.2	0.8	0.2	79.1
SPT-3	F-3	16.2	15.7	8.1	3.2	2.9	1.1	47.2
	F-4	14.9	30.5	19.8	1.7	3.2	1.8	71.9
	F-5	21.8	37.8	12.5	3.7	11.2	5.8	92.8
	F-6	31.2	22.4	7.2	2.4	6.7	2.3	72.2
	F-7	6.2	29.8	15.1	4.1	32.8	7.2	95.2
	F-10	14.9	39.4	23.2	9.4	4.1	1.9	92.9
	F-13	5.6	6.8	3.2	2.0	8.2	3.8	29.6
	F-11	16.7	17.8	6.6	1.6	2.1	1.9	46.7
	F-12	8.7	26.3	18.7	4.0	3.8	2.2	63.7
Average of all SPT								**71.5**

Table III-92 Quantity of Soil Particles from Erosion Transported to Each Creek in the Tangguh LNG Area that was Corrected to Percentage Size of Soil Particles <60 μ (71.5%) to be Floating Sediment

Floating Sediment in Period	Creek				Total
	S1	S2	S4	S5	
First Year					
Cleared Land, during Three Months (ton/month)	1551	1,109	262	0	2,922
Land Covered by *Cover Crops*, Following Months (ton/month)	6	4	1	0	11
Second Year (Landfill Option C1, with Maximum Transported Particles)					
Cleared Land, during Three Months (ton/month)	5,194	2,062	0	501	7,757
Land Covered by *Cover Crops*, Following Months (ton/month)	19	8	0	1	28
Third Year and So Forth					
Land Covered by *Cover Crops*, Following Months (ton/month)	24	12	1	2	39

Year One

In the first year, total floating sediments that will enter creeks in the first three months with condition of bare land is 2,922 tons/month; of this quantity 1,109 tons/month can enter creek S1, which unless drainage regulation and sediment trap are made, thus all floating sediments will enter Saengga River through S1 and ultimately become part of Bintuni Bay waters. In the following months, after the land is covered by cover crops, the amount of floating sediments able to enter creek S1 is 6 tons/month.

A total of 1,109 tons/month floating sediment in the first three months (also unless there is drainage regulation and sediment trap) will enter creek S2 that flows north and into Bintuni Bay waters. In the following months after the land is covered by cover crops, the amount of floating sediment able to enter creek S2 is 4 tons/month. Further, 262 tons/month floating sediment able to enter creek S4 in the first three months and in the following months after the land is covered with cover crops will become respectively 1 ton/month.

Year Two

In the second year, as in the first year, total soil particles transported in the initial three months of land clearing with condition of bare land of 7,757 tons/month will enter creek s found in the project site, of the above amount 5,194 tons/month will enter creek S1. In the following months after land is covered with cover crops, total floating sediments that will enter creek S1 will be 19 tons/month.

A total of 2,062 tons/month floating sediment will enter creek watershed S2 in the initial three months and become 8 tons/month in the following months after land is covered by cover crops. Further, 501 tons/month will enter creek S5 in the initial three months and become 1 ton/month in the following months.

Year Three and Furthermore

In the third year and so forth when land cleared is covered with cover crops, total transported sediments will be distributed to creek flow in the project site with total floating sediment that will enter creek S1 of 24 tons/month, S2 of 12 tons/month, S4 of 1 ton/month and S5 of 2 tons/month.

Based on the quantity of floating sediment able to enter each creek (**Table III-85**) and peak discharge for each creek (see Sub-chapter 3.3.1.5 Hydrology) TSS increment in each creek may be calculated, in the first and second years for the first three months in condition of bare land without vegetation and the following months after the land is covered by cover crops, with the Einstein-Brown formula (Vanoni, 1975) relating the number of floating sediment and discharge as follows:

$$\frac{T}{Q} \alpha\, \rho g v I$$

In which:

T = total transported sediment, ton/second

Q = discharge, m^3/second

ρ = water density, kg/m^3

g = gravitational acceleration, m/sec^2

v = flow velocity, m/sec

I = energy gradient

Assuming that:

Floating sediment < 0.06 mm (60μ), $\rho g v I$ = 1 to 1.25

In calculating predicted TSS increment assume $\rho g v I$ = 1.25. Results of calculation of TSS increment predictiong in each creek in the Tangguh LNG area are shown in **Table III-86**.

Table III-93 TSS Content Increment in Creeks in the Tangguh LNG area Corrected Toward Value of $\rho g v I$ = 1.25

Creek	Parameter	Unit	Cleared Land, for Three Months	Land Covered by Cover Crops, Following Months
First Year				
S1	Total Soil Transported	ton/second	6.0×10^{-4}	2.3×10^{-6}
	Peak Discharge	m^3/second	7.56	7.56
	TSS Increment	mg/L	**98.9**	**0.4**
S2	Total Soil Transported	ton/second	4.3×10^{-4}	1.5×10^{-6}
	Peak Discharge	m^3/second	3.77	3.77
	TSS Increment	mg/L	**141.9**	**0.5**

Creek	Parameter	Unit	Cleared Land, for Three Months	Land Covered by Cover Crops, Following Months
S4	Total Soil Transported	ton/second	$1.0x10^{-4}$	$3.8x10^{-7}$
	Peak Discharge	m^3/second	0.80	0.80
	TSS Increment	mg/L	**157.9**	**0.6**
S5	Total Soil Transported	ton/second	0	0
	Peak Discharge	m^3/second	1.20	1.20
	TSS Increment	mg/L	**0**	**0**
Second Year				
S1	Total Soil Transported	ton/second	$2.0x10^{-3}$	$7.3x10^{-6}$
	Peak Discharge	m^3/second	7.56	7.56
	TSS Increment	mg/L	**331.3**	**1.2**
S2	Total Soil Transported	ton/second	$8.0x10^{-4}$	$3.1x10^{-6}$
	Peak Discharge	m^3/second	3.77	3.77
	TSS Increment	mg/L	**263.8**	**1.0**
S4	Total Soil Transported	ton/second	0	0
	Peak Discharge	m^3/second	0.80	0.80
	TSS Increment	mg/L	**0**	**0**
S5	Total Soil Transported	ton/second	$1.9x10^{-4}$	$3.8x10^{-7}$
	Peak Discharge	m^3/second	1.20	1.20
	TSS Increment	mg/L	**201.3**	**0.4**
Third Year and Furthermore				
S1	Total Soil Transported	ton/second	0	$9.2x10^{-6}$
	Peak Discharge	m^3/second	7.56	7.56
	TSS Increment	mg/L	0	**1.5**
S2	Total Soil Transported	ton/second	0	$4.6x10^{-6}$
	Peak Discharge	m^3/second	3.77	3.77
	TSS Increment	mg/L	0	**1.5**
S4	Total Soil Transported	ton/second	0	$3.8x10^{-7}$
	Peak Discharge	m^3/second	0.80	0.80
	TSS Increment	mg/L	0	**0.6**
S5	Total Soil Transported	ton/second	0	$7.7x10^{-7}$
	Peak Discharge	m^3/second	1.20	1.20
	TSS Increment	mg/L	0	**0.8**

Note : Land clearing for the second year will take into consideration the area to be cleared for Landfill option C1 and C2

TSS Increment of Creeks in the First Year

The data in **Table III-86** indicate TSS content increment in creek S1, unless drainage is regulated and sediment trap built, it can reach 99 mg/L when it is a bare land without vegetation cover that takes place for three months and decreases to be 0.4 mg/L in the following months after cleared land is covered by cover crops.

While for creek S2, increment of TSS at the time of land clearing, in the first three months is 142 mg/L and becomes 0.5/L in the following months. For creek S4, TSS content increment in the first three months is 158 mg/L and decreases respectively to be 0.6 mg/L in the following months. Creek S5 is not affected by land clearing in the first year.

TSS Increment of Creeks in Second Year

In the second year, TSS increment in creek S1, unless drainage arrangement and sediment trap are made, can reach 331 mg/L at the time land is bare without vegetation cover, which this condition will take place for three months, and will decrease to be 1.2 mg/L in the following months after cleared land is covered with cover crops.

As for S2, TSS increment at the time of land clearing, in the first three months is 264 mg/L and becomes 1.0 mg/L in the following months. For creek S5, increment of TSS content in the first three months is 201 mg/L and decreases to respectively 0.4 mg/L in the following months. Creek S4 is not affected by land clearing in the second year.

TSS Increment of Creek s in Third Year and Furthermore

In the third year and subsequently after land that has ben cleared covered by cover crops, TSS content increment in creeks found in the project site, for S1 is 1.5 mg/L, S2 is 1.5 mg/L, S4 is 0.6 mg/L and S5 is 0.8 mg/L.

Environmental baseline of TSS in several creeks found in the Tangguh LNG area indicated TSS content ranged between 2 – 103 mg/L, and after raindays TSS was high. The increment of TSS will have an actual effect on creeks in the Tangguh LNG area, as it will cause creek sedimentation, particularly in the first three months of land clearing. Thus, control efforts are required for TSS to meet applicable surface water quality standards and to prevent creek sedimentation.

Creek S1 flows to the Saengga River. Environmental baseline data indicated that TSS content in the river was sufficiently high reaching 129 mg/L, apart from that the large discharge of the Saengga River and influenced by sea tides, meant that TSS input from creek S1 will not have a sufficiently large influence on the Saengga River.

Creeks S2, S4 and S5 flow directly to waters of Bintuni Bay in the Tangguh LNG area. Environmental baseline data of TSS in waters of Bintuni Bay in the Tangguh LNG area indicated that TSS content was sufficiently high, ranging between 32 mg/L to 267 mg/L with average value of 102 mg/L, while in the wet season the values ranged between 28 mg/L to 369 mg/L with average value of 139 mg/L. Thus TSS input from creeks S2, S4 and S5 will not have a sufficiently large influence on the waters of Bintuni Bay around the Tangguh LNG area.

Creek S5 (Nenek Mae, sacred creek) is considered sacred by the local indigenous community (Tanah Merah Baru and Saengga communities) ; so that the impact , from change in morphology and increase in TSS content due to land clearing towards the creek will be significant.

- **Impact Evaluation**

Predicted TSS increment in each existing creek in the Tangguh LNG area, due to soil erosion, as shown in **Table III-69,** indicated that increase in TSS cause negative impact mainly on creeks in the Tangguh LNG area.

TSS increment in creeks S1, S2, S4 and S5 when land clearing commenced is estimated to continue for approximately three months respectively during land clearing in the first and second years, after which with planting of cover crops, TSS increment will decrease in line with decreasing soil erosion rate in the following months after the land cleared is covered by cover crops.

In terms of intensity of impact, TSS increment in creeks S1, S2, S4 and S5 in the first three months after land clearing in the first year ranges between 99 - 158 mg/L and in the second year is quite high between 201-331 mg/L, however in the following year will decrease in the range of 0.4 – 1.5 mg/L, which is very low, according to decreasing soil erosion rate after the cleared land is covered by cover crops.

TSS content increment is local and only occur in creeks S1, S2, S4 and S5 in short term period. TSS increment in creeks is quite actual, but insignificant toward the final waters receiving suspended solids inputs namely the Saengga River and the marine waters of Bintuni Bay that already have sufficiently high TSS content.

Receptor sensitivity of direct TSS increment are creeks in the project site, since the creeks are ephemeral creeks that are sensitive to sediment entry, thus in terms of sensitivity are high mainly toward creek S5 held that is sacred by the local communities. However, the Saengga River and the marine waters of Bintuni Bay as final recipient of sediment input are not sensitive since the waters already have sufficiently high TSS content, so that receptor sensitivity is 'low'.

Table III-94 Impact Evaluation of Increase in Total Suspended Solids (TSS) Content Due to Soil Erosion

Impact Description	*Increase in total suspended solids (TSS) content as a result of increase in soil erosion is due to higher surface runoff that can erode the surface layer of soil. This is the result of the following activities:* • *Additional land clearing, which the estimated increase in soil erosion with further consequence of higher TSS content is maximum around 500 ha;*
	• *Cut and fill with total volume of around 6 million m³ for the Tangguh LNG Expansion Project; and* • *Site preparation.*

Impact Nature	**Negative**	**Positive**			
	Increase in TSS content is a negative impact that can occur due to increase in soil erosion by land clearing, cut and fill, and site preparation activities				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Increase inTSS content is a derivative impact (tertiary) of increase in soil erosion. Soil erosion is a derivative impact (secondary) of increase in surface water runoff that is a primary impact (direct impact) due to land clearing activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The entire construction phase will take place for approximately 4 years, however land clearing activities will take place for three months with the land without vegetation, and afterwards cover crops will be planted that will continue until construction in the area. *Apart from revegetation efforts with cover crops for cleared land but not directly utilized yet, a drainage system will simultaneously be built in the disturbed area. For this reason, increase in TSS content will only occur at the start of land clearing, cut and fill and site preparation activities in the construction phase , thus the impact is in category of 'Short Term'*				
Impact Extent	**Local**	**Regional**	**Global**		
	Increase in TSS content initially occurs in creeks S1, S2, S4 and S5 found in the Tangguh LNG area and unless the impact is managed properly will have an effect on the quality of Saengga and Bintuni Bay waters around the Tangguh LNG, so that it is categorized as 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Calculation result of predicted TSS content increment, indicates increment of TSS in creeks S1, S2, S4 and S5 in the first three months after land clearing, unless management of drainage and sediment trap *are made, ranging between 99 - 331 mg/L which is quite high. The TSS control efforts will be immediately done through drainage channel control and construction of* sediment trap *so that TSS content will decrease. After the first three months, cover crops will be immediately planted as land cover so that based on calculation of TSS increment will decrease in the range of 0.4 – 1.5 mg/L, which is very low.* *TSS content increment is local in nature, only occurring in creeks S1, S2, S4 and S5 in a short term period. Creek S1 flows to Saengga River, while creeks S2, S4 and S5 flow directly to the marine waters of Bintuni Bay in the Tangguh LNG area. TSS increment in the creeks is quite actual since the creeks are ephemeral in nature, and vulnerable to sedimentation. However, the impact is insignificant on Saengga River and seawaters of Bintuni Bay as the final waters of suspended solids receptors as already has quite high TSS content (Saengga River can reach 129 mg/L and Bintuni Bay waters range between 28 mg/L – 369 mg/L).* *Creek S5 (Kali Nenek Mae,* sacred creek*) is considered sacred by the indigenous local people (communities of Tanah Merah Baru and Saengga) ; so that the impact of morphological change as well as increase in TSS content due to land clearing, toward this creek is significant.* *Based on the nature of change that can be caused by TSS increment from the baseline condition, intensity of impact, local impact extent and short term duration of impact; the impact magnitude is concluded as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Receptors of TSS content increment are creeks in the project site within the boundary of Tangguh LNG property, since the ephemeral creeks are sensitive to sediment input, and creek S5 (Kali Nenek Mae, Sacred Creek*) is considered sacred by the local people thus receptor sensitivity is categorized as "high"*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact severity is categorized as 'high' since impact magnitude is 'medium' and receptor sensitivity is 'high'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Likelihood of TSS increment is high, due to number of rain days is relatively high throughout the year that can cause soil erosion as a source of "floating sediment" that also happening throughout the year.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*Impact severity and impact likelihood are both categorized as 'high', therefore the impact significance is categorized as 'major' and significant impact.*

3.3.1.9 Seawater Quality

a. Increase in Salinity Figure

- **Environmental Baseline**

  Salinity around the location of LNG 1 jetty (current wastewater outfall location) was 28.5 ‰ in the dry season and 25.5 ‰ in the wet season, based on the environmental baseline survey conducted for the AMDAL study in the months of July - August 2012 (dry season) and March - April 2013 (wet season). Salinity quality standard for mangrove area was 34 ‰ based on the MoE Regulation No. 51 Year 2004 for marine biota.

  Apart from the regulation, the Tangguh LNG also adhered to provisions of Wastewater Discharge Permit for the Tangguh LNG based on the MoE Decree No 125 Year 2013, which the salinity quality standard was 5% variation of environmental baseline at distance of 30 m from natural salinity content. From the results of monitoring performed every month during July 2012 – June 2013, salinity ranged between 24 – 30.5 ‰ at distance of 30 m from outfall and 23.4 – 30.5 ‰ in the location of the exclusion zone representing natural salinity content, so that the variation ranged between 0 – 3.4 %.

- **Impact Prediction**

  The operation activities of the Tangguh LNG produce five types of waste:

  1. Produced water;
  2. Oil-contaminated wastewater;
  - Chemicals- contaminated wastewater;
  3. Brine water reject; and
  4. Domestic wastewater.

  Volumes of each type of wastewater are shown in **Table III-71**. Each wastewater type will be managed and monitored prior to be comingled in a discharge pipeline and to be discharged through the same outfall in LNG 1 jetty or LNG 2 jetty.

Table III-95 **Estimated Volume of Wastewater based on Operating Scheme of Four LNG Trains**

Type of Wastewater	Treatment Unit	Volume (m^3/day)
Produced water	Produced Water Treatment Unit (PWT)	1,200
Oil contaminated water	CPI (Corrugated Plate Interceptor)	4,800
Chemically contaminated water	Neutralizing Pond	3,400
Domestic waste	Wastewater Treatment Installation (IPAL)	1,320
Brine water reject	-	32,832
Total		**43,552**
Total (m^3/hour)		**1,851 (rounded off to 1,900)**

Impact on seawater salinity mainly originated from brine water reject.

To predict impact, wastewater disposal modeling was done on the basis of total wastewater discharge from the outfall, i.e. 1,900 m^3/hour (rounded off based on operating scheme of 4 LNG Trains including the supporting facilities). Concentration of wastewater salinity used was 39 ‰, based on composite sampling of comingled wastewater undertaken 3 times in the period from December 2012 to March 2013. Modeling was done with discharge scenario in LNG 1 jetty and LNG 2 jetty in the wet season and dry season.

Figure III-52 and **Figure III-53** indicate minimum dilution factors of wastewater discharge in LNG 1 jetty during the dry season and wet season . Lowest dilution factor occurring in outfall location was 4.6 in the dry season and 5.7 in the wet season. Maximum concentrations of modeling results including environmental baseline concentrations are shown in **Table III-89**.

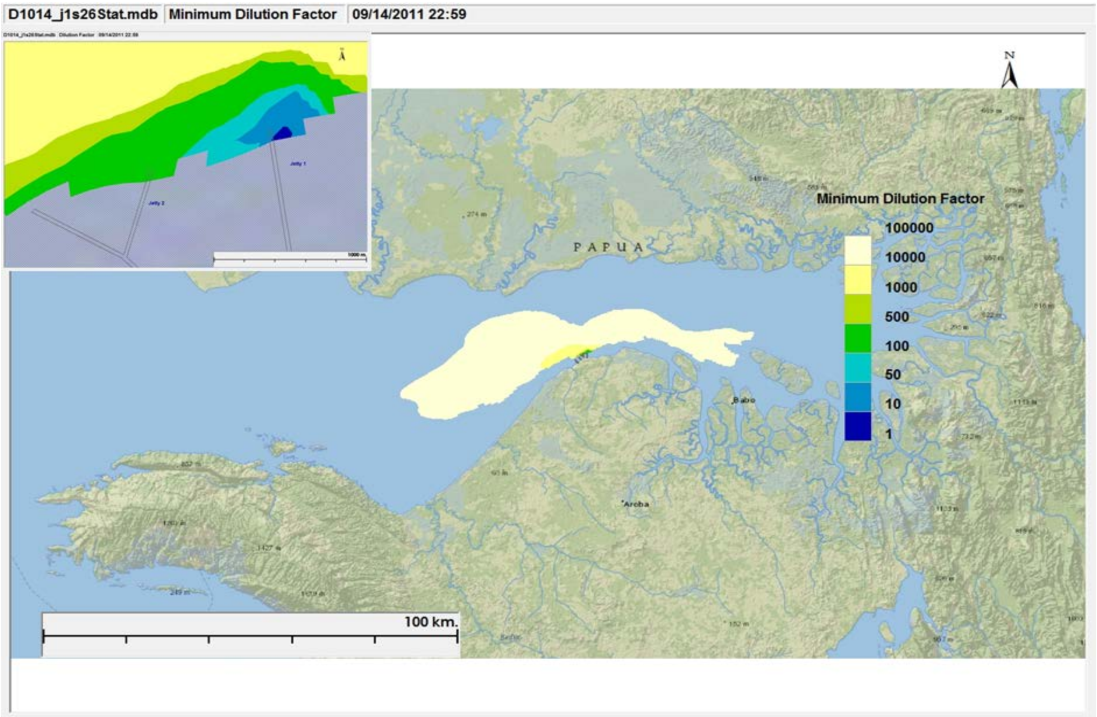


Figure III-52 Contour of Minimum Dilution Factor at LNG 1 Jetty in the Dry Season

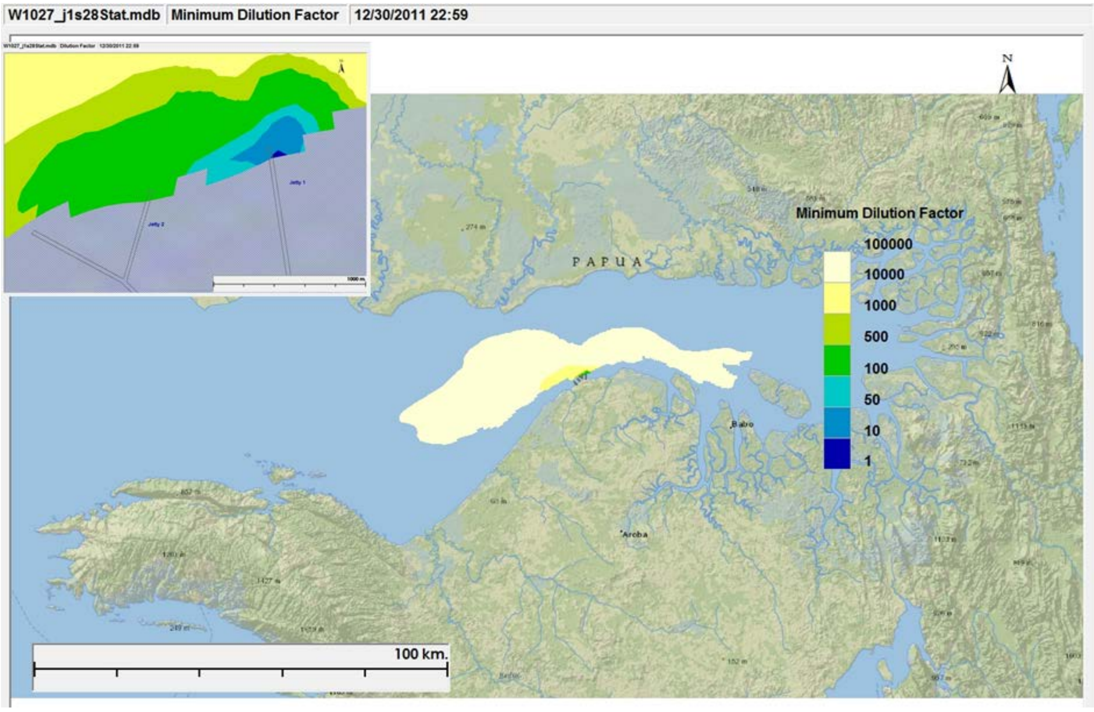


Figure III-53 Contour of Minimum Dilution Factor at LNG 1 Jetty in the Wet Season

Minimum dilution factor of combined wastewater discharge in LNG 2 jetty was 10.4 in the dry season and 10.2 in the wet season. **Figure III-54** and **Figure III-55** show minimum dilution factors for combined wastewater discharge at LNG 2 jetty in the dry season and wet season.

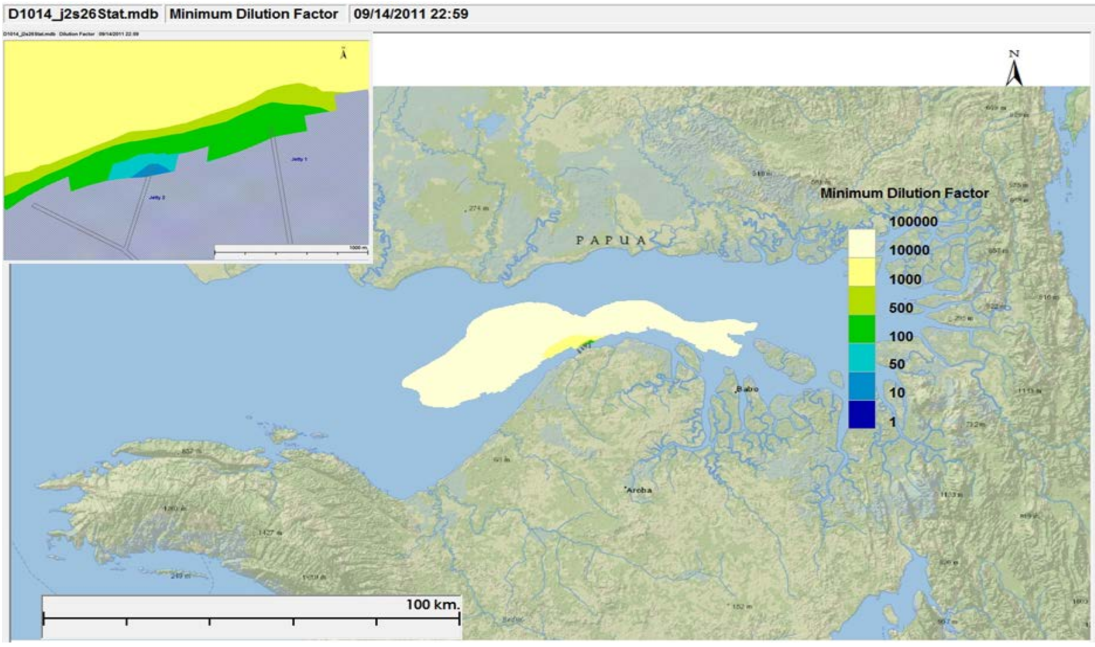


Figure III-54 **Contour of Minimum Dilution Factor at LNG 2 Jetty in the Dry Season**

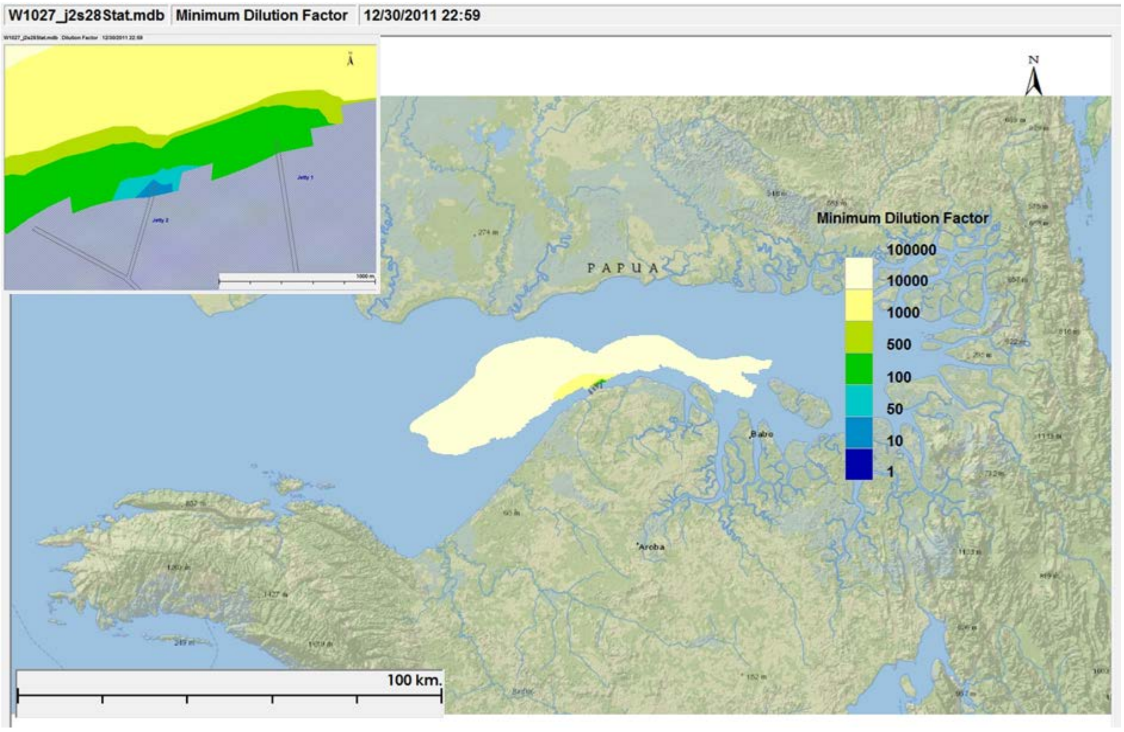


Figure III-55 **Contour of Minimum Dilution Factor at LNG 2 Jetty in the Rainy Season**

Table III-96 Predicted Maximum Concentration of Salinity

Location	Quality Standard		Distance from Outfall		
			50 m	100 m	500 m
Dry Season					
LNG 1 Jetty	34	Concentration (‰)	30.8	30.1	28.7
LNG 2 Jetty	34	Concentration (‰)	29.5	28.9	28.6
Wet Season					
LNG 1 Jetty	34	Concentration (‰)	27.8	26.8	25.7
LNG 2 Jetty	34	Concentration (‰)	26.8	26	25.6

Table III-97 Distance from Outfall where Salinity complies with the Quality Standard (5% of Ambient Seawater Salinity)

	High Tide		Low Tide	
	Distance	**Dispersion Factor**	**Distance**	**Dispersion Factor**
LNG 1 Jetty	3.4	6	1.8	6
LNG 2 Jetty	9.9	6	9.8	6

Based on **Table III-98** above, modeling results indicated that in the dry season and wet season increase of seawater salinity caused by wastewater disposal at distances 50 m, 100 m and 500 m were still below quality standard according to Environmental Minister Regulation No 51 year 2004. In comparison with the baseline data (based on wastewater disposal permit No. 125 year 2013, providing 5% tolerance of ambient seawater salinity at radius 30 m from outfall), results of near-field modeling indicated that salinity at high tide met quality standard of 5% of environmental baseline at distance 3,4 m from outfall , while low tide condition was at distance 1,8 m (**Table III-99**).

- **Impact Evaluation**

Table III-100 Impact Evaluation of Increase in Salinity

Impact Description	*With large wastewater volume and high salinity, wastewater discharge may have an impact of increase in concentrations of ambient seawater salinity.*				
Impact Nature	**Negative**	**Positive**			
	Wastewater may increase salinity concentration in the waters around the outfall location.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Increase in salinity concentration in the waters around the outfall location is a direct impact of desalination.				

Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Impact will be occured from the construction phase to operation phase of the Tangguh LNG, thus if the option of desalination water is applied the impact will last up to ±25 year since the operation phase commences.				
Impact Extent	**Local**	**Regional**	**Global**		
	The total quantity of wastewater to be discharged would be 1,900 m³/hour for operation based on the scheme of four LNG Trains and the supporting facilities, with maximum salinity of 39 ‰. Seawater salinity standard for mangrove area is 34 ‰ (MoE Decree No. 51 Year 2004 Annex III). In addition to the regulation, the Tangguh LNG also complies with the provisions of the Wastewater Discharge Permit for the Tangguh LNG based on the MoE Decree No 125 Year 2013, which the quality standard of salinity is 5% variation of environmental baseline at distance of 30 m from the natural salinity content. *Based on the modeling for wastewater discharge in LNG 1 and LNG 2 jetties, distribution of salinity still comply with the quality standard at distance of 50 m from outfall.* *Based on the above, the impact extent of increase in salinity is in category of 'local' since the impact will only occur in the study area.*				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Monitoring of salinity at the wastewater outfall indicated environmental baseline condition in the wet season (March - April 2013) was 25.5 ‰ and dry season was 28.5 ‰ (July-August 2012). Routine monitoring was also conducted monthly for LNG Train 1 and 2 operation activities conducted. From routine monitoring in the past year (July 2012-June 2013), salinity ranged between 24 – 30.5 ‰ at distance 30 m from outfall and 23.4 – 30.5 ‰ in the exclusion zone representing natural salinity content, thus variation ranged between 0 – 3.4 %. *Modeling results indicated that in the dry season and wet season,the increase of seawater salinity due to wastewater discharge at distance 50 m, 100 m and 500 m was still below quality standard in accordance with MoE Decree No 51 Year 2004.* *Wasewater Discharge from LNG 1 jetty:* *Near-field modeling indicated that salinity at condition of high tide met 5% quality standard of environmental baseline at distance 3.4 m from outfall, while at low tide the distance was 1.8 m.* *Wastewater Discharge from LNG 2 jetty:* *Results of* near-field *modeling indicated that salinity at high tide met 5% quality standard of environmental baseline at distance 9.9 m from outfall, while at low tide was at distance 9.8 m.* *It may be concluded that increase in salinity still met quality standard in accordance with Minister of the Environment Decree No. 51 Year 2004 Annex III. However compared with baseline, the discharge from LNG 1 jetty could only meet 5% limit of environmental baseline at distance 500 m in the wet season and dry season, while LNG 2 jetty discharge was generally better which only one condition slightly exceeded 5%, i.e. in the wet season at radius 50 m (5.1%).* *Thus, impact magnitude is cateqorized as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Receptors of increase in salinity are necton and mangrove. Nectons in Bintuni Bay have high tolerance toward fluctuation of salinity due to the tidal condition and wet/dry season. Mangrove has high range of tolerance toward salinity of brackish water (10 – 55 ‰). Sonneratia *species are generally found to survive in areas with soil salinity approaching seawater salinity. Several other types can also grow in high salinity such as* Aegiceras corniculatum *in salinity 20 – 40 ‰,* Rhizopora mucronata *and* R. Stylosa in *salinity 55 ‰, in fact* Lumnitzera racemosa *can grow in salinity 90 ‰ (Chapman, 1976a).* Bruguiera *types generally grow in areas with salinity of less than 25 ‰. (Noor, Khazali and Suryadiputra, 2006). Thus, receptor sensitivityis in category of 'low'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude is categorized as 'medium' and recptor sensitivity is categorized as 'low', thus the impact severity is categorized as 'low'.				

Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Wastewater discharge will occur continuously during the construction phase and will continue during the Tangguh LNG operation if the option of seawater desalination is applied. However, based on current operation, seawater salinity still comply with the standard in MoE Decree No 51/2004 the quality standaed for marine biota, however compared with environmental baseline in accordance with Wastewater Discharge Permit of the Tangguh LNG No 125 Year 2013, the discharge at LNG 2 jetty produced better results than at LNG 1 jetty. Thus, impact likelihood is categorized as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Therefore, impact severity is in category of 'low' and the likelihood of impact is 'medium', the Significance of Impact is 'negligible-minor' or insignificant impact. *Since the impact severity is categorized as 'low' and impact likelihood is categorized as 'medium', thus the impact significance is categorized as 'negligible-minor' or insignificant impact.*				

Based on evaluation results , the impact of combined waste disposal toward increased salinity may be categorized as 'negligible-minor', thus the impact is in category of 'insignificant impact'.

b. Increased in COD Value

- **Environmental Baseline**

Increase in COD concentration may be due to wastewater discharge in Bintuni Bay, particularly due to produced water discharge from the LNG Plant operation activities.

The Tangguh LNG operation activities produce five types of liquid waste:

a. Produced water;

b. Oil-contaminated wastewater;

c. Chemicals-contaminated wastewater;

d. Brine water reject; and

e. Domestic wastewater.

Respectively wastewater volumes are shown in **Table III-71**. Each wastewater type will be managed and monitored prior to be comingled in the discharge pipeline and discharged through the same outfall in LNG 1 jetty or LNG 2 jetty. Concentration of actual COD (from LNG Train 1 and 2) discharged through outfall, based on composite sampling of the wastewater undertaken 3 times in the period December 2012 to March 2013 was maximum 31 mg/L.

DO concentrations based on environmental baseline survey made for the AMDAL study for the months of July - August 2012 (dry season) and March - April 2013 (wet season) in locations around the outfall of dermaga LNG 1 were 5.55 mg/L in the dry season and 5.49 mg/L in the wet season, while quality standard was > 5 mg/L based on MoE Decree No 51 Year 2004 for marine biota.

- **Impact Prediction**

  Similar to salinity modeling, input of wastewater discharge modeling was 1,900 m^3/hour (calculation for four LNG Trains and the supporting facilities).

  The minimum dilution factors of wastewater discharge at LNG 1 jetty during the dry season and wet season are shown in **Figure III-52** and **Figure III-53**, while **Figure III-54** and **Figure III-55** display minimum dilution factor for combined wastewater discharge at LNG 2 jetty in the dry season and wet season. Lowest dilution factor at outfall location of LNG 1 jetty was 4.6 in the dry season and 5.7 in the wet season, and at LNG 2 jetty 10.4 in dry season and 10.2 in wet season.

- **Impact Evaluation**

Table III-101 Impact Evaluation – Wastewater Discharge toward Increase in COD Concentration

Impact Description	*Increase in concentration of COD may be caused by wastewater discharge in Bintuni Bay, mainly because of produced water discharge from the LNG Plant operation activities.* *Tangguh LNG operations produce five types of wastewater:* *1. Produced water;* *2. Oil-contaminated wastewater;* *3. Chemicals-contaminated wastewater;* *4. Brine water reject; and* *5. Domestic wastewater.* *Each type of wastewater will be managed and monitored prior to be comingled in the discharge pipeline and discharged through the same outfall in LNG 1 jetty or LNG 2 jetty. The total amount of wastewater is estimated to be 1,900 m^3/hour for the four LNG Trains and their supporting facilities.*				
Impact Nature	**Negative**	**Positive**			
	Wastewater discharge will increase COD content around the outfall.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Increase in COD concentration around the outfall *is a direct impact of wastewater discharge activity. This is also a residual impact because wastewater has been treated to reduce COD concentration prior to be discharged to sea through* outfall at *LNG 1 jetty and LNG 2 jetty.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will last during the Tangguh LNG operation (±25 years) since commencement of the operation phase.				
Impact Extent	**Local**	**Regional**	**Global**		
	Modeling of combined wastewater discharge in outfall *at LNG 1 jetty during low tide and LNG 2 jetty during high tide indicates dilution factor of around 100:1 at distance of 100 m from outfall. Meanwhile at LNG 1 jetty during high tide, and LNG 2 jetty at low tide, dilution factor was 100:1 at distance of 200 m from outfall. Therefore, impact extent is 'local'.*				

Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Quality standard of Wastewater for Oil and Gas Business and/or Activities and Geothermal Energy (MoE Decree No. 19 Year 2010, Annex I.C) for applicable COD content in wastewater to be discharged is 200 mg/L. With conservative assumption for properties of chemicals used and applying dilution factor from the modeling, if COD content in the wastewater discharge was 200 mg/l, thus at distance 200 m from outfall at LNG 1 jetty during low tide and LNG 2 jetty during high tide was 2 mg/L. With the same dilution factor at LNG 1 jetty during high tide and LNG 2 jetty during low tide, COD content were the same at 2 mg/L. Concentration of actual COD discharged through outfall based on composite sampling *conducted 3 times in the period of December 2012 – March 2013 was maximum 31 mg/l, with similar dilution factor, addition of COD content from wastewater discharge was 0.31 mg/L.* *Bintuni Bay has variation between high tide and low tide that may reach 4-6 m, thus water turbulence is quite large so as to cause relatively large re-aeration. This will result in relatively high dissolved oxygen (DO) content, as evident from the environmental baseline in which oxygen content met the quality standard (DO concentration in environmental baseline was 5.55 mg/L in the dry season and 5.49 mg/L in the wet season, while the quality standard was larger than 5 mg/L – MoE Decree No 51 Year 2004 for marine biota). This indicates that the relatively small influence of COD will not cause a significant impact toward increase in oxygen content.* *Therefore, impact magnitude is categorized as 'low'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	In this case, the receptor is Bintuni Bay waters that has tidal variation of 4-6 m, thus water turbulence is quite high. Therefore the category of receptor sensitivity is considered 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude is categorized as 'small' and receptor sensitivity is categorized as 'low', thus impact severity is categorized as 'slight'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Wastewater discharge will continue during Tangguh LNG operation. However based on modeling results with natural dispersion at sea the likelihood of COD increase is very limited. Therefore, impact likelihood is categorized as 'low'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact severity is categorized as 'slight' and impact likelihood is categorized as 'low',thus impact significance is categorized as 'negligible'				

Based on evaluation result, it is indicated that the impact of combined wastewater discharged toward increased in COD can be categorized as 'negligible', thus the impact is in category of 'insignificant impact'.

c. Increase in Ammonia Concentration

- **Environmental Baseline**

  Based on the environmental baseline survey made in the months of July - August 2012 (dry season) and March – April 2013 (wet season), concentration of ammonia (NH_3-N) around the outfall location indicated value of <0.02 mg/L (undetected), below the environmental quality standard based on MoE Decree No. 51/2004 for marine biota of 0.3 mg/L.

- **Impact Prediction**

  Similar to the salinity modeling, input of wastewater discharge flow modeling was 1,900 m^3/hour (calculation for 4 LNG Trains and the supporting facilities). Input of wastewater ammonia concentration was 3.71 mg/L, based on composite sampling of comingled wastewater conducted 3 times in the period of December 2012 – March 2013.

Impact toward increase in ammonia mainly originated from produced water discharged.

The minimum values of dilution factors of wastewater discharge at LNG 1 jetty in the dry season and wet season are shown in **Figure III-52** and **Figure III-53**, while **Figure III-54** and **Figure III-55** illustrate the minimum dilution factor for combined wastewater disposal at in LNG 2 jetty in the dry season and wet season. Maximum concentration of the modeling results including environmental baseline concentration are shown in **Table III-93**.

Table III-102 Predicted Maximum Concentration of Ammonia (NH_3-N)

Location	Quality Standard	Concentration of NH_3-N (mg/L)			
		Distance from *Outfall*			
		50 m	100 m	500 m	Environmental Baseline
Dry Season					
LNG 1 Jetty	0.30	0.82	0.59	0.08	<0.02
LNG 2 Jetty	0.30	0.37	0.14	0.06	<0.02
Wet Season					
LNG 1 Jetty	0.30	0.67	0.37	0.08	<0.02
LNG 2 Jetty	0.30	0.38	0.17	0.05	<0.02

In general, the discharge from LNG 2 jetty produced better results than from LNG 1 jetty. Ammonia concentration of wastewater discharge from LNG 1 jetty will only meet quality standard at radius 500 m in the dry and wet season, while that of LNG 2 at radius 100 m.

- **Impact Evaluation**

Table III-103 Impact Evaluation – Wastewater Discharge toward Increase in Ammonia Concentration

Impact Description	*Increase in concentration of ammonia may be caused by wastewater discharge, mainly from produced waster discharge from the LNG Pkant operation activities.*

<table>
<tr><td rowspan="1"></td><td colspan="5">The Tangguh LNG operation activities produce five types of liquid waste:
1. Produced water;
2. Oil- contaminated wastewater ;
3. Chemicals-contaminated wastewater;
4. Brine water reject; and
5. Domestic wastewater.

Each type of wastewater will be managed and monitored prior to be comingled in the discharge pipeline and discharged through the same outfall at LNG 1 jetty or LNG 2. Jetty. The total amount of wastewater is estimated to be 1,900 m³/hour for operation of the four LNG Trains and their supporting facilities.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Increase in concentration of ammonia may cause negative impact for Bintuni Bay.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Increase in concentration of ammonia in the waters around the outfall is categorized as direct impact. This is also residual impact since produced water will be treated beforehand to reduce ammonia concentration prior to be discharged to sea through outfall. Results of treatment still cause residual impact for ammonia parameter.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">The impact occurring is continuous during Tangguh LNG operation (±25 year) since the commencement of the operation phase.
Impact may occur for the duration of Tangguh LNG operation (25 years). However, based on experience, ammonia will usually increase only at the time of start up or after start up or in abnormal condition in the event of technical disturbance in the processing facility, in which several weeks will be required to return to normal condition.

In normal condition, concentration of ammonia in wastewater discharged meet applicable quality standard of 5 mg/l</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Based on modeling of wastewater discharge at LNG 1 jetty (option 1), increase in concentration of ammonia higher than requirement (0.30 mg/L based on MoE Decree Number 51 Year 2004 for marine biota will only occur until radius 500 m, while for LNG 2 jetty (option 2) until radius 100 m from outfall.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Based on the environmental baseline survey for the AMDAL study in the months of July - August 2012 (dry season) and March - April 2013 (wet season), concentrations of ammonia (NH_3-N) around the outfall location indicated value of < 0.02 mg/L, below the environmental quality standard stipulated in MoE Decree No 51/2004 for marine biota i.e. 0.3 mg/L.

Wastewater discharge modeling was conducted using the figure 1,900 m³/hour for total discharged wastewater with concentration of ammonia (NH_3-N) of 3.7 mg/L.

Option 1 – Wastewater discharge at LNG-1 Jetty
The Modeling results indicated that in the wet season, concentration of ammonia (NH_3-N) will increase to 0.67 mg/L in radius 50 m from outfall, then 0.37 mg/L in radius 100 m and 0.08 mg/L in radius 500 m from outfall. While in the dry season, concentration of ammonia (NH3-N) to be 0.82 mg/L in radius 50 m, then 0.59 mg/L in radius 100 m and 0.08 mg/L in radius 500 m from outfall.

Option 2 – Wastewater discharge in LNG -2 Jetty
The Modeling results indicated that in the wet season, concentration of ammonia (NH_3-N) will be 0.38 mg/L in radius 50 m from outfall, then 0.17 in radius 100 m, and 0.05 mg/L in radius 500 m. While in the dry season concentration of ammonia (NH_3-N) increase to be 0.37 mg/L in radius 50 m, then 0.14 mg/L in radius 100 m, and 0.06 mg/L in radius 500 m from outfall.

Based on current Tangguh LNG operational records (January 2012-May 2013), produced water discharge exceeding quality standard of ammonia (NH_3-N) of 5 mg/L in accordance with the wastewater discharge permit occurred only once for approximately one month before the produced water treatment unit with biological process satisfactorily resumed operation. During the time, concentration of ammonia in the sea around the outfall was monitored with results below 0.05 mg/L, less than the applicable ambient seawater quality standard.</td></tr>
</table>

Receptor Sensitivity	**Low**	**Medium**	**High**		
	The receptor of increase in concentration of ammonia will be the bay waters ecosystem. Sufficiently large addition of nutrients may cause eutrofication that will then result in altered composition of alga and nekton community (vertebrata)*. However, due to the high natural turbidity level of Bintuni Bay, the likelihood of algal bloom will be low. Thus the receptor sensitivity is in category of 'medium'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since impact magnitude is small, and receptor sensitivity is medium, the impact severity is categorized as 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Wastewater discharge will occur continuously during Tangguh LNG operations. However, increase in ammonia concentration generally occurs only during or after start up or in abnormal condition, in the event of technical disturbance in the produced wastewater treatment unit.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since impact severity is categorized as 'medium' and impact likelihood is categorized as 'low', thus the impact significance is categorized as 'minor' and is an isignificant impact.				

Evaluation results indicated that the nature of impact of combined wastewater disposal toward increase in ammonia concentration may be categorized as 'minor', thus the impact is in category of 'insignificant impact'.

3.3.2 Biology

3.3.2.1 Terrestrial Flora

a. Change in Land Cover

- **Environmental Baseline**

The 2011 Flora Fauna Survey report described that generally the principal types of forest ecosystem found in the proposed Tangguh LNG Project Expansion location comprised of (1) mangrove forest, (2) swamp forest, and (3) lowland forest. The forest area already acquired for the Tangguh LNG location overall measured 3,266 ha, in which ± 365 ha (11.18%) were areas that had been cleared for the current development of Tangguh LNG site and ± 39 ha were perimeter fence as the boundary of Tangguh LNG. From the cleared area, approximately 100 ha had been revegetated. Furthermore, for development of the LNG Train facility and supporting facilities as part of the Tangguh LNG expansion plan, land clearing will be required, covering a maximum of 500 ha. Land clearing will be done in two phases, during early works measuring ± 125 ha and the remainder in the future construction phase ± 375 ha.

Based on the land cover map of 2012 (**Figure III-56** – Land Cover), the 12 types of land cover consist of water bodies, primary dry forest, secondary dry forest, primary mangrove forest, secondary mangrove forest, primary swamp forest, secondary swamp forest, roads, LNG Train facility, young shrub, shrub and open land with total area of 3,266 ha. Areas of each land cover are displayed in **Table III-104** below.

Table III-105 Area of Land Cover

No.	Type of Land Cover	Area (Ha)
1	Water Body	6
2	LNG Train Facility	274
3	Primary Dry Forest	436
4	Secondary Dry Forest	1,496
5	Primary Swamp Forest	391
6	Secondary Swamp Forest	330
7	Road	61
8	Cleared Land	11
11	Secondary Mangrove	114
12	Young Shrub	95
13	Shrub	52
Total		**3,266**

Source: Land Cover Map 2012 (Tangguh LNG, 2012)

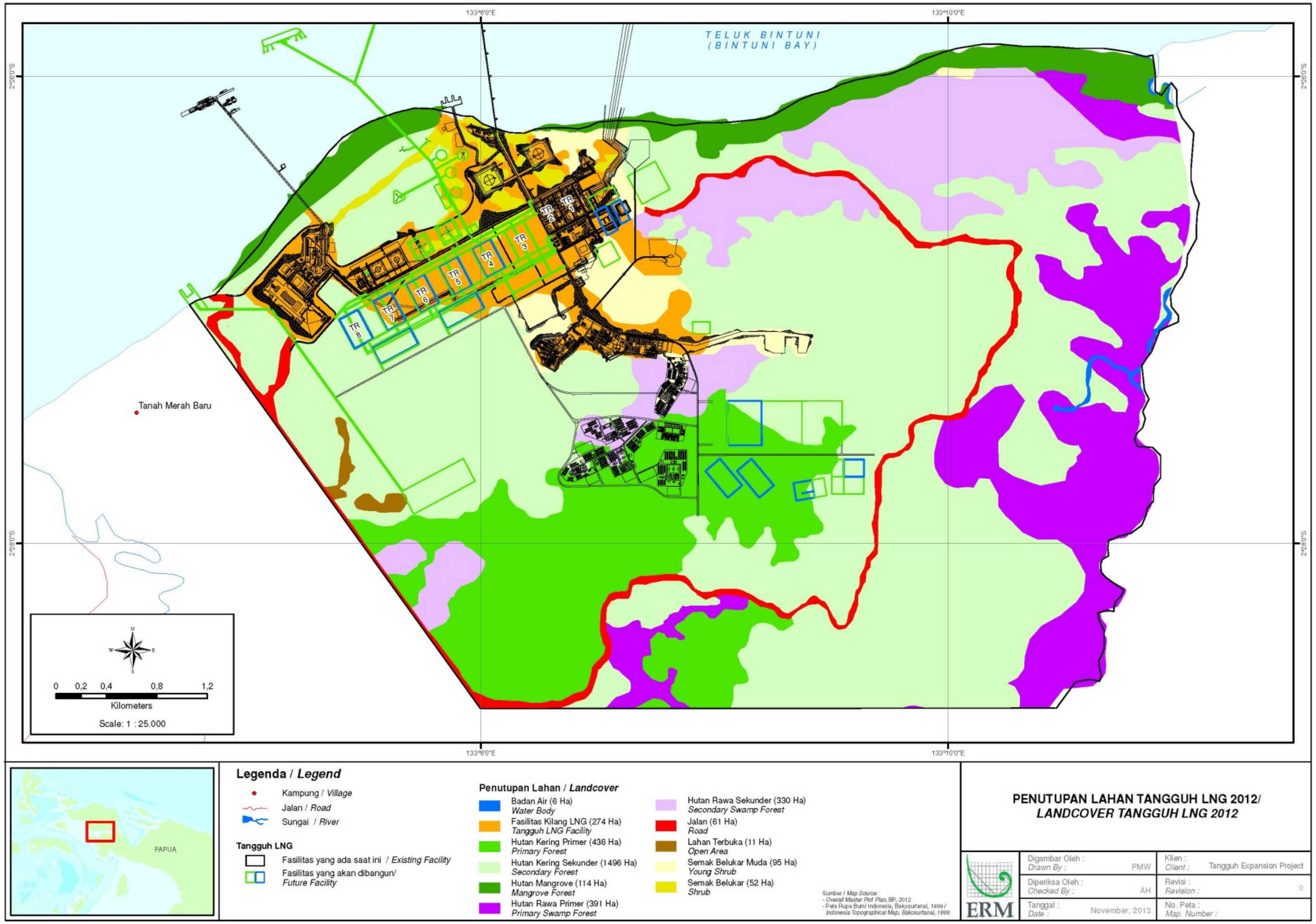


Figure III-56 Land Cover of Tangguh LNG 2012

Apart from land cover, the vegetation cover index was also assessed in the 2011 Flora Fauna Survey report using Landsat 5 Image and Landsat 7 ETM in 2000, 2008 and 2011. Furthermore, NDVI analysis was performed on the images to identify the existing vegetation density levels in the Tangguh LNG area.

Based on the analysis, information was obtained that sparse vegetation density increasingly diminished, from the year 2000 measuring 1,080 ha (38%), to 273 ha (9%) in 2008 and to 160 ha (6%) in 2011. Conversely, medium vegetation density level slightly fluctuated, in 2000 from 1,242 ha (43%) to 1,671 ha (58%) in 2008 and decreasing to 1,074 ha (37%) in 2011. The change was possibly due to conversion of medium vegetation density in 2008 to abundant vegetation density in 2011. Therefore abundant vegetation density consistently rose from 539 ha (19%) in the year 2000, to 918 ha or (32%) in 2008 and further increased to 1,628 ha (57 %) in 2011. Results of the vegetation density level analysis are shown in **Figure II-116** Vegetation Density in Buffer Zone from 2000 to 2011 in sub-chapter 2.2.1 Terrestrial Biology.

The analysis indicated an increase of vegetation with abundant density. This was due to establishment of the area as buffer zone for Tangguh LNG. The buffer zone is equipped with perimeter fence to limit access for external parties in order to maintain its function as buffer area in accordance with the AMDAL commitment approved in 2002. Tangguh LNG also revegetated the area previously cleared to provide access to construction activities of LNG Train 1 and 2 and their supporting facilities, however the area was not used for project physical facilities. Revegetation was able to be done in an area measuring approximately 100 ha with the priority on planting of local species.

- **Impacts Prediction**

  Land to be cleared consists of lowland tropical rainforest ecosystem with medium to dense vegetation density. Land clearing (± 500 ha) will reduce mangrove forest vegetation cover measuring ± 10 ha (± 9% of total mangrove area in the Tangguh LNG area) and lowland forest vegetation cover of ± 490 ha (± 25% of total lowland forest area within the Tangguh LNG area). The land clearing plan is presented in **Figure III-57.**

  In general, the lowland rainforest ecosystem is found in several locations of West Papua and the Bintuni Bay area, so as to be considered non-endangered ecosystem. The impact is predicted to decrease after revegetation activities of open land not used for permanent facilities are completed.

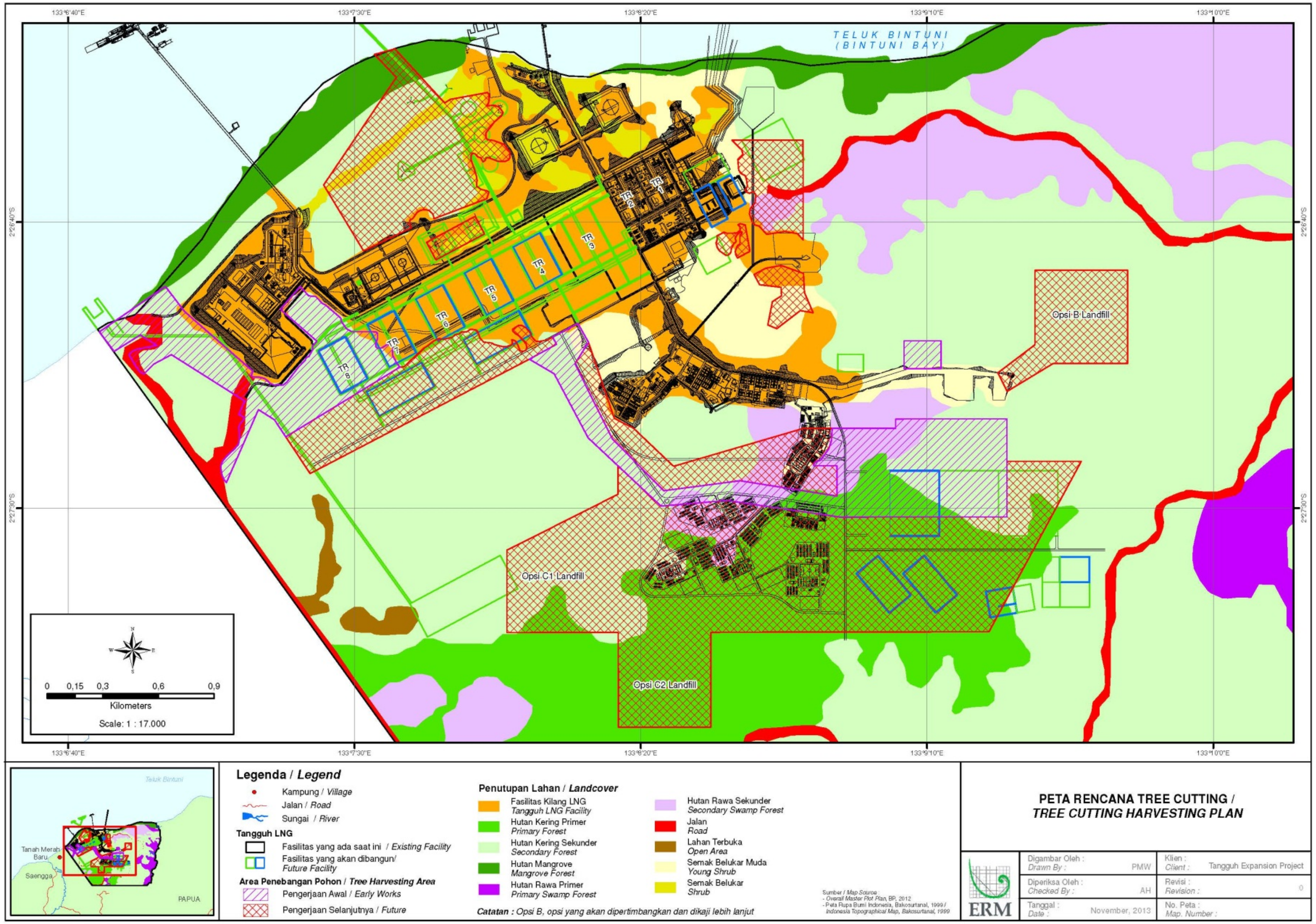


Figure III-57 Tree Harvesting Plan (Tangguh LNG, 2013)

- **Impact Evaluation**

The total area of Tangguh LNG measures 3,266 ha, in which the area cleared for the development of the existing LNG Train and supporting facilities was ± 404 ha (i.e. ± 365 ha for LNG Train facility and its supporting facilities and perimeter fence area of Tangguh LNG measuring ± 39 ha). Of the ± 404 ha that have been cleared, ± 100 ha have been revegetated. For future Tangguh LNG Expansion activities ± 500 ha will be cleared, i.e. ± 10 ha (± 9% of total mangrove forest area in the Tangguh LNG area) consisting of mangrove forest, and ± 490 ha (± 25% of total lowland forest area in the Tangguh LNG area) of lowland forest. A large portion of Tangguh LNG property not cleared for development of the LNG Train facility and supporting facilities will still be maintained as buffer area. Therefore, after the development of Tangguh LNG there will still be forest area of ± 2,462 ha to be maintained as buffer zone.

Revegetation activities will be undertaken in the area cleared for Tangguh LNG Expansion project purposes but not used as permanent facility. However, this will still not restore land cover back to its original state. Thus, the impact magnitude is categorized as 'medium'.

In relation to the loss of vegetation in the area to be cleared, several vegetation are in protected category both locally and globally, so that the sensitivity of impact is in category of 'high'. The protected flora species are *kantong semar* and *anggrek tebu*. Flora species in category of Endangered (EN) are bintangur daun halus (C*alophyllum insularum*) , while Vulnerable (VU) species are merbau (*Intsia accuminata*), merbau (*Intsia bijuga*), nate (*Myristica* cf. *lancifolia*) and *Pericopsis mooniana.*

Impact magnitude is 'medium', however the receptor sensitivity is categorized as 'high', thus the impact severity of change in land cover is in 'high' category.

Land clearing will be undertaken in phases; therefore impact likelihood will occur one time in each phase (in different space and time). Additional land clearing with maximum area of 500 ha will be conducted in two phases, i.e. land clearing in the first year for the area required in the initial construction phase (early work) covering ± 125 ha, and the remaining ± 375 ha in the second year in the future development phase. The phases of land clearing are shown in **Figure III-57.**

Impact severity is categorized as 'high' and the impact likelihood is categorized as 'low', and therefore impact significance of change in land cover is in 'moderate' category.

Table III-106 Impact Evaluation – Changes in Land Cover

Impact Description	*Twelve types of land cover are found in the Tangguh LNG area and the vicinity (Map 1) consisting of water bodies, primary lowland dry forest, secondary lowland dry forest, primary mangrove forest, secondary mangrove forest, primary swamp forest, secondary swamp forest, roads, settlement, young shrub, shrub and clearing.* *Land to be cleared comprise of lowland tropical rainforest ecosystem with medium to dense growth. Land clearing (± 500 ha) will reduce vegetation cover of mangrove forest (± 10 ha, i.e. ± 9% of total mangrove forest area in the Tangguh LNG area) and reduce lowland dry forest vegetation cover (± 490 ha, i.e. ± 25% of total lowland forest area in the Tangguh LNG area). In general, the rainforest ecosystem is found in several locations of West Papua and the Bintuni Bay region, so as to be considered* non-endangered ecosystem. *The impact is predicted to decrease after revegetation of open land not used for permanent facilities is completed*				
Impact Nature	**Negative**	**Positive**			
	Conversion of land cover may cause a 'negative' impact in the form of loss of vegetation and also habitat for wildlife in the project area to be used for supporting facility development in LNG Train 3 and 4.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Converted land cover is a 'direct impact ' of land clearing for the Tangguh LNG Expansion project				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Conversion of land cover for the forest area for Tangguh LNG Expansion project needs will be a permanent impact at least until the end of the Tangguh LNG operation phase. A portion of the cleared land not used for permanent facility will be revegetated so that for this portion the impact on converted land cover will be temporary until revegetation activities are completed.				
Impact Extent	**Local**	**Regional**	**Global**		
	Impact extent on converted land cover will be local, since land clearing activities are only done on the area of land previously acquired for the Tangguh LNG location.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The overall Tangguh LNG area measures 3,266 ha. Of the total area , the area cleared for development of the existing LNG Train and supporting facilities and the area for the Tangguh LNG boundary fence measures ± 404 ha. Of the ± 404 ha cleared area, ± 100 ha have been revegetated. For Tangguh LNG Expansion activities, an area measuring ± 500 ha will be cleared, consisting of ± 10 ha in the form of mangrove forest (± 9% of total mangrove forest in the Tangguh LNG area), and ± 490 ha is composed of lowland forest (± 25% of total lowland forest in the Tangguh LNG area). A large portion of the Tangguh LNG property not used for development of the LNG Train facility and supporting facilities will still be maintained as Buffer Zone *. Therefore, after Tangguh LNG Expansion activities the remaining forest area will still measure ± 2,462 ha to be managed as buffer zone.* *Revegetation activities will be conducted in the area cleared for Tangguh LNG Expansion project needs but not used as permanent facility. However this will still be unable to restore the land cover to its former condition. Thus, the impact magnitude is categorized as 'medium''.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	In relation to the loss of vegetation in the area to be cleared, some of the vegetation is in the category of protected both locally and globally, so that sensitivity of impact is in category of 'high'. *Protected flora species are kantung semar and anggrek tebu. Flora species in the Endangered (EN) category are bintangur daun halus (*Calophyllum insularum*) and Vulnerable (VU) are merbau (*Intsia accuminata*), merbau (*Intsia bijuga*), nate (*Myristica cf. lancifolia*) and* Pericopsis mooniana.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Impact magnitude is categorized as 'medium' and receptor sensitivity is categorized as 'high', therefore the impact severity is categorized as 'high'.				

Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	*Land clearing for development of Tangguh LNG measuring ± 500 ha will be done in phases, i.e. land clearing in the first year for areas required in the initial construction phase (*Early Work*) measuring ±125 ha and second year for the remainder of land to be cleared in the future construction phase of ±375 ha. Thus, the impact likelihood will occur one time in each phase (in different space and time) and included in category of 'low'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	'High 'impact severity and 'low' impact likelihood, will make the impact significance of land cover conversion 'moderate' and significant impact.				

b Changes in Structure and Composition of Flora Species

- **Environmental Baseline**

In lowland forest, trees with highest density for transect-1 are the kibo (*Xylopia caudate)* with density of 19 individuals/ha. In transect-2 with density of 29 individuals/ha are the *damar* (*Agathis labilardieri*) and damar/arowe/kibi/parade/marada (*Vatica rassak*), while for transect-3 with density of 15 individuals/ha are the *merbau* (*Intsia bijuga*). Tree species with highest density are also the dominant tree species in each transect.

Meanwhile for undergrowth, species with highest density in lowland forest in transect-1 are the grintingan (*Cynodon dactylon*); transect-2 are tesa/wantaro/taa/siropa (*Taenitis blechnoides*); and transect-3 are owe-owe (*Selaginella plana*). The three species of undergrowth with highest density are also dominant undergrowth species in each transect.

Habitus epifit and liana in lowland forest with highest density is *bunga ternate* (*Clitoria ternatae*), in transect-1 with density of 68 individuals/ha are kagetisa daun besar/medium (*Rhaphidophora sylvestris* Engl.), in transect-2 and transect-3 with respective densities of 74 individuals/ha and 142 individuals/ha. Habitus epifit and liana in lowland forest are dominated by pipi kisiri/deda (*Mikania cordata*) in transect-1 and large/medium leaf kagetisa (*Rhaphidophora sylvestris*) in transect-2 and transect-3.

In swamp forest, trees with highest density are watura (*Bruguirea parviflora*) with density of 42 individuals/ha. These are the tree species predominantly found in swamp forest. Meanwhile the highest density and also species dominance of undergrowth in swamp forest are pandan (*Pandanus* sp.) with density of 3,333 individuals/ha. For habitus epifit and liana with highest density and dominant species in swamp forest is yesilara (*Flagellaria indica*) with density of 105 individuals/ha.

In mangrove forest, tree habitus with highest density amd also the dominant species is the sapo (*Sonneratia alba*) with density of 149 individuals/ha. Meanwhile for undergrowth, in mangrove forest no undergrwoth species are found . As for epifit and liana with highest density in mangrove forest is the wadatene (*Lecanopteris carnosa*) with density of 15 individuals/ha.

Plant distribution pattern in tree habitus pohon in lowland forest, swamp forest, and mangrove forest in the Tangguh LNG area is clustered and evenly distributed. For pattern of undergrowth distribution in lowland forest and swamp forest in Tangguh LNG it is clustered, however significant distribution pattern is not found in mangrove forest. While distribution pattern for epifit and liana is clusered and evenly distributed.

- **Impact Prediction**

Land clearing on the area measuring ± 500 ha is predicted to have an impact of change in structure and composition of plant species, which are likely to be in category of protected, endangered species, or other species included in Appendix I & II CITES.

Change in structure and composition of vegetation only occurs on the cleared site (± 500 ha) will potentially cause impact on lowland forest ecosystem (± 490 ha, i.e. ± 25% of total lowland forest area in Tangguh LNG area) and mangrove forest ecosystem (±10 ha, i.e. ± 9% of total mangrove forest in Tangguh LNG area). It is predicted that land clearing will not change the structure and composition of vegetation in the existing mangrove ecosystem in the AMDAL study area. The impact is estimated to decrease upon completion of revegetation of open land not used for permanent facilities.

- **Impact Evaluation**

Mangrove forest to be cleared measures ± 10 ha (± 9%), this is quite small as compared to the existing mangrove forest in Tangguh LNG area of ± 114 ha. Similarly, the lowland forest area to be cleared, ± 490 ha (± 25%) of total lowland forest in the Tangguh LNG area of ±1,932 ha consisting of primary and secondary dry forest (**Table III-93**).

Apart from that, the structure and composition of similar flora species may be found around the Tangguh LNG area, i.e. in forest area not used for Tangguh LNG facilities at present as well as its development that also functions buffer zone of ± 2,462 ha. However, considering the presence of protected flora species on land to be cleared, the impact magnitude is in category of 'medium' impact.

In relation to the loss of vegetation in the cleared area, in which several protected species are found, the impact has 'high' sensitivity value.

Protected flora species are kantong semar and anggrek tebu. Flora species in category of Endangered (EN) are bintangur daun halus (*Calophyllum insularum*) and Vulnerable (VU) are merbau (*Intsia accuminata*), merbau (*Intsia bijuga*), nate (*Myristica* cf. *lancifolia*) and *Pericopsis mooniana.*

Since the impact magnitude is in 'medium' category and has 'high' receptor sensitivity level, the impact severity of change in structure and composition of flora species is in 'high' category.

Land clearing will be done in phases, so that impact likelihood will be one time in each phase (in different space and time). Additional land clearing for Tangguh LNG Expansion with maximum area of 500 ha will be conducted in two phases, i.e. land clearing in the first year for the area required in the initial construction phase (Early Work) measuring ± 125 ha and second year for the remaining land to be cleared in future construction phase of ± 375 ha. Therefore, the impact likelihood is in the 'small' category.

Since the impact severity is in 'high' category and also impact likelihood in 'small' category, change in structure and composition of flora species possesses impact significance categorized as 'moderate'.

Table III-107 Impact Evaluation – Changes in Structure and Composition of Flora Species

Impact Description	*Land clearing will be conducted in phases by tree cutting in the planned land clearing area for facility development related to the Tangguh LNG Expansion project.* *It is predicted that land clearing in the area will not change the structure and composition of mangrove ecosystem vegetation in the AMDAL study area. The impact is predicted to decrease upon completion of revegetation activities on unused bare land.*				
Impact Nature	**Negative**	**Positive**			
	Change in structure and composition of species is a 'negative' impact since it directly causes loss of vegetation due to land clearing activities.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in structure and composition of flora species is a secondary impact of land clearing activities, due to conversion of land cover, thus in category of 'derivative impact'.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Land to be cleared consists of area covered with vegetation. Loss of vegetation on the land to be cleared will change the structure and composition of flora species. Thus, the impact will be permanent on cleared land. However, the structure and composition of similar flora species may still be found around the Tangguh LNG area, i.e. in the forest area currently not used for Tangguh LNG and its development and serving as buffer zone of ± 2,462 ha.				
Impact Extent	**Local**	**Regional**	**Global**		
	Forest area to be cleared situated in Tangguh LNG area ± 500 ha (± 10 ha mangrove and ± 490 ha lowland forest) of total area previously acquired for the site of Tangguh LNG i.e. measuring 3,266 ha. Dispersion of changed structure and composition of flora species will be limited to the planned land clearing area in Tangguh LNG site. Thus change in composition and structure of flora species in the Tangguh LNG area is in category of 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Land clearing of maximum ± 500 ha is estimated to have an impact on the structure and composition of flora species, which are possibly among protected plants, endangered species, or other species included in Appendix I & II CITES. Change in structure and composition of vegetation only takes place in the cleared site (± 500 ha) that will potentially cause an impact on the lowland forest ecosystem (± 490 ha) and mangrove forest ecosystem (± 10 ha). *Structure and composition of species may usually be seen from density level of flora species, domination of flora species and also the dispersion pattern. Based on the 2011 survey, it was found that lowland forest in the project location including flora species with highest density at tree level in transect-1 was kibo (*Xylopia caudata*), in transect-2 damar, arowe (*Vatica rassak*) and damar (*Agathis labilardieri*) and in transect-3 merbau (*Intsia bijuga*). For species with the highest domination in transect-1 was kibo (*Xylopia caudata*), damar, arowe (*Vatica rassak*) in transect-2 and merbau (*Intsia bijuga*) in transect-3.*				

<table>
<tr><td></td><td colspan="5">Meanwhile sapo (Sonneratia caseolaris) was the flora species with the highest density level and also the dominant plant Species in mangrove forest area. The two types of forest possess distribution pattern clustered and evenly distributed, however in mangrove forest, the evenly distributed pattern was not found.

Mangrove forest to be cleared measures ± 10 ha (± 9%), this is small compared with total area of mangrove forest in the Tangguh LNG area of ± 114 ha. Similarly the area of lowland forest to be cleared, measures ± 490 (± 25%) ha of total lowland forest in Tangguh LNG area of ± 1,932 ha

Apart from that, similar structure and composition of flora species may still be found around the Tangguh LNG area, i.e. in forest area currently not used for Tangguh LNG as well as its development and serving as buffer zone of ± 2,462 ha. However, considering the presence of flora species on land to be cleared, the impact magnitude is in category of 'medium' impact.</td></tr>
<tr><td rowspan="2">Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">In connection with the loss of vegetation on land cleared, in which several species are inprotected category, this means the impact has 'high' sensitivity.

Protected flora species are kantong semar and anggrek tebu. Flora species in category of Endangered (EN) is bintangur daun halus (Calophyllum insularum) and Vulnerable (VU) are merbau (Intsia accuminata), merbau (Intsia bijuga), nate (Myristica cf. lancifolia) and Pericopsis mooniana.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Slight</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">Because the impact magnitude is in category of 'medium' and possesses 'high' receptor sensitivity level, the impact severity of change in flora species structure and composition is in 'high' category.</td></tr>
<tr><td rowspan="2">Impact Likelihood</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Land clearing will be conducted in phases, so that the impact likelihood will be one time in each phase (in different space and time). Additional land clearing with maximum area of 500 ha will be done in two phases, i.e. land clearing in the first year for area required in the initial construction phase (Early Work) measuring ± 125 ha and the second year for remaining land to be cleared in the future construction phase measuring ± 375 ha</td></tr>
<tr><td rowspan="2">Impact Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">Because impact sevirty is in category of 'high' and also the impact likelihood in 'small' category, change in flora species structure and composition has impact significance in 'moderate' category and is a significant impact.</td></tr>
</table>

c. Changes in Flora Species Diversity

- **Environmental Baseline**

The flora and fauna survey was conducted in 2011, in which the flora survey was made on three types of forest, namely lowland forest (transect-1, transect-2 and transect-3), swamp forest, and mangrove forest. Based on the survey, a total of 484 plant types were found, with the following details: a total of 468 species of plants were identified by their scientific names and 16 species of plants were not identified by scientific name.

From the survey results, 17 flora species protected both by the Government of Indonesia through Government Regulation No.7 year 1999, and internationally through CITES and IUCN are shown in **Table III-108** below.

Table III-109 **Protected Flora Species**

No.	Scientific Name	Local Name	Location	Plant Status		
				PP	CITES	IUCN
1	*Aquilaria filaria* (Oken.) Merrill	Gaharu	Hdr-3	TD	App. II	TT
2	*Bromheadia finlaysoniana* (Lindl.) Miq.	Pandan small	Hdr-1, Hdr-2	TD	App. II	TT
3	*Bulbophyllum* sp.	Anggrek putih	Hr	*Un.*	App. II	*Un.*
4	*Calophyllum insularum* P.F. Stevens.	Bintangur daun halus	Hdr-1, Hdr-2, Hdr-3	TD	TT	EN B1+2c
5	*Cyathea latebrosa* (Wall.) Copel.	Tegabe	Hdr-1, Hdr-2, Hdr-3	TD	App. II	TT
6	*Cyathea lurida* (Bl.) Copel.	Tegabe	Hdr-1	TD	App. II	TT
7	*Flindersia laevicarpa* White & Francis	Tiang-1 T3P6	Hdr-2, Hdr-3	TD	TT	VU
8	*Gonystylus macrophyllus* (Miq.) Airy Shaw	Yebi-yebi	Hdr-1, Hdr-2	TD	App. II	VU
9	*Grammatophyllum speciosum* Bl.	Anggrek kuning	Hdr-1, Sbc	D	App. II	TT
10	*Horsfieldia irya* (Gaertn.) Warb.	Firoro, nete-nete	Hdr-1, Hdr-3	TD	TT	LC
11	*Instia acuminata* Merrill	Merbau	Hdr-3	TD	TT	VU
12	*Intsia bijuga* A. Gray.	Merbau	Hdr-1, Hdr-2, Hdr-3	TD	TT	VU
13	*Myristica* cf. *lancifolia* Merrill	Nate, nesaro	Hdr-1, Hdr-2, Hdr-3	TD	TT	VU
14	*Myristica globosa* Warb.	Sp5-T1P4	Hdr1, Hdr-2	TD	TT	NT
15	*Pericopsis mooniana* Thwaites	Pohon-3 T3P8	Hdr-2 Hdr-3	TD	TT	VU
16	*Pholidota chinensis Lindl.*	Anggrek bonggol	Hdr-2	TD	App. II	TT
17	*Spathoglottis plicata Bl.*	Anggrek tanah	Hdr-1, Hdr-2, Hdr-3	TD	App. II	TT

Source: SFF 2011 Report, BP Tangguh

PP= Government Regulation No 7 Year 1999; CITES = *Convention on International Trade in Endangered Species of Wild Fauna and Flora* Appendix, IUCN (*International Union for Conservation of Nature and Natural Resources*) ver 2.3 of 2010

Habitat: Hdr-1= Lowland forest transect 1, Hdr-2= Lowland forest transect 2, Hdr-3= Lowland forest transect 3, Hr= Swamp forest, Hm= Mangrove forest, Sbc= *basecamp vicinity*

Status of Vegetation: EN= Endangered, VU= Vulnerable, LR= Lower Risk, NT= Nearly Threatened, LC= Least Concern, D= Protected, TD= Not protected, App.= *Appendix*, TT= Not registered, *Un.*= *Undeterminated*

- **Impact Prediction**

  The impact on diversity of flora species is a secondary impact of change in structure and composition of species, and a tertiary impact of reduced land cover.

It is estimated that land clearing activities measuring ± 500 ha in the Tangguh LNG area may reduce the number of rare and protected flora, as specified in Government Regulation No. 7 year 1999, Appendix II (CITES) and IUCN list and also reduces useful flora.

Apart from that, land clearing will remove vegetation in the area or result in bare land. In condition of clearing it will be difficult for natural forest species to grow because the species will require shade from direct sunlight in order to develop. Exotic and invasive flora are tolerant to cleared land with direct sunlight, so that open area is suitable for exotic and invasive species. However, it is estimated that the condition will only last some 3-4 years from the start of revegetation until it succeeds, and the area will no longer be bare.

- **Impact Evaluation**

The total area Tangguh LNG property measures 3,266 ha, the area cleared for current Tangguh LNG operation and perimeter fence area of Tangguh LNG is 404 ha. Of ± 404 ha cleared, a total of ± 100 ha has been revegetated. The Tangguh LNG Expansion plan will require land clearing on ± 500 ha of land, consisting of ± 490 ha (± 25% of total lowland forest area) lowland forest and ±10 ha (± 9% of total mangrove forest area) mangrove forest. The total area to be cleared is quite small compared with the total lowland forest area in the buffer zone of Tangguh LNG covering ± 1,932 ha and mangrove forest ± 114 ha. Besides that, similar types of forest are also commonly found in the vicinity of the Tangguh LNG location.

Diversity of flora may still be found around the Tangguh LNG area, i.e. in forest area not used for current Tangguh LNG facility and planned development that functions as buffer zone of ± 2,462 ha. However, with protected flora species in the area planned to be cleared, the impact magnitude is in category of ‘medium’ impact.

In connection with potential loss of flora species due to land clearing, including species in the protected category both locally and globally, receptor sensitivity is categorized as ‘high’. Protected flora species are *kantong semar* and *anggrek tebu*. Flora species in category of Endangered (EN) is bintangur daun halus (*Calophyllum insularum*) and Vulnerable (VU) are merbau (*Intsia accuminata*), merbau (*Intsia bijuga*), nate (*Myristica* cf. *lancifolia*) and *Pericopsis mooniana*.

Since the impact magnitude is in ‘medium’ category and receptor sensitivity is ‘high’, the impact severity is in category of ‘high’.

Land clearing will be conducted in phases, so that the impact likelihood will occur one time in each phase (in different space and time). Additional land clearing with maximum area of ± 500 ha will be made in two phases, i.e. land clearing in the first year for the area required in the initial construction phase (*Early Work*) measuring ± 125 ha and the second year for the remaining land to be cleared in the future construction phase measuring ± 375 ha. Land clearing phases are shown in **Figure III-57**.

Since impact severityis in category of 'medium' and impact likelihood in category of 'small', the significance of impact of change in flora diversity is in category of 'moderate'.

Table III-110 Impact Evaluation – Changes in Flora Species Diversity

Impact Description	*Land clearing to be conducted in phases by tree cutting in the area on which facilities related to Tangguh LNG Expansion project plan will be built.*				
Impact Nature	**Negative**	**Positive**			
	Change in flora species diversity will be negative since the change will occur as a result of decrease in flora species in the land clearing area.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in flora diversity is a tertiary impact of land clearing activities due to change in land cover and change in structure and composition of flora species, therefore it is categorized as secondary impact.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Duration of change in flora species diversity will take place 'permanently', due to loss of vegetation in the cleared area that cannot be restored to its initial condition.				
Impact Extent	**Local**	**Regional**	**Global**		
	The forest area planned to be cleared for Tangguh LNG Project development is ± 500 ha (± 10 ha mangrove and ± 490 ha lowland forest) of the total Tangguh LNG area measuring 3,266 ha. Impact toward flora diversity will be limited to the planned land clearing area. Thus change in flora diversity in the Tangguh LNG area is in category of 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	*From the previous flora and fauna survey related to the lowland tropical rainforest ecosystem in the buffer zone of Tangguh LNG (2007), 615 species were identified. Furthermore, there are 169 species in the sago community. Among the species , two were identified as protected (*Nepenthes ampullaria *and* Grammatophyllum speciosum*) based on PP No.7 Year 1999, four are endangered species based on IUCN, and nine species included in Appendix II (CITES). Species distribution is considered even in all Tangguh LNG buffer areas, mainly in the lowland tropical rainforest ecosystem.* *Exotic species found in the Tangguh LNG area are* Homalanthus nutans *and several invasive species found in the Tangguh LNG area among others,* Imperata cylindrica, *Mikania* micrantha *and* Mimosa pigra. *Based on the above condition, it is estimated that land clearing activities measuring ± 500 ha in the Tangguh LNG area may cause :* *1. Reduction of rare and protected flora found in the IUCN list and Appendix II (CITES);* *2. Land clearing will remove vegetation in the area or convert it to bare land. In such condition it will be difficult for natural forest species to grow since the species require shade from direct sunlight in order to develop. Exotic and invasive flora are species that are tolerant to bare land with direct sunlight, so that the cleared land is a suitable condition for exotic and invasive species. However this condition will last for approximately 3-4 years from the start of revegetation until revegetation succeeds, so that the area will no longer be bare.*				

	The total area of Tangguh LNG property is 3,266 ha, total area cleared for Tangguh LNG operation currently is 404 ha and 100 ha is already revegetated. *The Tangguh LNG Expansion plan will require land clearing of ± 500 ha consisting of ± 490 ha (± 25% of total lowland forest area) and ± 10 ha (± 9% of total mangrove forest area).* *Total area to be cleared is small compared with total lowland forest area in the buffer zone of Tangguh LNG of ± 1,932 ha and mangrove forest ± 114 ha. Besides that similar types of forest are commonly found in the area around the Tangguh LNG location.* *Flora diversity of may still be found in the vicinity of Tangguh LNG area, namely in the forest area not used for the current Tangguh LNG facility as well as its development, and the area functions as buffer zone measuring ± 2,462 ha. However, with the presence of protected flora species on the land to be cleared, the impact magnitude is in category of 'medium' impact.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	In connection with potential loss of flora species in the cleared area, which are in category of protected both locally and globally, receptor sensitivity is in category of 'high'. *Protected flora species are kantong semar and anggrek tebu. Flora species in category of Endangered (EN) are bintangur daun halus (*Calophyllum insularum P.F. Stevens.*) and Vulnerable (VU) are merbau (*Intsia accuminata*), merbau (*Intsia bijuga*), nate (*Myristica cf. lancifolia Merrill*) and* Pericopsis mooniana *(*Thwaites*).*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude in medium category and receptor sensitivity is high, the impact severity is in category of 'high'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	*Land clearing will be conducted in phases, so that impact likelihood will occur one time in each phase (in different space and time). Additional land clearing with maximum area of ± 500 ha will be conducted in two phases namely land clearing in the first year for the area required in the initial construction phase (*Early Work*) measuring ± 125 ha and the second year for remaining land to be cleared in the future construction phase measuring ± 375 ha.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since impact severity is in 'medium' category and impact likelihood is 'small', impact significance of change in flora diversity is in category of 'moderate' and is significant impact.				

3.3.2.2 Terrestrial Fauna

a. Change in Diversity of Fauna Species

- **Environmental Baseline**

Based on the results of flora and fauna survey in 2011 in the Tangguh LNG area, 11 species of mammals were found, consisting of seven types of fruit-eating bats , two types of insect-eating bats and two types of rats. Besides the 11 species above, four species of mammals were positively present in the Tangguh LNG site, namely the Timor deer, (*Cervus timorensis*); wild pig (*Sus scrofa*) and stray dogs (*Canis Familiaris*) and cats (*Felis domesticus*), in which the Deer (*Cervus timorensis*) was in category of *Vulnerable* in IUCN and also protected by the Government of Indonesia in Government Regulation No.7 Year 1999.

Meanwhile, for the bird group, in the survey of 2011 , 44 families were found with overall total of 146 types. One bird species receiving international attention was Kasuari Gelambir Ganda (*Casuarius casuarius*) in the Vulnerable category in the IUCN list. There was also one type, the Julang Papua Bird (*Rhyticeros plicatus*), that although not registered in IUCN (*Data Deficiency*), however the species was protected by the Government of Indonesia through Law No.5 Year 1990 and Government Regulation No.7 Year 1999. Overall, 41 bird species are protected by the Government of Indonesia through Law No.5 Year 1990 and PP No.7 Year 1999.

Herpetofauna encountered consisted of 31 species including 12 amphibian species and 19 reptile species. From the species found, nearly all were not protected by laws of the Republic of Indonesia except for estuary crocodiles *Crocodilus porosus*. The crocodiles, although included in Appendix II CITES , now Indonesia has agreed that zero export quota from their capture and export will proceed, if the animals kept can meet the provided quota. Six species of monitor lizards included in Appendix II, among which was *Varanus salvadori*, with export quota for 2007 of 200 heads. Not one type of herpetofauna species in the LNG Tangguh area was included in the IUCN red list.

Dragonfly, bee and bug survey activities in 2011 encountered 272 individual insects. Most of the insects were caught in the morning- afternoon, totaling 243 individuals during the day and 29 at night. Based on identification, the survey activities managed to collect data of 20 types of dragonflies, 8 types of bees and 10 types of bugs. Nine types of dragonflies were in the IUCN list with category *Least Concern*, while other types did not enter the protected list of IUCN, CITES nor the that of the Government of Indonesia. Further details may be found in Chapter 2 Environmental Baseline, Sub Chapter 2.2.1.2 on Terrestrial Fauna.

- **Impact Prediction**

  The fauna mentioned above were found in lowland tropical rainforest ecosystem in the location planned to be cleared for the Tangguh LNG Expansion project. The impact of change of fauna species diversity of the activity is not estimated to cause extinction, but will reduce the presence of the fauna, since the fauna will move to other locations.

- **Impact Evaluation**

  Based on survey results in 2011, 15 mammal species were found, in which one species, the Deer (*Cervus timorensis*) was included in vulnerable category in IUCN and also protected by the Government of Indonesia in Government Regulation No.7 Year 1999.

From the bird group, 146 types were found. One bird type, the *Kasuari Gelambir Ganda* (*Casuarius casuarius*) was included in V*ulnerable* category in the IUCN list. The Julang Papua Bird (*Rhyticeros plicatus*), although entered IUCN Data Deficiency category, the species was endemic to Papua and one indicator that the forest in the Tangguh LNG area was still in sufficiently good condition for reproduction of fruit eating fauna species (Frugivora) and relatively intact mutualistic relation (mutually beneficial) between tropical plant pollinating fauna species.

Herpetofauna found consisted of 31 species consisting of 12 amphibian species and 19 reptile species. Only three species entered the IUCN list with category of *Least Concern*, two species were protected by the Government of Indonesia through Government Regulation No.7 Year 1999 and three species included in CITES for Appendix II.

The wildlife mentioned above were in ecosystem of lowland forest to be cleared for the Tangguh LNG Expansion Project. In terms of condition of habitat, the wildlife habitat was not the only one in the ANDAL study area, and in fact similar habitats outside perimeter fence of Tangguh LNG area were still quite extensive.

With 'local' impact extent, although impact duration in the category of 'permanent' and involving protected fauna, the impact magnitude is in category of 'medium'.

Rare and protected wildlife species found in the Tangguh LNG project area are also commonly encountered outside the project area and have adaptability toward environmental change, so that receptor sensitivity may be categorized as 'low'. However, due to presence of fauna in vulnerable and least concern category, receptor sensitivity to change in fauna diversity is in category of 'medium'

With 'medium' impact magnitude and 'medium' level of receptor sensitivity, the impact severity of change in fauna diversity is in category of 'high'.

Change in fauna diversity will follow the phases of land clearing, i.e. land clearing in the first year for the area required in the initial construction phase (Early Work) measuring ± 125 ha and second year for remaining land to be cleared in the future construction phase measuring ± 375 ha, so that the impact likelihood will occur once in each phase (in different space and time).

Impact severity is in 'high' category and impact likelihood is in 'small' category, so that change in species diversity possesses 'moderate' impact significance.

Table III-111 Impact Evaluation – Change in Fauna Species Diversity

Impact Description	*Impact on fauna species diversity is the impact of land clearing activities and construction of the LNG Train and its facilities.* *It is estimated that the impact of change in fauna species diversity from this activity will not cause extinction of fauna species, but will reduce the presence of the fauna, since the fauna will move to another location.*				
Impact Nature	**Negative**	**Positive**			
	Change in wildlife habitat will reduce wildlife habitat in the project area. This will be a negative impact, since the diminishing habitat will be converted to LNG Trains 3 and 4 and supporting facilities.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in fauna diversity is a derivative impact of change in distribution of fauna species and change in structure and composition of flora species due to land clearing activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The change in fauna diversity as an impact of change in wildlife habitat due to land clearing activities for LNG Train 3 and 4 and supporting facilities will be permanent. Land to be cleared consists of forest that is a wildlife habitat. The loss of vegetation on land to be cleared will cause change in structure and composition of flora species that will affect movement, and change in fauna species diversity.				
Impact Extent	**Local**	**Regional**	**Global**		
	*Of the total Tangguh LNG area measuring 3,266 ha, land covering ± 365 ha have been cleared for LNG Train 1 and 2, perimeter fence of Tangguh LNG area measuring ± 39 ha and land clearing plan for Tangguh LNG Expansion of ± 500 ha (consisting of ± 490 ha lowland forest and ±10 ha mangrove forest). So that after revegetation of ± 100 ha, the forest area not used by Tangguh LNG and its development will measure ± 2,462 ha functioning as b*uffer zone. *The impact extent is limited to the planned land clearing area in the Tangguh LNG area. Thus the impact extent of change in fauna species diversity in the Tangguh LNG project area is in 'local' category.*				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	*Based on survey results in 2011 , 15 species of mammals were found , in which one species,i.e. the Deer (*Cervus timorensis*) was in category of* Vulnerable in the *IUCN and also protected by the Government of Indonesia in Regulation No.7/1999.* *Of the bird group, 146 species were found. One bird species namely Kasuari Gelambir Ganda (*Casuarius casuarius*) is in the category of* Vulnerable in the *IUCN list. Papua Julang bird (*Rhyticeros plicatus*), although not registered in the IUCN, is an endemic species of Papua and an indicator that the condition of forest in the Tangguh LNG area can still support the development of fruit eating bird species (*Frugivora*) and of relatively-intact mutualistic relations between tropical plant pollinator fauna species.* *Herpetofauna found consisted of 31 species encompassing 12 amphibian species and 19 reptile species. Only three species are in the IUCN list in category Least Concern, two species are protected by the Government of Indonesia through Regulation No.7/1999 and three species are included in CITES for* Appendix *II.* *The fauna mentioned above were found in lowland forest ecosystem to be cleared for the Tangguh LNG expansion project.* *The forest area to be cleared and functioning as wildlife habitat measures ± 500 ha (± 10 ha mangrove and ± 490 ha lowland forest). It is not the only wildlife habitat in the ANDAL study area, and in fact similar habitats outside the limits of the study area are still quite extensive.* *With the impact extent in 'local' category, however it is of permanent duration and involving protected fauna, thus the impact magnitude is in 'medium' category.*				

Receptor Sensitivity	**Low**	**Medium**	**High**		
	*Rare and protected wildlife species found in the Tangguh LNG project area are also commonly found outside the project area and have adaptability to environmental change , so that receptor sensitivity may be categorized as 'low'. However due to presence of fauna classified as v*ulnerable and least concern, the *receptor sensitivity to change in fauna diversity is in category of 'medium'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	With 'medium' impact magnitude and 'medium' receptor sensitivity , the impact severity of change in fauna diversity is in 'high' category.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	*Change in distribution of wildlife species will follow the phases of land clearing, namely land clearing in the first year for the area required in the initial construction phase (*Early Work*) measuring ± 125 ha and in the second year for the remainder of land to be cleared in the future construction phase measuring ± 375 ha, so that the impact likelihood occurring is one time in each phase (in different time and space). Of total Tangguh LNG area measuring ± 3,266 ha, after land utilization for the current LNG Train facility and its development, around 2,462 ha of lowland forest still serve as buffer zone and still shelters similar fauna species as those found in the cleared areas. Therefore, the impact of change in fauna species distribution is in category of 'small'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact severity is in category 'high' and impact likelihood is in 'small' category, so that change in species diversity possesses 'moderate' impact significance and is a significant impact.				

b. Change in Distribution of Fauna Species

- **Environmental Baseline**

The results of the flora and fauna survey in 2011, identified that the lowland forest had the highest level of findings and diversity for all taxa, namely mammals, birds, herpetofauna and insects.

Based on survey results of 2011 in the Tangguh LNG area, 11 mammal species were found consisting of seven types of fruit-eating bats, two types of insect-eating bats and two types of rats. Besides the 11 species, four species of mammals were positively identified in the Tangguh LNG site, namely the Timor Deer (*Cervus timorensis*); wild pigs (*Sus scrofa*) and stray dogs (*Canis Familiaris)* and Cats (*Felis domesticus*), in which the Timor Deer (*Cervus timorensis*) is included in the category of vulnerable species in IUCN and also protected by the Government of Indonesia in Regulation No.7 Year 1999.

As for birds, 146 bird types were found , encompassing as 63 types found in lowland forest Transect-1, 88 types in lowland forest Transect-2, 86 types found in lowland forest Transect-3, 22 types found in mangrove ecosystem, 28 types found in coastal forest, and 24 types found in savanna and the Tangguh LNG project area.

Herpetofauna were predominantly found in lowland forest rather than mangrove forest, swamp forest or areas around *Camp* Stinkul, the overnight camp area. Amphibians were only found in lowland forest and *Camp* Stinkul. Reptiles were found in three habitats, namely lowland forest, mangrove forest and swamp forest. Two types of snakes were only found in lowland forest.

Insects were found in nearly all survey locations, namely in lowland forest, lowland areas and around rivers, mangrove and swampes near the coast. Locations with predominance of insects were in lowland forest, consisting of 24 types encompassing 11 dragonfly, six bees and seven bugs. In the coastal swamp area, 15 types were found consisting of seven dragonflies, five bees and three bugs. Furthermore, in lowland and river areas, the 14 types found were ten dragonly, two bees and two bugs, while mangrove was the location with lowest number of insect findings, or only four types consisting of dragonflies.

- **Impact Prediction**

Reduction of the lowland forest and mangrove area for development of facilities related to Tangguh LNG Expansion plan measuring respectively ± 490 ha and ± 10 ha may result in declining area of wildlife habitat. Apart from that, tree cutting activities with chainsaw and use of equipment during construction have potential to raise noise level that will cause migration of some fauna species (birds, mammals, reptiles, amphibians).

With the possibility of wildlife migration due to land clearing activities, there is potential of change in fauna species distribution.

Fauna species with difficulty in adapting to new environments are among others land mammals such as wallaby (*Dorcopsis muelleri*), *Echymipera Clara*, *Echymipera kalubu*, *Petaurus breviceps*, and *Strigocuscus gymnotis*, and particularly species protected by Government Regulation No. 7 Year 1999, IUCN, and CITES.

- **Impact Evaluation**

Impact toward change in distribution of species is a secondary impact of decreasing wildlife habitat that will cause several species to move from their native habitats and may eventually cause change in distribution of species in the area. The area of habitat undergoing conversion (± 500 ha) is small compared with the total area of the Tangguh LNG area (3.266 Ha) and similar types of wildlife habitat are still found around the project location, so as to enable wildlife to seek new habitat outside the Tangguh LNG area as well as outside the study area border.

Change in species distribution in terms of movement pattern will have direct consequence on the wildlife activities. The receptors of habitat change are the wildlife included in protected category by the Government of Indonesia and in rare category by IUCN. However, habitats of wildlife in categories of rare and protected are also commonly found outside the project area , and the wildlife have adaptability to environmental changes so the receptor sensitivity is in 'medium' category .

Thus the impact magnitude is in 'medium' category and as the receptor sensitivity is also in 'medium' category, change in species distribution included in impact severity is 'high'. Impact likelihood is in 'small' category, since change in species distribution will follow the phases of land clearing, namely land clearing in the first year for areas required in initial construction phase (Early Work) measuring ± 125 ha and in the second year for remaining land to be cleared in future construction phase measuring ± 375 ha, so that the impact likelihood will occur once in each phase (in different space and time).

Impact severity is in 'high' category with impact likelihood in 'small' category 'small', the impact significance of species distribution is in 'moderate' category.

Table III-112 Impact Evaluation – Change in Fauna Species Distribution

Impact Description	*The impact on fauna distribution derives from land clearing and construction activities of the LNG Train and supporting facilities. Land clearing also has potential to cause wildlife migration, so as to also cause change in distribution of fauna species.*				
Impact Nature	**Negative**	**Positive**			
	Change in distribution of fauna species is negative since it will result in migration of species including fauna species that have difficulty in adapting to new environment as well as protected species.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The impact of change in distribution of fauna species is a secondary impact of rising noise level and reduced wildlife habitat due to land clearing and construction of LNG Train and its supporting facilities that can cause species to migrate from their native habitat and change the species distribution in the area. Thus the change in fauna species distribution is a derivative impact.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Change in wildlife habitat affecting change in fauna species distribution due to land clearing activities will continue past the project period, so that the Duration of Impact is permanent.				
Impact Extent	**Local**	**Regional**	**Global**		
	Of the total Tangguh LNG area measuring 3,266 ha , land clearing for LNG Train 1and 2 measures ± 365 ha, Tangguh LNG area perimeter fence of ± 39 ha and land clearing plan for Tangguh LNG expansion of ±500 ha (consisting of ± 490 ha lowland forest and ± 10 ha mangrove). So that after revegetation of ± 100 ha, forest not used by Tangguh LNG and its development of ± 2,462 ha functioning as buffer zone. *Impact extent is limited to the area to be cleared in the Tangguh LNG area. Thus, change in fauna species distribution due to change in wildlife habitat in the Tangguh LNG project area is 'local'.*				
Impact	**Negligible**	**Low**	**Medium**	**High**	

Magnitude	*Tree cutting with chainsaw and use of equipment during construction have potential to raise the noise level that will cause migration of some fauna species (birds, mammals, reptiles, amphibians). Fauna species having difficulty adapting to new environments include land mammals such as the wallaby (Dorcopsis muelleri), Echymipera clara, Echymipera kalubu, Petaurus breviceps, and Strigocuscus gymnotis, as well as particular species protected by Government Regulation No. 7 /1999, IUCN, and CITES.* *The habitat area estimated to change (measuring ± 500 ha) that will be used for Tangguh LNG Expansion is relatively 'small' in comparison to total area of Tangguh LNG (3,266 ha).*				
	Areas of lowland forest that have been cleared for LNG Train 1 and LNG Train 2 and their supporting facilities measure ± 404 ha (including Tangguh LNG area perimeter fence of ± 39 ha) in which approximately 100 ha have been revegetated. The forest area not utilized by Tangguh LNG and its development measures ± 2,462 ha functioning as buffer zone, *in which fauna species including similar wildlife are still found.* *With impact extent of local but permanent nature and involving protected fauna the impact magnitude is in 'medium' category.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Change in species distribution, in terms of movement pattern, will have direct impact on lives of fauna. The Receptors of habitat change are the wildlife included in protected category by the Government of Indonesia and rare category by IUCN. *However, habitats of rare and protected wildlife are also commonly found outside the project area and the wildlife have adaptability to environmental change, so that receptor sensitivity is in 'medium' category.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since impact magnitude is in 'medium' category and receptor sensitivity also in 'medium' category, change in species distribution included in impact severity is 'high'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	*Change in wildlife species distribution will follow the phases of land clearing, namely land clearing in the first year for the area required in the initial construction phase (*Early Work*) on ± 125 ha and the second year for the remainder of land to be cleared in future construction phase on ± 375 ha, so that impact likelihood will occur once in the respective phases (in different space and time).* *There will be potential change in species distribution with movement of wildlife, in which several species will be able to move from their original habitats and adapt to new environments. Of the total Tangguh LNG area covering ± 3,266 ha, after land utilized for the current LNG Train facility as well as its development there will still be around 2,462 ha lowland forest functioning as* buffer zone *and sheltering similar fauna species as those in the cleared area. Therefore the impact likelihood of change in fauna species distribution is in category of 'small'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	As the impact severity is in category of 'high' with impact likelihood in category of 'small', the significance of impact of species distribution change is in 'moderate' category and is a significant impact.				

c. Change in Wildlife Habitat

- **Environmental Baseline**

The types of ecosystems present in the Tangguh LNG area and the vicinity comprise of mangrove forest, coastal forest, swamp forest and lowland forest. As a wildlife habitat, the presence of the ecosystem types have provided shelter for wildlife.

Of the total project area measuring ± 3,266 ha, the area cleared measures ± 404 ha (± 365 ha for LNG Train 1 and 2 and their supporting facilities and ± 39 ha for the Tangguh LNG area perimeter fence). Of the ± 404 ha that have been cleared, ± 100 ha have been revegetated. A maximum area of ± 500 ha (± 10 ha mangrove forest and ± 490 ha lowland forest) will be cleared for Tangguh LNG Expansion activities. Therefore, forest area measuring ± 2,462 ha remains and will be managed as buffer zone and also as wildlife habitat.

- **Impact Prediction**

  Land clearing and tree cutting for the Tangguh LNG Expansion area are predicted to reduce the wildlife habitat area in Tangguh LNG area to about ± 20%. Change to wildlife habitat will only occur in the cleared area of ± 500 ha (± 10 ha mangrove forest and ±490 ha lowland forest). The quality of the wildlife habitat is also predicted to decline due to noise from land clearing, heavy equipment mobility, and human activities.

- **Impact Evaluation**

  The forest area to be cleared and which is wildlife habitat measures ± 500 ha (± 10 ha mangrove and ± 490 ha lowland forest). The habitat is not the only wildlife habitat in the ANDAL study, and in fact similar habitat outside the study area (outside Tangguh LNG area fence) is still quite extensive.

  Several types of animals are protected and included as rare species according to IUCN, namely the Deer (*Cervus Timorensis*) and Kasuari Gelambir Ganda (*Casuarius casuarius*) listed by IUCN in the Vulnerable category. Apart from that, a bird species is endemic to Papua, i.e. the Julang Papua Bird (*Rhyticeros plicatus*) and Estuary Crocodile (*Crocodylus porosus*) in the protected list of the Government of Indonesia. The presence of rare and protected wildlife species is not only found in the Tangguh LNG area, but is also common outside the project area. In addition, the wildlife have adaptability to environmental change, so that the rare and protected fauna species are able to adapt.

  The duration of impact is estimated to be permanent and impact extent is 'local' thus making the impact magnitude of change in wildlife habitat in category of 'medium'.

  Change in wildlife habitat of reduced area will directly affect wildlife activities, however the presence of rare and protected wildlife species is also common outside the project area, with adaptability to environmental change, so that receptor sensitivity is in 'medium' category.

  Combined impact magnitude in 'medium' category and receptor sensitivity in 'medium' category, thus impact severity of change in wildlife habitat is in 'high' category

Change in wildlife habitat will follow the phases of land clearing, i.e. land clearing in the first year for the area required in the initial construction phase (Early Work) measuring ± 125 ha and in the second year for the remaining land to be cleared in the future construction phase measuring ± 375 ha, so that the impact likelihood will occur one time in each phase (in different space and time).

Impact severity is in 'high' category and impact likelihood is 'small', so that the impact significance of wildlife habitat change is categorized as 'moderate'.

Table III-113 Change in Wildlife Habitat

Impact Description	*Land clearing and tree cutting for the Tangguh LNG Expansion project are estimated to reduce the wildlife habitat area in the buffer zone of Tangguh LNG to about 20%.* *Change in wildlife habitat will only take place in the cleared area measuring 500 ha (± 10 ha mangrove forest and ± 490 ha lowland forest). The quality of wildlife habitat also declines as a result of land clearing activities during the construction phase of the Tangguh LNG Expansion Project.*				
Impact Nature	**Negative**	**Positive**			
	Land clearing will reduce wildlife habitat, in which habitat is a place to live, find food and reproduce for wildlife. The loss of vegetation cover from land clearing activities will also have an effect on decreasing habitat area.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Change in wildlife habitat is a direct impact of land clearing activities for development of LNG Train supporting facilities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Land to be cleared is composed of forest as a wildlife habitat. Loss of vegetation on land to be cleared will also cause a 'permanent' change in wildlife habitat.				
Impact Extent	**Local**	**Regional**	**Global**		
	Of total Tangguh LNG area measuring 3, 266 ha, land clearing has been conducted for LNG Train 1 and 2 measuring ± 365 ha, Tangguh LNG area perimeter fence of ± 39 ha and land clearing plan for Tangguh LNG expansion of ±500 ha (consisting of ± 490 ha lowland forest and ± 10 ha mangrove). So that after revegetation of ± 100 ha, the forest area not used by Tangguh LNG and its development will be ± 2,462 ha functioning as buffer zone. *The impact extent is limited to the area to be cleared in the Tangguh LNG area. Therefore, the impact extent of change in wildlife habitat in the Tangguh LNG project area is 'local'.*				
Impact	**Negligible**	**Low**	**Medium**	**High**	

<table>
<tr><td>Magnitude</td><td colspan="5">The type of ecosystem found in the Tangguh LNG area and the vicinity comprises of mangrove forest, coastal forest, swamp forest and lowland forest. As wildlife habitats, the presence of the ecosystem types can become home to wildlife.

The forest area to be cleared and as habitat for wildlife is ± 500 ha (± 10 ha mangrove and ±490 ha lowland forest). This is not the only wildlife habitat in the ANDAL study area, and in fact similar habitats found outside the study area borders are still quite vast.

Several species of rare and protected fauna according to IUCN are the Deer (Cervus Timorensis) and Kasuari Gelambir Ganda (Casuarius casuarius) listed in IUCN in category of Vulnerable. In addition, a birs species that is endemic to Papua is the Julang Papua Bird (Rhyticeros plicatus) and Estuary Crocodile (Crocodylus porosus) in the protected list of the Government of Indonesia. Rare and protected wildlife species, are not only found in the Tangguh LNG project area but also commonly found outside the project area. Apart from that, the wildlife have adaptability to environmental change, so that the types of rare and protected fauna are able to adapt.

The duration of impact is permanent and also the Impact extent that is local will make the impact magnitude of change in wildlife habitat in category of ‘medium’.</td></tr>
<tr><td rowspan="2">Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">Change in wildlife habitat in the matter of declining area will directly affect wildlife, however, rare and protected wildlife species are also commonly found outside the project area and have capacity to adapt to environmental change, so that receptor sensitivity is in category of ‘medium’.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Slight</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">Impact Magnitude is ‘medium’ and combined with receptor sensitivity in ‘medium’ category, makes impact severity of change in wildlife habitat in category of ‘high’.</td></tr>
<tr><td rowspan="2">Impact Likelihood</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Change in wildlife species distribution will follow the phases of land clearing, i.e. land clearing in the first year for the area required in the initial construction phase (Early Work) measuring ± 125 ha and in the second year for the remaining area to be cleared in the future construction phase of ± 375 ha, so that impact likelihood occurring is once in each phase (in different time and space). Of the total Tangguh LNG area measuring ± 3,266 ha, after land use for the current LNG Train facility as well as its development, there are still around 2,462 ha lowland forest functioning as buffer zone and possessing similar fauna species as those found in the cleared area. Therefore, the impact likelihood of change in wildlife habitat is in ‘low’ category.</td></tr>
<tr><td rowspan="2">Impact Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">Impact severity is in ‘high’ category and impact likelihood in ‘small’ category, thus the impact significance of change in wildlife habitat is ‘moderate’ and is a significant impact.</td></tr>
</table>

3.3.2.3 Marine Biota

a. Change in Nekton Diversity (Including Marine mammals)

- **Environmental Baseline**

  Predicted impacts on all varieties of nekton are focused on marine mammals as these types of marine biota are sensitive to disturbances caused by human activities.

  Several studies and monitoring activities of marine mammals in Bintuni Bay conducted by Tangguh LNG since 2005 to 2013 recorded the appearance of at least five species of marine mammals all of which are members of the *Cetacea* ordo consisting of four species of dolphins and one whale species, namely:

a. Indo-Pacific Hunchback dolphins (*Sousa chinensis*);

b. Spinner dolphins (*Stenella longirostris*);

c. Indo-Pacific bottle-nose dolphins (*Tursiops aduncus*);

d. Bottle-nose dolphins (*Tursiops truncatus*); and

e. Bryde whales (*Balaenoptera brydei*).

Marine mammals are divided into three Ordo, *Cetacea*, *Sirenia* and *Carnivora*. In tropical waters, specifically the waters of Bintuni Bay, so far only the *Cetacea order* was found, divided into two groups, the *Odontocetes and Mysticete.* All dolphin species found in Bintuni Bay waters are members of the *Odontocetes* group, while *Bryde* whales found are members of the Mysticete group.

Based on frequency of encounters and type found, *Sousa chinensis* was the most common, while the most infrequently found was the *Bryde* whale. Other dolphins such as *Stenella longirostris*, *Tursiops aduncus* and *Tursiops truncatus* have nearly similar percentage of encounters.

- **Impact Prediction**

Impact toward change in diversity of nekton (including marine mammals) originate from two activities, namely sea transportation activities for workforce, equipment and materials in the construction phase and wastewater disposal in the operation phase.

1. <u>Sea Transportation of Workforce, Equipment and Material</u>

Sea transportation during the construction phase will be required to support mobilization of workforce, materials and equipment. Vessels estimated to be used in the construction phase of LNG Train and supporting facilities are support vessel, tug boat, material barge and LCT.

The frequency and number of vessels used to transport equipment and materials during the construction phase is estimated based on list of equipment to be used, as shown in Table **I-16** on Estimate of **Equipment to be Used in LNG Train Construction**, Sub-chapter 1.2.3 on LNG Plant Activities**.** The equipment will be mobilized by barge to BOF jetty and Combo Dock.

In seawaters where visibility is a limiting factor, sound and hearing are absolute factors and very significant in the lives of marine mammals. Sound and hearing may be beneficial to maintain unity of the group in social life, for E*cholocation* in identifying and obtaining food, to detect the sound of approaching predators, and also to avoid dangerous situations such as potential collision with objects at sea (J. Gordon *et al*., 2004).

Most marine mammal groups produce and receive sound. Underwater vocalization may be *Clicking noise*, *Trills*, *Warbles*, *Whistles*, and vocalization resembling tinkling of bells (J. Gordon *et al*., 2004). The *Odontocetes* group is known to communicate at medium frequency (from 1 kHz to over 20 kHz) with several species also echolocating at high frequency (from 20 – 150 kHz). This is the reverse of the *Mysticetes* group, with echolocation system at low range of frequencies (<10 Hz - <10 kHz) (**Figure III-58**).

Activities of vessels are among the contributors to increase in underwater sounds in the sea, mainly those with low frequency, however higher sound frequency is also produced depending on vessel size and propulsion system used. It is estimated that around 85% of sounds from vessel activities are produced from ship propulsion systems due to rotation of *Propellers* (Barlow & Gentry 2004 in Genesis 2011). Noise produced has potential to mask sounds of marine mammal activities.

As shown in **Figure III-58** most sound energy emitted from vessels (commercial) is below 1 kHz, however it is also known that sounds from smaller vessels with stronger propulsion system are able to produce ambient sound at frequencies of over 1 kHz (Kipple 2002 in Genesis 2011). This condition has potential to disturb marine mammals that emit and receive sounds in low frequencies.

The potential for masking at higher frequencies (1-25 kHz) is present when ships approach marine mammal groups. In this condition, the *Odontocetes* group that also operates at the same frequency might experience sound masking by ships' noise.

The potential for masking of ships' noise may also impact on the behavior of marine mammals. Starting from small behaviors such as disorientation toward the sound source, to those of large potential such as long Term behavior change in the matter of searching for food, navigating and reproductive activities.

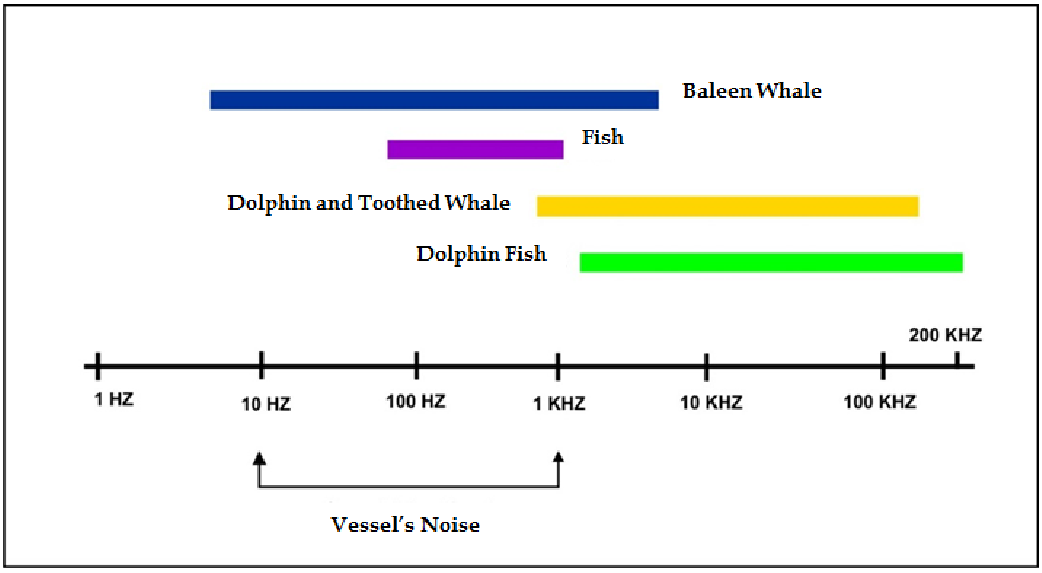


Figure III-58 Correlation of Frequency between Marine Mammal Sounds and Vessels' Noises (source: B. Southall, NMFS/NOAA)

When a vessel approaches, marine mammals may change or stop producing sounds that they use to communicate, search for food, avoid predators and other alertness toward their environment (Au & Green 2000, Van Parijs & Corkeron 2001). Bottle-nose dolphins (*Tursiops truncatus*) reportedly change their sound levels in the presence of rising noise levels due to ships.

Studies on the hearing of Indo-Pacific bottle-nose dolphins by Houser et al. 2008 described the hearing capacity of the mammal as ranging between 150 Hz to 160 kHz.

2. Wastewater Management

Tangguh LNG operation activities produce five types of wastewater:

- Produced water;
- Oilly contaminated water;
- Chemically contaminated water;
- Brine water reject; and
- Domestic wastewater (sewage).

Each type of wastewater will be managed and monitored prior to commingling into the discharge pipeline and discharged through the same outfall at LNG 1 jetty or LNG 2 jetty. The total amount of wastewater is estimated to be 1,900 m^3/hour for operation of the four trains and their supporting facilities.

The impact of wastewater management activities toward change in nekton diversities (including marine mammals) is a secondary impact of ammonia increase in seawater.

Based on modeling of wastewater discharge options in LNG 1 jetty and LNG 2 jetty as explained in Sub chapter 3.1.1.2 Seawater Quality Impact in relate to ammonia parameter it may be concluded that ammonia concentration exceeding 0,3 mg/L (Water Quality Standard, Minister of the Environment Regulation No. 51 Year 2004 for Marine biota) only occurred in radius 500 m from the outfall, while for disposal option at LNG 2 jetty only occurred in radius 100 m from the outfall.

- **Impact Evaluation**

As described above, noise produced by human activities (*Anthropogenic*), including sea transportation activities have potential disturbance to several physiological functions of marine mammals including short- term behavioral change and with worst assumption of behavioral change it might occur in the long term (Payne & Webb 1971, NRC 2003, 2005). The type and impact magnitude depend on characteristics of sound source, environment and marine mammals as receptors. The large number of small vessels used that generally have strong propulsion system emitting noise at low to medium frequencies, may have an impact of masking sounds of the *Odontocetes* group (including dolphins) frequently found in Bintuni Bay waters. Additionally, low frequency noises produced by large ships such as *Tankers* may impact on sound masking for the *Mysticetes* group, i.e. *Paus Bryde* that was also encountered in Bintuni Bay waters.

The possibility of mammal collision by moving ship might occur although so far since the presence of Tangguh LNG no such incident has been recorded that was due to Tangguh LNG activities. Several types of marine mammals will immediately avoid areas disturbed by ships' movements, however conversely several types of marine mammals especially groups of *Sousa chinensis* dolphins will approach moving vessels (Erftemeijer, et. al. 1989). For current operational activities, Tangguh LNG has implemented a procedure for marine mammal protection, among others regulations on vessel routes and speed. This procedure will continue to be applied for Tangguh LNG Expansion activities.

Evaluation of the impact of liquid waste disposal on higher ammonia concentration gives 'minor' result so that it is estimated that potential derivative impact will not cause significant impact on nekton (including marine mammals).

Based on the above description, the impact of sea transportation activities for workforce, equipment and materials in the construction phase of LNG Train and supporting facilities, as well as wastewater discharge in the operation phase toward change in nekton diversity (including marine mammals) is in 'medium' category.

Table III-114 Impact Evaluation – Sea Transportation Activities for Workforce, Equipment and Materials and Wastewater Management Activities toward Change in Nekton Diversity (including Marine mammals)

Impact Description	*Change in nekton diversity (including marine mammals) due to sea transportation for workforce, equipment and materials in the construction phase and wastewater discharge in the operation phase.* *<u>Sea Transportation for workforce, equipment and material</u>* *Source of potential impact of sea transportation activities originate from vessel movement and underwater noise from vessels. Vessels estimated to be used in the construction phase of the LNG Train and supporting facilities are* support vessels, tug boats, material barges *and LCT.* *<u>Wastewater discharge in the operation phase</u>* *Tangguh LNG operation activities produce five types of wastewater:* 1. *Produced water;* 2. *Oilly contaminated water;* 3. *Chemically contaminated water ;* 4. *Brine water reject; and* 5. *Domestic wastewater (Sewage).* *Each type of wastewater will be managed and monitored prior to comingling into the discharge channel and discharged through the same outfall in LNG 1 jetty or LNG 2 jetty. The total amount of wastewater is estimated to be 1,900 m^3/hour for operation of the four LNG Trains and supporting facilities.*				
Impact Nature	**Negative**	**Positive**			
	Marine mammals (dolphins and whales) are sensitive to direct disturbance from vessel movement of waves formed and possibility of collision with marine mammals, besides that acoustic energy caused by transportation activities may disrupt communication and navigation systems of marine mammals so that they will avoid the area.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Disturbance due to underwater noise, waves formed and possible collision of marine mammals are direct impacts of vessels' movements. *Wastewater discharge, in this case especially increase in concentration of ammonia, may cause derivative impact of disturbance toward nekton (including marine mammals).*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact of vessel movement for sea transportation of workforce, equipment and material will be sustained during the construction phase (up to 4 years) while the impact of wastewater discharge will continue during the operation period of the Tangguh LNG project , i.e. for ±25 year since the operation phase commences. Therefore the Duration of Impact is categorized as 'Long Term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Sea transportation activities for workforce from Babo and Kokas heading to Combo Dock, *equipment and material may originate from outside Bintuni Bay toward BOF as well as* Combo Dock *and in the opposite direction.* *Wastewater discharge activities during the operation phase will be made from LNG 1 jetty or LNG 2 jetty.* *Based on modelling of wastewater discharge from LNG 1 jetty (option 1), increase in concentration of ammonia higher than requirement (0.30 mg/L based on Environment Minister Regulation Number 51 Year 2004 for marine biota) will only occur within radius of 500 m, while for LNG 2 jetty (option 2) until radius of 100 m from the outfall.* *Overall, the impact extent will be 'local'.*				
Impact	**Negligible**	**Low**	**Medium**	**High**	

Magnitude

Marine mammals commonly found in Bintuni Bay are Sousa chinensis besides Stenella longirostris, Tursiops aduncus and Tursiops truncates from the Odontecetes group (dolphins and toothed whales) producing and receiving sounds at frequencies of nearly 1 kHz to nearly 200 kHz.

Sea Transportation of workforce, equipment and material

Bintuni Bay is the habitat of several species of dolphins and whales such as Sousa chinensis and Stenella longirostris, which are sensitive to acoustic energy. Acoustic energy produced from ships' movements may cause disturbances of communication, navigation and orientation to marine mammals.

As shown in ***Figure III-58*** *most of the sound energy emitted from ships (commercial) are below 1 khz (**Figure III-58**), however it was also known that noise from smaller vessels with stronger propulsion system were able to produce ambient noise at frequency over 1 kHz (Kipple 2002 in Genesis 2011). The condition has potential to disturb marine mammals that emit and receive low frequency sounds.*

The potential of masking at higher frequency (1-25 khz) occurs when vessels are near a group of marine mammals. In such condition, the Odontocetes group that also operates at the same frequency might experience sound masking by vessel's noise.

Besides sound masking due to vessel's noise, potential vessels noises may also impact on the behavior of marine mammals. Starting from small behaviors such as disorientation toward sound sources, to larger ones such as long-term behavioral change in searching for food, navigation and reproductive activities.

Possible collision of mammals with moving ships may occur although since the presence of Tangguh LNG up to now such incidents due to Tangguh LNG activities have not been recorded. Several species of marine mammals will immediately avoid the area disturbed by vessel's movement, however on the other hand several species of marine mammals mainly groups of Sousa chinensis dolphins will approach the moving ship (Erftemeijer, et. al. 1989).

Wastewater discharge in the operation phase

Modeling of wastewater discharge was done using the figure 1,900 m^3/hour for total amount of wastewater discharged with concentration of ammonia of 3,7 mg/L.

Wastewater discharge in LNG 1 Jetty

Results of modeling indicate that in the wet season, concentration of ammonia will rise to 0,67 mg/L in radius 50 m from outfall, *and 0,37 mg/L in radius 100 m and 0,08 mg/L in radius 500 m from the outfall. Meanwhile in the dry season, concentration of ammonia will reach 0,82 mg/L in radius 50 m, and 0,59 mg/L in radius 100 m and 0,08 mg/L in radius 500 m from outfall.*

Option 2 – Wastewater discharge at LNG 2 Jetty.

Results of modeling indicated that in the wet season concentration of ammonia will become 0.38 mg/L in radius 50 m from outfall, *and 0.17 mg/L in radius 100 m, and 0.05 mg/L in radius 500 m. Meanwhile in the dry season there will be rising concentration of ammonia of 0.37 mg/L in radius 50 m, then 0.14 mg/L in radius 100 m, and 0.06 mg/L in radius 500 m from outfall.*

From current Tangguh LNG operational records (January 2012-May 2013), produced water discharge exceeding ammonia quality standard of 5 mg/L according to wastewater discharge permit occurred only once for approximately one month prior to the produced water processing installation with biological process resuming normal operation. During that period, ammonia concentration in the sea around the outfall was monitored with results below 0.05 mg/L that was still less than ambient seawater quality standard in effect.

Based on the above explanation, the impact magnitude is in category of 'medium'.

Receptor	**Low**	**Medium**	**High**		

Sensitivity	*Receptors are nekton (in category of marine mammals) sensitive to acoustic energy.* *Besides masking sounds of vessel's noises, potential vessel noises may also have an impact on the behavior of marine mammals. Starting from small behaviors such as disorientation of direction toward the sound source, until large potential such as long-term behavioral change in searching for food, navigating and reproductive activities. However, nekton have high ability to swim and avoid.* *Similarly in areas with condition of high ammonia, nekton are able to evade, so that receptor sensitivity is in category of 'medium'.*				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	Since the impact magnitude and receptor sensitivity are in 'medium' category, the impact severity is in 'high' category.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Possible disturbance toward marine mammals caused by transportation activities is small based on current experience in which dolphins are even found swimming behind vessels. *Mounting concentrations of ammonia generally occur only during or after* start up *or in abnormal condition in the event of technical disturbance in produced water processing unit so that disturbance to nekton as a result of wastewater discharge is small*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Since impact severity is 'high' and impact likelihood is 'low', the significance of impact is categorized as 'moderate' and is a significant impact				

3.3.3 Social – Economic – Cultural

3.3.3.1 Demography: Changes in Migration (Mobility), Change of Population Structure and Population Growth

a. Environmental Baseline

Construction Phase

The high economic growth in the Teluk Bintuni and Fakfak regencies because of the disclosure of area and industrialization (one of them is Tangguh LNG) to any destination in the population migration into the two areas. The districts of Babo, Bintuni, and Kokas become the entry point of people coming outside the region, which enter by sea, air and land transportation. According to UGM (2009), migrants entering this area are aiming to look for employment and establish businesses. With an average population growth per year in Teluk Bintuni Regency of 3.50% and in the Fakfak Regency of 3.92%, it indicates that the migrants exceed natural population growths due to births and deaths. For example, the population composition at the Tanah Merah, Saengga, and Onar Villages in the Sumuri District in 2002 and 2009, can be observed in detail in **Table III-104**.

Table III-115 Inhabitants of Tanah Merah, Saengga and Onar Based on the Category of Indigenous People and Permanent Migrants in 2002 and 2009

No.	Category of Inhabitants	Tanah Merah (persons)		Saengga (persons)		Onar (persons)	
		2002	2009	2002	2009	2002	2009
1	*Indigenous people*	617	516	435	433	175	132
2	*Permanent migrants*	0	216	0	191	0	190

No.	Category of Inhabitants	Tanah Merah (persons)		Saengga (persons)		Onar (persons)	
		2002	2009	2002	2009	2002	2009
Total		617	732	435	624	175	322

Source: adopted from the Center of Population and Policy Studies, UGM, 2009

Three districts with the largest population growth are respectively the Bintuni District (11.35%), Sumuri District (8.39%), and Babo District (8.18%). The Bintuni District is the capital city of the Teluk Bintuni Regency, while the Sumuri District is the location in which the Tangguh LNG operates, bordering close to the Babo District. While three districts with the highest population growth are respectively the Central Fakfak District (6.78%), Fakfak District (6.01%), and East Fakfak (4.10%).

Population growth due to migration influx into the Bintuni Bay area can be observed in **Table III-116.** The data indicates that an increased percentage of migrant population in 2007 and decreased in 2009 occur particularly in Tanah Merah and Saengga Villages. This phenomenon occurred because year 2007 was the peak of construction work in the Tangguh LNG 1 and 2 Train Expansion Project, which was then followed by a decrease in the population growth percentage in the two villages as Tangguh LNG started to operate in 2009.

Data of 2010 indicate a population of unproductive age (age < 14 years and > 64 years) and productive age (age 14–64 years) in the Teluk Bintuni Regency that are respectively 35.57% and 64.43%, while for the Fakfak Regency are respectively 36.64% and 64.36%. Meanwhile, the population structure based on religious groups are Christians, Muslims, Catholics and other religions (Hindu, Buddha, and Confucianism) in the Teluk Bintuni Regency are respectively 37.60%; 46.31%; 15.91%; and 0.17%, while for the Fakfak Regency it is respectively 21.40%; 59.02%; 19.30%; and 0.28% (BPS Bintuni Bay and Fakfak, 2011).

The following **Table III-105** indicates an actual change in the number of religious people since 2002, 2007, and 2009 in the Tanah Merah, Saengga, and Onar Villages in the Sumuri District, the location in which Tangguh LNG operates.

Table III-117 Development of Religious People in the Tanah Merah, Saengga, and Onar Villages in 2002, 2007 and 2009

No.	Religion	Villages in the Sumuri District – Location of LNG BP Tangguh								
		Tanah Merah (%)			Saengga (%)			Onar (%)		
		2002	2007	2009	2002	2007	2009	2002	2007	2009
1	Christian	56.7	55.8	53.5	4.2	14.4	12.5	8.5	24.9	34.9
2	Catholic	25.0	21.1	22.0	94.6	70.3	16.8	49.7	19.2	17.6
3	Muslim	18.3	21.7	23.3	1.2	15.3	70.7	41.8	55.6	47.5
4	Hindu	-	0.9	1.2	-	-	-	-	0.3	-
5	Buddha	-	0.5	-	-	-	-	-	-	-

Source: adopted from the Center of Population and Policy Studies, UGM, 2009

As illustrated in the following **Table III-89,** in 2003 the comparison percentage of Indigenous People and permanent migrants were 71%:29%. Increasingly, this comparison changed in which the percentage of the Indigenous People decreases and finally in 2027 dropped sharply to only 18%, while the migrant population increased to 82%. The percentage comparison of the Indigenous People and migrant population at the time Tangguh LNG operated in 2019 is 42% (Indigenous People) compared to 58% (migrant population).

Table III-118 Inhabitants of Tanah Merah, Saengga, and Onar Based on the Percentage Category of the Indigenous People and Migrant Population in 2002, 2007, and 2009

No.	Tribe/Ethnic	Percentage of Population Growth of Indigenous People and Migrants in the Villages of Sumuri District								
		Tanah Merah (%)			Saengga (%)			Onar (%)		
		2002	2007	2009	2002	2007	2009	2002	2007	2009
A.	**Indigenous People**									
1	Sumuri	75.5	58.4	60.8	76.1	60.8	72.4	49.0	42.8	45.8
B	**Migrant**									
2	Bugis, Buton, and Makasar	0.3	3.7	4.7	0,1	11,8	9.2	4.6	7.9	8.1
3	Maluku	4.4	10.1	7.5	0.6	3.6	2.1	27.8	37.3	7.9
4	Other (Java, Sunda, Batak, etc)	19.8	27.8	27.0	23.2	23.8	16.3	18.5	28.1	19.3
Total B		24.5	41.6	39.2	23.9	39.2	27.6	50.9	36	35.3

Source: adopted from Population and Policy of UGM Study Center, 2009

b. Prediction and Evaluation of Impact

Construction Phase – Prediction of Impact

The LNG Plant construction activities and its support facilities (the camp and health facilities), including the Marine Facilities construction, will absorb more or less 10.500 workers. This activity is predicted to have an impact on the in-migration population from various areas for employment or establish businesses as illustrated in **Figure III-59**, regarding the influx of migrants in three villages in 2009 at the start of the LNG Train 1 and 2 operations. Similarly to survey results performed in 2002 until 2012, it was predicted that there will be an increase in the in-migration in the Bintuni Bay area based on economic interests. The projected number of migrants in 2014 is estimated to reach 5,661 people, whereas the projection in 2015 is estimated to reach 7,516 people. This in-migration will certainly increase the number of population and change the population structure according to age, education, gender, ethnic and religion. It can be clearly prediction that the influx of 10,500 workers will increase the percentage of the productive age group that will change the population structure in the surroundings of the Bintuni Bay. Apart from that, in-migration is predicted to cause pressure on the existence opf the Indigenous People.

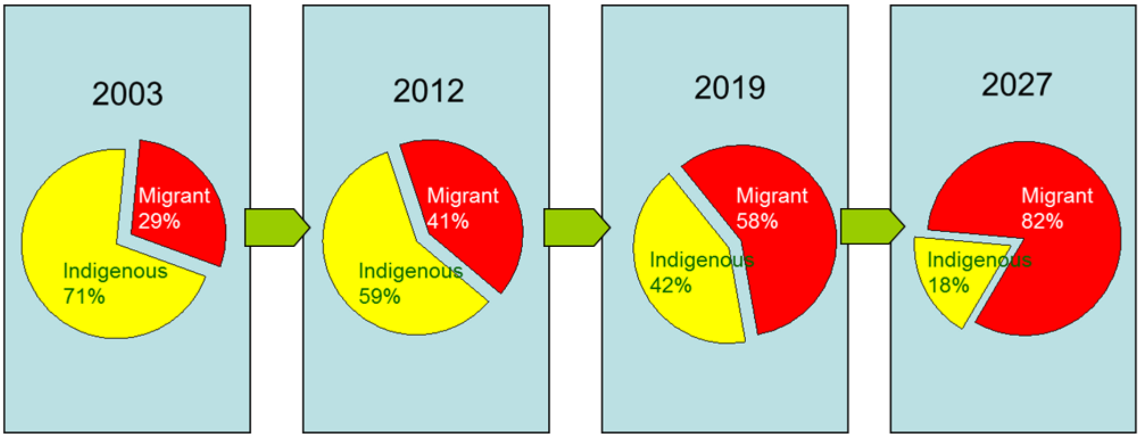


Figure III-59 Projection of Indigenous People and Migrant Composition

The impact on changes in demographics (migration, structure and population growth) has a secondary derivative impact in the form of assimilation and acculturation, increased vulnerability of the Indigenous People, the changes in disease pattern, and tertiary derivatives such as changes in social norms and values, changes in cultural heritage, changes in environmental health and changes in disease prevalence.

The demobilization process of workforce is identified to lead former workers to seek better economic opportunities in other areas, or return to their hometowns. It should also be noted that part of the workers originating from other regions would possibly settle in the surroundings of the Bintuni Bay because of other economic opportunities apart from the Tangguh LNG operation activities. This is predicted to have a long-term impact on the structure of community population in the study area.

At the end of the construction period, there will be the workforce demobilization process, in which workers will return to their original places that will have impacts on outgoing migration, changes in population structure and population growth. Part of the workers may decide to remain in the villages surrounding Tangguh LNG operation site to obtain other economic opportunities, apart from the Tangguh LNG operation activities.

Construction Phase – Impact Evaluation

Although the LNG Plant construction activities will last for 5 years so that it is classified as a 'short' period impact, however the in-migration workers may cause changes in demographic impact that will include impacts on the changes of the population structure and population growth during the construction phase of LNG Plant activities.

The construction work of the LNG Plant will provide work opportunities for the local community; however will also attract migrants from outside the Bintuni Bay area's to obtain job opportunities and business opportunities. This condition will most likely affect the community growth with 'negative' impacts on the local community structure change, such as the marginalized Indigenous People because they are less capable to compete with the migrants. Accordingly, the sensitivity of this impact can also be categorized as 'high'.

The impact likelihood is categorized as 'average' by considering the varied migration flow between the north shore and south shore of the Bintuni Bay and Fakfak. In the south shore, the likelihood of population migration and population structure changes tends to be higher due to the huge economic opportunities. Meanwhile, the likelihood of changes in population migration and population structure is relatively lower at the north shore of the Bintuni Bay and Fakfak compared to the south shore of the Bintuni Bay.

Table III-119 Impact Evaluation - LNG Plant Activities in Construction Phase against Demographic: Changes in Migration (Mobility), Changes in Population Structure and Growth

Impact	*Changes in demographic as a result of job opportunities and business opportunities of Indigenous People* prioritized) and local community is predicted to cause the changes in population structure and growth during the (LNG Plant activities in construction phase.*				
Nature of Impact	**Negative**	**Positive**			
	The LNG plant activities in construction phase will provide job opportunities to Indigenous People (prioritized) and local community. It will also attract migrants from outside the area to gain job and business opportunities, which will affect the population growth that negatively impact to population structure of Indigenous People*.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The LNG plant activities in construction phase will provide job opportunities to Indigenous People (prioritized) and local community. It will also attract migrants from outside the area. Thus, this activity is predicted to result changes in population structure.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG plant activities in construction phase will occur during less than 5 years, so the impact duration is classified as 'short'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The changes in population structure in the villages surrounding Tangguh LNG operation site cause the impact extent is classified as 'local'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Larger**	
	The average of population growth per year in Teluk Bintuni Regency is 3.50%, while Fakfak Regency reaches 3.92%. This shows that the number of migrants is more than the total of population growth due to birth and mortality.				
	The intensity of workforce recruitment by contractors is predicted to be conducted every month during the construction period (5 years) in the villages surrouding Tangguh LNG operation site. Job opportunities are predicted to attract migrants to the villages that will have an impact on changes in the population structure of Indigenous People. Thus, the magnitude of the impact is classified as 'average'.*				

<table>
<tr><td rowspan="2">Sensitivitas Penerima Dampak</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">The intensity of workforce recruitment by contractors is predicted to be conducted every month during the construction period (5 years) in the villages surrounding Tangguh LNG operation site. Job opportunities are predicted to attract migrants to the villages that will have an impact on changes in the population structure of Indigenous People*. Thus, the sensitivity received by the impact receptor is classified as 'high'.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">The impact magnitude that shows in-migration to the villages surrounding Tangguh LNG operation site as a result from job opportunities will change the population structure. On the other side, there are limited capacity of Indigenous People* and public services in the villages. Thus, if there is any pressure occured towards population structure, it will affect significantly to the existence of Indigenous People*.</td></tr>
<tr><td rowspan="2">Impact Likelihood</td><td>Very Small</td><td>Small</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">The impact likelihood is categorized as 'average' by considering the in-migration flows that vary between the north shore and south shore of Teluk Bintuni and Fakfak regencies. In the southern region, the opportunities of migration and changes in population structure tend to be high due to the huge economic opportunities. While in the north shore of Bintuni Bay and Fakfak, the opportunities of in-migration and changes in population structure are low (not significant).</td></tr>
<tr><td rowspan="2">Impact Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">There is the possibility of changes in population structure of local workforce recruitment activities during LNG plant activities in construction phase, but due to the sensitivity of Indigenous People* is 'high', then the impact of these activities can be categorized as an important impact ('major') and must be managed.</td></tr>
</table>

<u>*Operation Phase – Impact Prediction*</u>

The LNG Plant activities during the operations are predicted to last for 25 years and 1500 workers employed during this phase, are expected to impact the influx of people from various areas to work or start businesses. This migration influx will certainly increase the number of population and change the population structure according to age, education, gender, ethnic and religion.

During the construction phase, the characteristics and cultural identity of the Indigenous People* can be restored, if the migrants are likely to return to their point of hire. Then in the operation phase, the migrant workers will settle or there might even be a secondary derivative impact in the form of assimilation and acculturation, increased vulnerability of Indigenous People* and changes in disease patterns. In addition, tertiary derivative impacts also occur such as: changes in social norms and values, changes in cultural heritage, changes in environmental health, and changes in disease prevalence. As illustrated in the **Table III-108,** the percentage of the Indigenous People* in 2027 will drop sharply to only 18%, while the migrants will reach 82%. The percentage difference of the Indigenous people and migrants at the time the Tangguh LNG operates in 2019 is 42% (Indigenous people) compared to 58% (migrants). Whereas in 2003 the ratio was 71% compared to 29%. More can be observed in **Table III-108**.

Table III-120 Population Growth and its Prediction in the Surrounding Tangguh LNG operation in the year of 2003, 2012, 2019, and 2027

Num.	Population Categories	Population Growth (%)

		2003	2012	2019	2027
1	Indigenous People	71%	59%	42%	18%
2	Permanen Migrant	29%	41%	58%	82%

Source: Analyzed from Diverse Relevant Sources (ERM, 2013)

Operation Phase – Impact Evaluation

LNG Plant operation activities will provide job opportunities and business opportunities for the local community that will attract migrants from outside the region to obtain economic benefits from the activities. The influx of migrants into the villages surrounding Tangguh LNG operation site is predicted to have a negative impact on the structure change and local population growth in the villages up until the regency levels. Based on census data of PSKK UGM in 2011, the changes in population structure in the villages surrounding Tangguh LNG operation site showed that the villages were initially dominated by Indigenous People*. Since, there are an economic development growth at the Bintuni Bay and the contribution of the presence of Tangguh LNG, the structure of Indigenous People* significantly decreases and simultanesouly continue.

The intensity of recruitment is performed according to the needs of the LNG Plant operation activities, and it is predicted that workers working within the Tangguh LNG fence will maximally reach 1,500 people. Most of the contractor workers will work and settle outside the fence in villages surrounding Tangguh LNG operation site, up until the regencies, which will lead to direct interaction with the community.

Job opportunities and business opportunities during the operation phase of Tangguh LNG expansion activities (± 25 years since the operations phase begun) are predicted to attract migrants to obtain economic benefits in the region. As a result, this will lead to significant impacts on the changes demographics such as population structure and population growth as well as competitions between the local community and migrants to access social and economic aspects. Accordingly, this impact also has a high level of vulnerability, because the capacity of the local community and carrying capacity of the public services are still very limited.

Table III-121 Impact Evaluation – LNG Plant Activities in Operation Phase against Demographic: Changes in Migration (Mobility), Changes in Population Structure and Growth

Impact	*The LNG Plant activities in operation phase is predicted to result changes in the population structure and growth as a result from in-migration as a derivative impact of job opportunities and business opportunities to Indigenous People*.*				
Nature of Impact	**Negative**	**Positive**			
	The LNG Plant activities in operation phase will open job opportunities and business opportunities for Indigenous People of which attract migrants from outside the area to gain economic benefit from the activities. The in-migration to the villages surrounding Tangguh LNG operation site which will affect the population growth that negatively impact to population structure of Indigenous People*.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**

	*The LNG plant activities in operation phase will result changes in population structure and growth as a result of in-migration which is a derivative impact of job opportunities and business opportunities for Indigenous People**				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG plant activities in operation phase will last less than 25 years since the operation phase begun. Since the job opportunities impact is predicted to occur during more than 5 years, the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Changes in population structure will occur in the villages surrounding the LNG Plant operation activities to district/regency. Therefore, the impact extent is classified as regional.				
Impact Magnitude	**Diabaikan**	**Kecil**	**Sedang**	**Besar**	
	The average of population growth per year in Teluk Bintuni Regency is 3,50%, while Fakfak Regency reaches 3,92%. This shows that the number of migrants is more than the total of population growth due to birth and mortality. *The intensity of workforce recruitment is implemented in regard with the LNG Plant activities in operation phase, so it is assumed that the number of workforce working inside Tangguh LNG fence is 1,500 workers at maximum. Most of the contractors' workers will work and live outside the fence (in the villages surrounding Tangguh LNG operation site reach to regency of which build direct interation with the community). The job opportunities and business opportunities from the contractors during ± 25 years since the operation phase begun that are predicted to migrants to gain the economic benefit from that area. These result significant impact to population structure and population growth at the level of village and regency. Thus, the resulted impact is classified as 'high'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on the census data of PSKK UGM in 2011 showed that the percentage of Indigenous People currently at 55%, lower than the data in 2003 which reached 71%, and the percentage is predicted to continue to decline.* *The capacity of Indigenous People* living in villages surrounding Tangguh LNG operation site is limited only able to meet the needs of daily life, and has no surplus for allocation of other needs such as saving, investing, and access to good public services (education, health, and others). Changes in population structure caused by in-migrants will have an impact on the economic competition and access to public services among Indigenous People* and migrants, so that the sensitivity of impact is classified as 'high'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Based on the census data of PSKK UGM in 2011 showed changes in population structure in the villages surrounding Tangguh LNG operation site that previously dominated by Indigenous People. However, the economic growth development in Teluk Bintuni, and the presence of Tangguh LNG. The Indigenous People composition significantly continues to decrease.* *The incoming migrants surrounding the LNG plant activities who settle in the long term period is predicted to create pressure on the population structure and growth in the villages. On the other hand, the capacity of Indigenous People* and support on the limited access to public services which are expected to lead to competition between migrants and Indigenous People*. Thus, the level severity of impact is 'very high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of changes in population structure and growth in the villages is predicted to very likely occur. Thus, the impact likelihood is classified as 'medium'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*The incoming migrants surrounding the LNG plant activities is predicted significantly to create pressure on the population structure and growth, particularly on the changes in population structure of Indigenous People* gradually decrease. The impact potentially creates the marginalization of Indigenous People*.* *Thus, the impact is 'major' and classified as significant impact so it must be managed properly.*

Post Operation Phase – Impact Prediction

If the operation phase will start in 2019 then it is predicted that in 2044 Tangguh LNG will enter the post-operation phase. Workforce demobilization during the LNG Plant activities in post-operation phase is predicted to directly lead to impacts such as changes in demographic, pressure changes on vulnerable community groups, increased unemployment and changes in local businesses. The impact on the population demographics changes will lead to secondary derivative impacts such as assimilation and acculturation, changes in population composition and pressure on the Indigenous People, changes on the population growth and development of disease patterns. The impact of the population growth changes will lead to tertiary derivative impacts such as the changes in population structure.

The workforce demobilization activity and decrease in business activities will cause that the local workers settling in the surroundings of Tangguh LNG are expected to leave their hometowns to seek job elsewhere, or continue their business elsewhere. However, due to prolonged operations of up until ± 25 years since the operations phase starts, most likely the workers and their families consider the Bintuni Bay areas as their permanent settlements. This is a general overview commonly occurring in post-operation phases.

Post Operation Phase – Impact Evaluation

The LNG Plant post-operation activities are predicted to affect the changes in demographic (migration, structure and population growth). This is due to workforce demobilization and decreased business activities, which lead to local workers living in the surrounding Tangguh LNG operation site to leave their hometowns to seek job elsewhere, or to continue their businesses elsewhere. Similarly, the workers and business migrants will return to their respective hometowns or possibly settle.

When conditions in the Bintuni Bay area, in particular the level of education, knowledge and skills of the Indigenous People do not grow according to the demands of times, the departure of skilled workers and business people who drive the economy is predicted to affect the population structure into a negative direction, and slow the population growth. The demographic impact on LNG Plant activities in post-operation phase is a derivative impact of the workforce demobilization and decreased business opportunities for the Indigenous People*. LNG Plant post-operation activities will have affects in the long term if the post-operation issue settlements leave long-term matters to be resolved. The impact extent is classified as a 'local'.

Workforce demobilization is also predicted to cause unemployment in villages surrounding Tangguh LNG operation site. By observing the existing criteria, it is predicted that at that time most of the people in the villages are able to meet their living needs, save and invest, however migrants dominate the population structure. Accordingly, workforce demobilization during the post-operation period will have a sensitivity impact that is classified as 'moderate' and leads to a 'high' vulnerability as it will change the structure and population growth in the villages, besides other social changes. The impact likelihood of changes in the population structure and population growth in the villages is predicted to be inevitable.

Table III-122 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Demographic: Changes in Migration (Mobility), Changes in Population Structure and Growth

Impact	*The LNG Plant activities in post-operation phase is predicted to result impact on the changes in demographic. It is caused by workforce demobilization and decline in business opportunities that will cause the local workers living in surrounding Tangguh LNG operation site. The local workers are predicted to leave their hometown to seek job and continue their business in other places.*				
Nature of Impact	**Negative**	**Positive**			
	Workforce demobilization and decline in business opportunities will be implemented at LNG Plant activities in post-operation phase. The activities are predicted to cause the local workers and business actors to leave their hometown. This situation is predicted to impact the changes in population structure in a negative direction, and delay the population growth.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The demographic impact on the LNG Plant activities in post-operation phase is a derivative impact from workforce demobilization and decline in business opportunities for Indigenous People.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant activities in post-operation phase will take place in the long-term period, because demographic impact is predicted to occur at the end of Tangguh LNG operation phase in a period of more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The workforce demobilization and decline in business opportunities are predicted to affect to the changes in in population structure in the vilages surrounding LNG Plant activities in post-oepration phase. Thus, the impact extent is classified as local.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The average of population growth per year in Teluk Bintuni Regency is 3,50%, while Fakfak Regency reaches 3,92%. This shows that the number of migrants is more than the total of population growth due to birth and mortality. *The intensity of workforce demobilization and decline in business opportunities is implemented gradually in the long term period but not simultaneously. While the impact extent occurs locally in the villages surrounding Tangguh LNG operation site. By considering this, the impact magnitude is classified as 'medium'.*				
Sensitivitas	**Low**	**Medium**	**High**		

Penerima Dampak	*Workforce demobilization and decline in business opportunities will be implemented at LNG Plant activities in post-operation phase. The activities are predicted to cause the local workers and business actors to leave their hometown that are finally dominated by migrants. The percentage of with high skilled Indigenous People* is fewer than migrants and working as contractors' employee.* *Workforce demobilization is also predicted to result the unemployment in the villages Tangguh LNG operation site. By considering on that time, community in the villages will have to fulfill their needs, save and invest. However, migrants dominate the population structure. Thus, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The workforce demobilization and decline in business opportunities are implemented gradually in the long term period, while the magnitude is predicted to the villages surrounding Tangguh LNG operation site. On the other side, population structure in the villages Tangguh LNG operation site in that tome is predicted to be dominated by migrants and only small number of Indigenous People.* *The disappearance of high skilled workers and business actors is a economic wheel that is predicted to cause impact on population structure. Other impact from the activities is the emergence of unemployment in the village because of job opportunities in Tangguh LNG or contractors. Thus, the workforce demobilization and decline in business opportunities is classified as vulnerable towards the population structure and growth in the villages.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The opportunities of impact on population structure and growth in the villages are predicted to likely occur, so it is classified as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	On the LNG Plant activities in post-operation phase, population structure in the villages is predicted to be dominated by migrants of whom the percentage of skilled population is significant. The workforce demobilization and decline in business opportunities in the post-operation phase is predicted to result the skilled population migration and other business actors to other place. *Workforce demobilization is also predicted to result the unemployment in the villages Tangguh LNG operation site. The population migration and unemployment are predicted to change the population structure significantly. Thus, the nature of impact is 'major' and classified as significant impact and must be managed before the end of Tangguh LNG operation.*				

3.3.3.2 Workforce: Job Opportunities, Workforce Demobilization

a. Environmental Baseline

Construction Phase

The presence of Tangguh LNG in the Bintuni Bay area contributes to the economic development of the region. This is further accelerated by the formation of the Teluk Bintuni Regency as expansion of the Manokwari Regency in 2005. In the last eight years a change in the community livelihood patterns occurred in the Bintuni Bay, in particular with the increased percentage of people working as employees.

Based on census data of 2011, the unemployment rate in DAVs reached 8% of the entire workforce, decreased compared to the census data of 2003 that reached 21%. It is predicted that the decreased unemployment rate is affected by the rapid economic growth in the Bintuni Bay regio.

At the household economic level, the survey also indicated that the community is at the level wherein they are able to meet household needs, however are not capable yet to save and invest.

The two issues lead to a relatively high sensitivity in the community if issues on employment arise. Most of the people in the villages expect that Tangguh LNG activities will provide work opportunities. Data on public consultation performed in 2012 indicate that 8% of the people aspirations and attention to Tangguh LNG are related to employment and 7% to economic development, including business opportunities – which ultimately are related to work.

However, at the end of Tangguh gas field productions, Tangguh LNG will enter the final stage of gas production activities in the Bintuni Bay. Gradually there will be decreased demands for goods and services, workforce demobilization and no contract Expansions for Tangguh supporting contractors.

It is predicted that at that time the local people have the skills and abilities to better invest. The local community dependence on Tangguh LNG will be relatively high, due to either employment as well as businesses. The end of Tangguh LNG activities is predicted to affect the local community life and the environment. Part of skilled local workers is predicted to move from the village, while contractors will also move their investments.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Workforce requirements at various levels will be gained from villages in the surroundings of the Teluk Bintuni and Fakfak regencies, the West Papua Province and Papua as well as from outside Papua. However, the significant impact is predicted to affect communities living in the villages surrounding Tangguh LNG operation site.

Construction Phase – Impact Evaluation

Considering the impact magnitude, including the number of workers involved and the high intensity of recruitment, as well as observing the community social economic condition of which 8% of the workforce is still unemployed, this impact is significant and should be properly managed.

Table III-123 Impact Evaluation – LNG Plant Activities in Construction Phase against Workforce: Job Opportunities, Unemployment

Impact	*Job opportunities for Indigenous People* and local community to work at the construction phase of LNG Plant.*				
Nature of Impact	**Negative**	**Positive**			
	Job opportunities for Indigenous People and local community in construction phase will give the opportunity to enhance the community's level of income.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The workforce recruitment for Indigenous People and local community is directly implemented by the contractor but facilitated and monitored by Tangguh LNG*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant construction will last for 5 years. It concludes that the job opportunities offered to Indigenous People and local community is short because the impact occurs more than a year.*				
Impact Extent	**Local**	**Regional**	**Global**		

	The workforce recruitment is not only implemented in the villages closest to the project area, but also district, regency, and province levels.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the 2012 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total labor force of Indigenous People living in the villages surrounding Tangguh LNG operation site is lower compared to the 2003 at a rate of 21%.* *The scope of workforce recruitment of Indigenous People* and local community is at the level of district, regency, and province, with the high intensity (once in a month). However, considering the duration of impact is only short term period (5 years), the impact magnitude is categorised as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact of job opportunities for Indigenous People and local community is classified as 'high' because the construction phase will provide great number of job opportunities for Indigenous People and local community. However, the job opportunities are only provided in short time (5 years). Therefore, when workforce demobilization is impelemented, the unemployment of Indigenous People* and local community increase. The impact is sensitive to Indigenous People* and local community.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'high' caused by the short time of impact duration. However, the impact includes regional level with high intensity (twice a week). On the other side, the job opportunities issue is a sensitive issue for Indigenous People and local community.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The project of Tangguh LNG's contractor in construction phase will implement the workforce recruitment for Indigenous People and local community in huge number. However, workers derived from Indigenous People* and local community are only hired in a short time period (5 years).*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact significance is at the level of 'major' because job opportunities will be opened to Indigenous People and local community in huge number. This activity also leads to an increased unemployment due to workforce demobilization at the end of the construction period, so the impact is classified as 'significant impact', and requires proper management by Tangguh LNG and its contractors.*				

<u>Operation Phase – Impact Prediction</u>

By considering the impact magnitude including the number of workers involved and the high recruitment intensity, as well as observing the social economical condition of the community of which 8% of the workforce is still unemployed, this impact is significant and should be properly managed.

Table III-124 Impact Evaluation – LNG Plant Activities in Operation Phase against Job Opportunities

Impact	*The operation of Tangguh LNG is predicted to open job opportunities for Indigenous People* (prioritized) and local community to work at the LNG Plant activities in operation phase.*				
Nature of Impact	**Negative**	**Positive**			
	Job opportunities for Indigenous People and local community in construction phase will give the opportunity to enhance the community's level of income.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The workforce recruitment for Indigenous People and local community is directly implemented by the contractor of Tangguh LNG*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant activities in operation phase will occur less than 25 years since the operation phase begun, so the impact duration is classified as long term period.				
Impact Extent	**Local**	**Regional**	**Global**		
	The workforce recruitment is not only implemented in the villages surrounding Tangguh LNG operation site, also at the level of district, regency, and province. Thus, the impact extent is classified as regional.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the 2012 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total labor force is lower compared to the 2003 at a rate of 21%. *The scope of workforce recruitment of Indigenous People* and local community is at the level of district, regency, and province, with the high intensity (once in a month). However, considering the duration of impact is only long term period (± 25 years). Thus, the impact magnitude is categorised as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact of job opportunities is classified as 'high' because operation phase will provide great number of job opportunities for Indigenous People (prioritized) and local community. However, the community capacity is classified as low, so they are predicted to obtain job opportunities at the unskilled or low skilled level. Thus, the impact sensitivity is classified as medium for Indigenous People* and local community. The sensitivity of impact receptor is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'high' because the gap between expectation of Indigenous People and local community to work at Tangguh LNG. Meanwhile, the job opportunities that can be obtained is predicted to the level of unskilled or low skilled because the limited capacity of Indigenous People* and local community. Thus, the impact severity is classified as 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	In the operation phase of Tangguh LNG, job opportunities are predicted to be executed through operation contractor. It is predicted to hire 3,500 workers that will be involved in the activities, and the opportunity is likely to occur. Thus, the positive impact likelihood is classified as 'medium'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*The positive impact of job opportunities from the Tangguh LNG operation activities is classified as 'major'. It is because the operation phase will require less than 3,500 workers to work at Tangguh LNG contractor during long term period. On the other side, the expectation of Indigenous People and local community is high. Thus, the impact is classified as significant ('major') and must be managed.*

Post Operation Phase – Impact Prediction

The Tangguh LNG post-operation activities are predicted to impact the workforce. During this period, gradual workforce demobilization will occur for a relatively long-term period by considering the ongoing operations needs. The impact is predicted to strongly affect the local workers living in villages surrounding Tangguh LNG operation site, who are predicted to work for supporting contractors of the Tangguh LNG operations.

The impact is relatively vulnerable, because local workers and contractors heavily depend on Tangguh LNG. Workforce demobilization is predicted to cause unemployment in the villages. However, local workers will have better skills. At the time Tangguh LNG contractors start to reduce their workforce, they can move to other contractors or other locations to obtain better jobs.

Post Operation Phase – Impact Evaluation

During the post-operation phase, there will be workforce demobilization as well as contractors supporting its operations by Tangguh LNG. It is predicted that the activities will lead to job opportunities impacts in the villages, however by considering that the workforce demobilization is conducted gradually in a long term, while the local workers already obtained better skills, the impact of manpower demobilization is expected to be 'moderate', however it should be managed.

Table III-125 Impact Evaluation – LNG Plant Activities in Post Operation against Workforce Demobilization

Impact	*The post-operation activities of Tangguh LNG are predicted to implement the local workforce demobilization.*				
Nature of Impact	**Negative**	**Positive**			
	Local workforce demobilization on the post-operation activities of Tangguh LNG is predicted to cause unemployement in the villages surrounding Tangguh LNG operation site. Thus, the impact is 'negative'.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The local workforce demobilization is directly implemented by the Tangguh LNG contractor.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The the post-operation activities of Tangguh LNG will last for long term period.				
Impact Extent	**Local**	**Regional**	**Global**		
	The workforce demobilization will be affected to community living in the villages surrounding Tangguh LNG operation site up to regency, so the impact extent is classified as 'regional'.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the 2011 census data by PSKK UGM showed the unemployment rate in DAVs reached 8% of the total labor force is lower compared to the 2003 at a rate of 21%. *The intensity of workforce demobilization is implemented gradually in the long term period. While the impact extent occurs locally in the villages surrounding Tangguh LNG operation site. By considering this, the impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the post-operation activities of Tangguh LNG is predicted that the population structure will be changed by the dominant number of migrants and apart from this number is Indigenous People and local. The livelihood system of community is predicted to be changed, for example, more people will work at contractor office or trading/services sectors, than traditional sector i.e. fisheries, agriculture, and gatherer. This situation shows the sensitivity of the community is quite high in case of workforce demobilization of Tangguh LNG. Since Tangguh LNG is a major company in the Bintuni Bay region where many employees and contractors depend on it.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'high' caused by population structure will be changed by the dominant number of migrants and apart from this number is Indigenous People and local. The livelihood system of community is predicted to be changed, for example, more people will work at contractor office or trading/services sectors. This situation create a high vulnerablity due to workers and contractor's dependency on Tangguh LNG.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	In the post-operation phase, the workforce demobilization will be implemented gradually in regard with Tangguh LNG. Also, they have sufficient skills to apply for jobs in other place. Thus, the likelihood of unemployment in the villages may occur, so the impact likelihood is classified as 'small'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The workforce demobilization in the post-operation phase of Tangguh LNG is predicted to create unemployment impact in the villages. However, demobilization is implemented gradually with better community skills considering at that time. Therefore, the chances of unemployment may occur in the villages because the community has had enough skills to work in other industries. Thus, the impact is critical ('moderate') and should be managed prior to the end of operation phase of Tangguh LNG.				

3.3.3.3 Changes in Local Business Growth

a. Environmental Baseline

Construction Phase

Types of businesses owned by the people in the surroundings of Bintuni Bay are among others farm products, fishing tools, fishery products and agricultural products. In general, transmigrated people primarily drive the local business growth. As happened in the Sebyar Rejosari Village, business growth is driven by transmigrated people who formally worked in a sago processing company that is now closed (IPB Food Security Survey, 2010)

Also based on the IPB Food Security Survey in 2010, for example the Babo District, in particular the Irarutu III Village has the highest number of economic facilities compared to all survey locations conducted. The Irarutu III Village has 132 kiosks/stalls and six markets, which is the most compared to other districts in Teluk Bintuni Regency.

Meanwhile, the Tanah Merah Village in the Sumuri District has the second highest number of economic facilities, i.e. 15 kiosk/stalls and a market. Commodities sold are plantation crops, fishery and agriculture products. There are also shrimp collectors in the Onar Lama Village that are utilized by the people to accommodate catches from the sea.

Types of business owned by the people consist of crops, fishery and agricultural products. Observed from above mentioned survey data, the orientation of the economic activity are almost entirely commercial. It is predictable that based on such economy, the presence of kiosks/stalls and markets are very important in the local business growth. Apart from that, there are also betel nut sellers. This is because betel nut chewing is a habit of the people.

Table III-126 Agriculture Products in Tanah Merah, Saengga, and Onar Villages in 2009

Type of Commodities	Tanah Merah	Saengga	Onar
Average production of vegetables and fruits per farmer	1.003 kg	804 kg	400 kg
Average sago production per farmer	1.019 kg	1,780 kg	1.600 kg
Total vegetables and fruit farmers	34 orang	30 orang	2 orang
Total sago (tap) farmers	6 orang	8 orang	1 orang
Total vegetables and fruit production	34.102 kg	24.120 kg	800 kg
Total sago products	6.114 kg	14.240 kg	1.600 kg

Source: Social Economic Survey of UGM, 2009

Table III-114 indicates agriculture produce of the Tanah Merah, Saengga, and Onar Villages in 2009. The three villages are villages adjacent to the Tangguh LNG location. The Tanah Merah Village is the village with the highest or most vegetables and fruit total production as well as total farmers compared to the Saengga and Onar Villages. This is likely due to the correlation of the three villages proximity to the Tangguh LNG location.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Workforce recruitment and mobilization activities for the construction of the LNG Plant will significantly affect the local business growth in villages surrounding the project as well as workers' transit villages such as Kokas and Irarutu III to meet the needs of workers and job seekers for goods, services and possibly accommodations. The community development program implemented by Tangguh LNG in the previous years also affects the local business growth. Similar to the descriptions of workforce parameters, it is predicted that this activity will have a derivative impact on the increase of income rates and affect the change in livelihood patterns as well as increased access to healthcare.

It is predicted that the workforce demobilization will affect the outgoing migration, which will also affect demands for goods and services in local markets. The arising derivative impacts are the slowing down of economic activities, which were originally driven by the migrants.

Construction Phase – Impact Evaluation

Tangguh LNG Plant construction will involve 10,500 workers in its peak period. The activities require foodstuff (vegetables, fish etc.) and daily needs to meet the requirements of construction workers, which are predicted to provide business opportunities for the local people, i.e. by becoming suppliers of the workers needs during the construction period. Ultimately, it is predicted that it will affect the increase in their household income.

It is predicted that target areas to purchase foodstuff and other daily needs conducted by Tangguh LNG contractors may originate from people at the village, district up until the regency levels. Based on experience, Tangguh LNG contractors will purchase foodstuff and other daily needs based on relatively high intensities (2 times a week).

At present, the local people are acting as suppliers of foodstuff for Tangguh LNG employees, usually through cooperatives and stocking points. With a workforce of 10,500 people, the supply to meet foodstuff needs will significantly increase. This will lead to relatively high expectations of the local people to be involved to supply foodstuff necessities for the workers during the LNG Plant construction period, however there is the possibility that the people will experience obstacles or difficulties in supplying the needs for foodstuff. This is due to the insufficient ability to maintain the quantity and quality of the supply.

Table III-127 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Local Business Growth

Impact	*The LNG Plant activities in construction phase will involve 10,500 workers at peak times. These activities will require food and daily necessities to meet the needs of construction workers. It is predicted to open business opportunities for local people.*				
Nature of Impact	**Negative**	**Positive**			
	Purchase of food and daily necessities by the Tangguh LNG contractor to the local community is expected to increase household income.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The LNG plant activities in construction phase require large amounts of workforce. The increase in the labor force is predicted to enhance the need for food and other daily needs, so there will be business opportunities for local people to supply those needs.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG plant activities in construction phase lasted for approximately five years. During this time, the fulfillment of the needs of food and other daily needs will increase before decreasing again at the end of construction. Those needs will be supplied from the local community. Due to the impact of local community business growth occurred more than one year, then according to the social aspect, the impact occurs in a 'short term' period.				
Impact Extent	**Local**	**Regional**	**Global**		
	The scope of purchase of food and other daily necessities carried out by Tangguh LNG contractors that is likely from community at the level of village, district to district, and regency. Thus, the impact extent is regional.				
Impact	**Negligible**	**Small**	**Medium**	**Large**	

Magnitude	*Tangguh LNG contractors will purchase food and other daily needs with plenty high intensity (2 times a week). Scope of the purchase of food and other daily needs are likely from community at the level of village, district to district, and regency. However, these purchases is predicted only occur in Tangguh LNG construction period that lasted approximately 5 years.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At this time, the Tangguh LNG always absorbing local products from fisheries and agriculture provided by multiple stocking points. Throughout the year 2013, the data on August showed Tangguh LNG has absorbed as much as 209,542 kg of local products from agriculture and fisheries. *Based on a survey study of community's ncome by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local people expect to capture business opportunities from LNG plant construction activities. However, the entrepreneurial capacity of communities to manage the investment is low. People are still less able to capture the business opportunities. This creates a gap that leads to the creation of social vulnerability. Thus, the vulnerability of business opportunity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	At this moment, the community provides food supplies through cooperative and stocking point for Tangguh LNG operations needs. In the construction phase, the foodstuff will raise significanlt to meet the needs of 10,500 workers. People's expectations are high enough to be able to provide foodstuff for workers during LNG plant construction. However, community will possibly have difficulty in providing the foodstuff. Therefore, the impact likelihood is at the level of 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	There is a gap between the high expectations of the community with the ability to provide foodstuff for workers in the LNG plant construction, while the likelihood of that gap is at the level of 'medium'. Thus, the impact is classified as 'major' and is a significant impact that needs to be managed.				

Evaluation results described in the Table on impact evaluation indicates that the workforce recruitment and demobilization activities are assessed and classified as a 'major' or 'significant' impact on the environment component of economic changes in the local business growth.

Operation Phase – Impact Prediction

The workforce recruitment and mobilization activities of approximately 1,500 people for the operations of the LNG Plant will directly affect (primary impact) the growth of the local business in the villages surrounding Tangguh LNG operation site. The local business growth is also affected by the implementation of the community development program conducted by Tangguh LNG in the previous years (PSKK UGM, 2011). It is predicted that these activities may lead to a derivative impact against the increase in level of income and changes in livelihood patterns as well as access to healthcare.

The workforce demobilization is predicted to affect the outgoing migration, which also affects the demands for goods and services in local markets. The derivative impact occurring is the slow-down of economic activities that originally were driven by migrants.

Operation Phase – Impact Evaluation

The LNG Plant operation activities will involve 1,500 workers over approximately the next 25 years since the operations phase starts. The activities will require foodstuffs (vegetables, fish, crabs, etc.) and daily needs to meet the requirements of the workers. Business opportunities for the local people or contractors may spread out from the villages, districts, regencies up till the province levels.

Although this significant opportunity is available, however the community capacity to capture business opportunities is still limited, due to constraints in the issue of skills, management and capital for the business. However, as at present the local people already supply the needs for foodstuffs (vegetables, shrimp, crabs and fish) for Tangguh LNG workers through cooperatives in the villages, their expectations and involvements to remain as suppliers are high, so that the impact sensitivity of the local business growth is classified as a moderate sensitivity level. The duration of the impact is classified as 'long term' with a regional spread because this business opportunity will be prioritized for the local community living in villages in the surrounding Tangguh LNG operation site, at the districts, regencies and province levels and is categorized as long term (± 25 years). The local community and regional Government expectation for economic layover effects from the Tangguh LNG operation activities from the villages up till the regency levels. However, due to the limited capacity of the local community to operate businesses that may support the Tangguh LNG operations the vulnerability of impact level is classified as 'high'.

At present, the people already start to supply the needs for foodstuffs (vegetables, shrimps, crabs and fishes) for the workers of Tangguh LNG operation activities. In the future, business opportunities will increase to a long term. Therefore, contractors outside the fence will perform most of the operations support in order to perform Tangguh LNG strategy. Nevertheless, there is still a discrepancy related to the communities' capacity to capture business opportunities. This discrepancy has been resolved with the existence of cooperatives and small business units in the villages that already grow and it is expected that in the future it may capture the future business opportunities.

Table III-128 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Local Business Growth

Impact	*The operation activities of LNG Plant are predicted to create impact on business opportunities for Indigenous People*.*				
Nature of Impact	**Negative**	**Positive**			
	Purchase of food and daily necessities by the Tangguh LNG contractor to Indigenous People is expected to increase household income.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The local businesses growth is the impact of 'derivative' in which at that phase, business opportunities will be opened for local contractors to support operation phase of Tangguh LNG.				
Impact	**Temporary**	**Short Term**	**Long Term**	**Permanent**	

Duration	*LNG plant activities in operation phase will last for approximately 25 years since the operation phase begun. Due to the impact of changes in business growth for Indigenous People* experienced more than 5 years, then impact duration is 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Business opportunities for local contractors will spread from level of village, district, regency to province, so the impact extent is 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, the Tangguh LNG always absorbing local products from fisheries and agriculture provided by multiple stocking points. Throughout the year 2013, the data on August showed Tangguh LNG has absorbed as much as 209,542 kg of local products from agriculture and fisheries. *Business opportunities are predicted for Indigenous People* living in the villages surrounding Tangguh LNG operation site, at the level of district, regency and province in the long term period (±25 years). The intensity will follow the needs of the operation phase of Tangguh LNG. Thus, the impact magnitude is 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Community capacity to capture business opportunities are still limited, due to the constraints in the problem of skills, management and capital. However, at this time the community has been supplying the needs of food (vegetables, shrimp, crabs and fish) for Tangguh LNG workers through cooperatives in villages. Thus, the impact sensitivity is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Indigenous People and local government expect the economic multiplier effect of the operation phase of Tangguh LNG to occur from village level to district level. However, Indigenous People* have limited capacity of to run a business that can support the Tangguh LNG operation. Thus, the impact causes 'high' level of vulnerability.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	In the operation phase of Tangguh LNG, business opportunities open to local contractors, because most of the support work of operations will be done by contractors outside the Tangguh LNG fence. Thus, the positive impact likelihood from local business growth is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	At this time, community have started to supply the needs of food (vegetables shrimp, crabs and fish) for workers in the operation phase of Tangguh LNG. In the future, business opportunities will be increased in accordance with the Tangguh LNG strategy where most of the operations support work will be done by contractors outside the fence. There are gaps between the capacity of communities to capture business opportunities and the business opportunities itself. At this point cooperatives and small business units in the villages have grown, and are expected to be able to capture future business opportunities. Thus, the positive impact of the local business growth from local business growth activities is a significant impact or classified as 'major' and needs to be managed.				

Evaluation results described in the Table of impact evaluation indicates that the workforce recruitment and demobilization activities are classified as 'major' impacts or 'significant impacts' against the changes of local business growth.

<u>Post Operation Phase – Impact Prediction</u>

The workforce demobilization activity in post-operation phase of Tangguh LNG will lead to decreased demands for goods and services for the needs of Tangguh LNG. There will also be a decline in the communities' income in particular employees of Tangguh

LNG. This will ultimately affect the local business growth, especially directly to the suppliers.

The impact of this decline in local business growth will also affect the decline in level of income of community, which eventually also results tertiary derivative impact in the form of a decline in access to education, decline in access to healthcare and changes in livelihood patterns.

Post Operation Phase – Impact Evaluation

The decreased demand for goods and services will directly affect the sustainability of local businesses. The decline in business activities of Tangguh LNG are predicted to affect the communities living in villages up till the regencies and can last for a long time. It is also predicted that this impact will affect the communities in the villages up until the regencies in which the contractors supporting Tangguh LNG operations activities conduct their activities.

According to analysis results presented in **Table III-106**, it is predicted that in the post-operation phase, migrants will dominate the population structure. On the other side, the local contractors usually have high dependence on Tangguh LNG activities. Therefore, if there is a decline in the Tangguh LNG business activities occur, then it is predicted to affect the local contractors leading to moderate impact sensitivity. However, it may result a high vulnerability if the condition of the economic and social development in the Bintuni Bay area's are not developed for community welfare.

Table III-129 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Local Business Growth

Impact	*In the post-operation phase, there will be decline in goods and services demand for Tangguh LNG needs. This is predicted to affect the local business growth.*				
Nature of Impact	**Negative**	**Positive**			
	On the operation phase, there are many contractors of Tangguh LNG operated in the villages, regency and province. A declining demand for goods and services by the Tangguh LNG, is predicted to decline the local business growth.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The drop in demand for goods and services will have an impact on the sustainability of local business growth.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant activities in operation phase will last for long term period of time. It is predicted that the impact of changes in local business growth of Indigenous People at the end of operation phase of Tangguh LNG and will inherent in 5 years period of time.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Decline in business activities in Tangguh LNG is predicted to result impact to community living in the villages to regency.				
Impact	**Negligible**	**Small**	**Medium**	**Large**	

Magnitude	*At this time, Tangguh LNG always absorbs local products from fisheries and agriculture sectors which is provided from multiple stocking points. Throughout the year 2013, the August data showed that Tangguh LNG has absorbed as much as 209.542 kg of local products from agriculture and fisheries.* *Decline in business activities will occur gradually in the long term in accordance with the needs of Tangguh LNG operation activities. The impact on decline in business activities is predicted to be encountered by community in the villages to regency in whom the contractors who support the operation activities of Tangguh LNG implement its activities. By considering this, the ipact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the Post-Operation phase, it is predicted that the composition of Indigenous People is dominated by migrants. And at this phase, the Indigenous People* has had the ability to invest well. However, the local contractor has a dependency on Tangguh LNG activities, so if there is a decline of business activity in the Tangguh LNG, then it is predicted to have an impact on local contractors. By considering this, the sensitivity of the impact is 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Indigenous People and local government expect the economc multiplier effect of the Tangguh LNG activity to occur from village to district level. A decline in business activity in the Tangguh LNG is gradual long-term impact on the predicted local contractor business activities that depends a lot on the Tangguh LNG. Based on these considerations, the impact of the severity is 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The likelihood of decline in local business growth is likely to occur ('high') because the local contractor has dependency on the Tangguh LNG in running its business.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	In the Post-Operation phase, the decline in business activities in Tangguh LNG is predicted to occur gradually in the long term period of time. This is also predicted to result impact to local contractor's business activities. On the other side, there is a dependency of local contractor to the Tangguh LNG activities. Thus, the impact is significant or classified as 'major', and need to be managed prior to the end of operation phase of Tangguh LNG.				

Evaluation results presented in the impact evaluation Table indicates that the Workforce Recruitment and Demobilization are classified as a 'major' impact or significant impact on the Changes in Local Business Growth.

3.3.3.4 Changes in Business Opportunities

a. Environmental Baseline

Operation Phase

Communities living in the villages surrounding Tangguh LNG operation site are in general more familiar to the economic development in the fisheries and agricultural sectors compared to the business activities. This is because economic development in the business sector is frequently obstructed by administrative managerial knowledge of the community and the marketing system.

Data of survey conducted by PSKK UGM in 2011 indicate that the communities' percentage of DAVs working in the fisheries and agricultural sectors are larger compared to the percentage in the small businesses sector, namely 21.3% compared to 17%. Apart from that, most of the communities working in the small business sector tend to be limited to small-scale trade (such as kiosks and stalls), which are operated by migrants.

However, to provide business opportunities for the people, Tangguh LNG provided opportunities for the people to fulfill the foodstuff needs of the employees through stocking points that formally started in 2009.

b. Impacts Prediction and Evaluation

Operation Phase – Impact Prediction

During the operations phase of LNG Plant, Tangguh LNG requires substantial services to support the foodstuff of Tangguh LNG employees and to support the maintenance of various Tangguh LNG facilities, such as electronic repair services (air conditioning, television, etc.), laundry services for Tangguh LNG employees, services for employee uniforms and services in other sectors.

In the framework to support sustainable business developments for the Indigenous People*, it is predicted that Tangguh LNG needs for maintenance service facilities, businesses to meet the foodstuff needs and other business opportunities will be provided for Indigenous People living in the surrounding Tangguh LNG operation site as their business sectors. It is expected that in the future, the businesses will be developed and managed by the Indigenous People, and are not directed to only fulfill the needs of Tangguh LNG, but are also able to meet the more extensive market needs for goods and services.

Operation Phase – Impact Evaluation

The LNG Plant operation activities will involve workers for approximately 25 years since the start of the operations phase. This activity will require foodstuffs (vegetables, fishes, crabs, etc.) and daily needs to fulfill the employees' needs. Business opportunities for the communities or local contractors will be spread out from the villages, districts, regencies up until the province level.

Table III-130 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Business Opportunities

Impact	*The operation activities of LNG Plant is predicted to give impact on business opportunities for Indigenous People*, from various sectors of the jobs which are deliberately aimed at the Indigenous People* by the Tangguh LNG.*				
Nature of Impact	**Negative**	**Positive**			
	Business opportunities which is delivered by Tangguh LNG to Indigenous People is predicted to enhance the business activities and growth of Indigenous People*, as well as to increase Indigenous People's income.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Business opportunities which is delivered to Indigenous People is a direct impact from the operation activities of LNG Plant. The business opportunities is delivered to Indigenous People* in order to support the operation activities of Tangguh LNG.*				

Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG plant activities in operation phase will last for approximately 25 years since the operation phase begun. Due to the impact of changes in business growth for Indigenous People experienced more than 5 years, then impact duration is 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Business opportunities for local contractors will spread from level of village, district, regency to province, so the impact extent is 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, Tangguh LNG always absorbs local products from fisheries and agriculture sectors which is provided from multiple stocking points. Throughout the year 2013, the August data showed that Tangguh LNG has absorbed as much as 209.542 kg of local products from agriculture and fisheries. *Local business opportunities will be prioritized for Indigenous People* living in the villages surrounding Tangguh LNG operation site, at the level of district, regency and province in the long term period (±25 years). The intensity will follow the needs of the operation phase of Tangguh LNG. Thus, the impact magnitude is 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Community capacity to capture business opportunities are still limited, due to the constraints in the problem of skills, management and capital. However, at this time the community has been supplying the needs of food (vegetables, shrimp, crabs and fish) for Tangguh LNG workers through cooperatives in villages. Thus, the impact sensitivity is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Indigenous People and local government expect the economic multiplier effect of the operation phase of Tangguh LNG to occur from village level to district level. However, Indigenous People* have limited capacity of to run a business that can support the Tangguh LNG operation. Thus, the impact causes 'high' level of vulnerability.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	At the Tangguh LNG operation phase, the business opportunities will open to the local contractor, because most of the support work in the operation phase will be done by the contractors outside the Tangguh LNG fence. Thus, the opportunity of positive impact from local business opportunities is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	At this time, community have started to supply the needs of food (vegetables shrimp, crabs and fish) for workers in the operation phase of Tangguh LNG. In the future, business opportunities will be increased in accordance with the Tangguh LNG strategy where most of the operations support work will be done by contractors outside the fence. There are gaps between the capacity of communities to capture business opportunities and the business opportunities itself. At this point cooperatives and small business units in the villages have grown, and are expected to be able to capture future business opportunities. Thus, the positive impact of the local business growth from local business growth activities is a significant impact or classified as 'major' and needs to be managed.				

3.3.3.5 Changes in Livelihood Patterns

a. Environmental Baseline

Construction Phase

As a general illustration, the community in the Teluk Bintuni and Fakfak Regencies has livelihood patterns related to agricultural activities (including farming), fisheries, civil servants, traders, carpentry and micro-economic businesses activities. UGM Survey and Census (2011) stated that livelihood patterns of people living in coastal areas and rural areas are different. In coastal areas, people generate additional income mainly from activities related to fisheries. As for rural areas, additional income is generated from activities related to agriculture. For example, people in the Weriagar District indicate that people working outside main jobs exceed people working only in main jobs. In other words, it can be predicted that these other jobs are important alternatives of income. In addition, apart from working as fishermen or farmers, people in the Babo District also have a number of skills that may become alternatives for the peoples' additional income. Most have skills to cook and carpentry.

In general and when detailed into percentage of population based on types of work, the National Labor Survey in 2010 state that most of the people in the Teluk Bintuni Regency depend on agriculture, hunting and fisheries by 42%, the services sector by 19%, the trade sector by 11% and others 28%. In the Fakfak Regency, the livelihood pattern is almost the same to Teluk Bintuni Regency in which the majority population of the Fakfak Regency working in the agriculture and fisheries sectors are 1,782 people. While other patterns include working for local Government such 3,456 people working as civil servants in 2009, as well as 474 people working as Indonesian National Military and police officers in 2010.

Fishery activity is the main livelihoods that are almost performed by all villages in the surroundings of the Bintuni Bay. For example, the majority of people in the Babo District having livelihoods as trader's amount to 221 people, the second order is as teachers/civil servants/the military/police force/ village officials as many as 208 people. Meanwhile, the rest still have a livelihood in the fisheries and agricultural sectors (UGM Survey and Census, 2011).

Changes in livelihood patterns, in particular the people in the surrounding Tangguh LNG operation site are as stated by the Social Economic Survey in 2009, that during the period of 2002–2009 significant changes occurred in the communities' livelihoods in Tanah Merah and Saengga. During this period, there were also interventions of fisheries and agricultural programs from Tangguh LNG, apart from job opportunities at Tangguh LNG and its contractors. For example, changes in livelihood in the Tanah Merah, Saengga, and Onar villages that are villages in the surrounding Tangguh LNG operation site can be observed in detail in **Table III 119**.

Table III-131 Livelihood of Tanah Merah, Saengga, and Onar Communities in 2002, 2007, and 2009

Sector	2002		2007		2009	
	Total	%	Total	%	Total	%
Tanah Merah						
Fishery	110	54,7	23	14.3	27	13,8

Sector	2002		2007		2009	
	Total	%	**Total**	%	**Total**	%
Agriculture	16	8,0	10	6,2	40	20,4
Trade & Small Businesses	18	9,0	19	11,8	25	12,8
Tangguh LNG Employees	37	18,4	64	39,8	44	22,4
PNS/TNI/Police/Private	20	10,0	45	28,0	60	30,6
Subtotal	**201**	**100**	**161**	**100**	**196**	**100**
Saengga						
Fishery	68	62,4	62	32,1	36	22,2
Agriculture	0	0,0	8	4,1	38	23,5
Trade & Small Businesses	5	4,6	13	6,7	9	5,6
Tangguh LNG Employees	31	28,4	37	19,2	36	22,2
PNS/TNI/Police/Private	5	4,6	73	37,8	43	26,5
Subtotal	**109**	**100**	**193**	**100**	**162**	**100**
Onar						
Fishery	36	76,6	83	84,7	71	78,0
Agriculture	0	0,0	2	2,0	3	3,3
Trade & Small Businesses	8	17,0	6	6,1	3	3,3
Tangguh LNG Employees	3	6,4	5	5,1	7	7,7
PNS/TNI/Police/Private	0	0,0	2	2,0	7	7,7
Subtotal	**47**	**100**	**98**	**100**	**91**	**100**
Total N	**357**		**452**		**449**	

Source: Re-calculated from URS 2002 and social economic survey by UGM 2007 & 2009

Workforce recruitment and demobilization activities for the construction of the LNG Plant in construction phase will involve many local workers, in particular for types of work that do not require skills or low skills. These activities will significantly affect the communities' life patterns that for part are due to the shift from traditional livelihoods to become employees of the Tangguh LNG Expansion Project. This will affect the communities' livelihood patterns. The impact is an advance derivative impact of the income level of community due to the recruitment and demobilization activities as well as the local business growth.

Similarly, the workforce demobilization activities during the post-construction and the post- operation phases will significantly affect the income of local workers, who are directly derived from the impact of employment loss due to the workforce demobilization, which is predicted to also affect the livelihood patterns. The in-migration of workers during the operation phase will significantly affect the communities' life pattern, which is partly due to the shift of the traditional livelihood to become employees of the Tangguh LNG Expansion Project, in particular in the construction of the LNG Plant and its supporting facilities.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

The workforce recruitment and demobilization activities also have direct or primary impacts in the form of employment and unemployment opportunities, as well as changes to the local business growth. These two impacts lead to secondary derivative impacts such as changes in level of income that eventually result in tertiary impacts i.e. changes in livelihood patterns. The in-migration of workers during the construction will significantly affect the communities' life pattern, which is partly due to a shift from the traditional livelihoods to employment in the Tangguh LNG Expansion Project, in particular during the construction of the LNG Plant and its support facilities.

Workforce demobilization will lead to unemployment of approximately 10.500 workers who have to look for other livelihoods. Included are the workers of the local people who may have no other choices but to return to their former livelihoods or may start new business opportunities with the additional skills and expertise they obtained from working at the project.

Construction Phase – Impact Evaluation

The LNG Plant construction is predicted to cause changes in the local community livelihoods. This is a tertiary derivative impact of the workforce recruitment and demobilization activities. The workforce recruitment impact and business opportunities are positive impacts, while the impact of workforce demobilization and unemployment has negative impacts on the local communities' livelihoods pattern changes. This impact is classified as a short-term impact, because the LNG Plant construction is predicted to last for approximately 5 years.

The LNG Plant construction activities will create job opportunities and business opportunities for the local community and simultaneously disturbances for fishermen in villages surrounding Tangguh LNG operation site. The activity impact will be locally in the villages surrounding Tangguh LNG. The community in villages surrounding LNG Plant, in particular on the north coast and Fakfak mostly work in the traditional sector, such as fishermen, farmers and gatherers, however with the presence of the Tangguh LNG Expansion Project livelihood changes occurred and they are working as employees in a number of companies in the Bintuni Bay.

Table III-132 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Livelihood Patterns

Impact	*LNG plant Activities in construction phase is predicted to result changes in livelihood of local community. This is a derivative impact of the workforce recruitment and demobilization, business opoortunities for local community and fishery activity disturbance.*				
Nature of Impact	**Negative**	**Positive**			
	The workforce recruitment and job opportunities impacts are 'positive' impacts, while the workforce demobilization impact and fishery activity disturbance result 'negative' impacts on the changes in livelihood patterns of local community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The workforce recruitment and demobilization, business opportunities for community and fishery activity disturbance are predicted to result a derivative impact to changes in livelihood patterns of local community.				
Impact	**Temporary**	**Short Term**	**Long Term**	**Permanent**	

Duration	*LNG plant activities in construction phase lasted for approximately five years. During this time, the impact of changes in livelihood patterns will occur. Since the changes in livelihood patterns is experienced by local community more than a year, so the impact duration is classfied as 'short term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The LNG plant activities in construction phase will create job opportunities and business opportunities for local communities as well as fishery activity disturbance of fishermen in the villages surrounding Tangguh LNG operation site. The impact of these activities will be 'local' in the villages surrounding Tangguh LNG operation site				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	National Labor Force Survey in 2010 stated that most of the population of Teluk Bintuni Regency depend on the agriculture, hunting, farming and fisheries as 42%, 19% service sector, 11% trading sector 11% and 28% others. In the Fakfak Regency, livelihood pattern which is almost similar to Bintuni, the majority of the population in the regency working in agriculture and fisheries in the amount of 1,782 people, while other types of work, including work in the local government offices, 3,456 civil servants in in 2009, working as an Indonesian military and police officers as much as 474 lives in 2010. *LNG plant Activities in construction phase is predicted to result a significant changes in livelihood of local community. However, it will only occur in short period of time and in 'local' magnitude. The impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Community in the villages surrounding Tangguh LNG operation site, particularly on the north shore and Fakfak mostly have livelihood in the traditional sector, fishermen, farmers and gatherers. Currently, many of the community members who work as employees at several companies in the Bintuni Bay. LNG construction activities will provide job opportunities and business opportunities to the local community, but the capacity of people to the skills and experience required is low. Thus, the sensitivity of job opportunities is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Community in the villages surrounding Tangguh LNG operation site have high expectation to obtain job opportunities and business opportunities in the construction activities in LNG Plant. Nevertheless, However, the limited capacity of the community to achieve these expectations coupled with fishery activity disturbance to fishermen in villages surrounding Tangguh LNG operation site cause of this issue becomes significant, so that the impact severity is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of changes in livelihood patterns as a derivative impact from the LNG Plant activities in construction phase including workforce recruitment and demobilization, business opportunities for Indigenous People and fishery activity disturbance in the villages surrounding Tangguh LNG operation site is likely to occur. Thus, the impact likelihood is classified as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact of changes in the livelihood pattern of community as a result of the LNG plant activities in construction phase is 'major', because it also has a 'high' severity level with the possibility of changes in livelihood patterns of community are also high, so the impact should be managed. Thus, the impact is critical ('major') and must be managed.				

Evaluation results as described in the impact evaluation Table indicates that the workforce recruitment and demobilization are classified as a 'major' or significant impact of the economic environmental component on the changes of the communities' livelihood pattern.

Operation Phase – Impact Prediction

The workforce recruitment activities also have direct or primary impacts on the job opportunities and changes in the local business growth whereas these two impacts will lead to secondary derivative impacts in the form of changes in level of income that eventually will cause tertiary impacts in the form of changes to livelihood patterns. Significant in-migration of workforce during the operation phase will affect the communities' livelihood patterns, which partly is due to the shifting of the traditional livelihood to employment at the Tangguh LNG Expansion Project, in particular the LNG Plant construction and its supporting facilities.

Operation Phase – Impact Evaluation

The LNG Plant operation activities are predicted to cause changes to the local communities' livelihoods. This is a tertiary derivative impact of the workforce recruitment and business opportunities for the local people. The workforce recruitment and business opportunities are positive impacts on the changes in livelihood patterns of the local community.

The LNG Plant activities in operation phase will last for approximately 25 years. Accordingly, the impact period is classified as long term and it is predicted to create job opportunities and business opportunities for the local communities as well as provide changes to the livelihood patterns of local community in villages surrounding Tangguh LNG operation site up until the district and regency levels.

At present, the communities' conditions are still limited to capture job opportunities and business opportunities offered by Tangguh LNG. However, field observations indicate that the local communities maintain high expectation to obtain economic benefits of the LNG Plant operation activities; however, the limited communities' capacity to reach the expectations causes that the impact severity is classified as 'high'.

Table III-133 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Livelihood Patterns

Impact	*The LNG Plant Activities in Operation Phase causes the changes in livelihood of local community. This is a derivative impact from workforce recruitment and business opportunities for local community.*				
Nature of Impact	**Negative**	**Positive**			
	The workforce recruitment and business opportunities are classified as 'positive' impacts, towards the changes in changes in livelihood patterns of local community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Workforce recruitment and business opportunities for local community are predicted to result a 'derivative' impact such as changes in livelihood patterns of local community.				
Impact	**Temporary**	**Short Term**	**Long Term**	**Permanent**	

Duration	*LNG plant activities in operation phase will last for approximately 25 years since the operation phase begun. Due to the impact of changes in livelihood patterns experienced by Indigenous People* more than 5 years, then impact duration is 'long term' period of time.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The LNG plant activities in operation phase is predicted to create job opportunities and business opportunities for Indigenous People at the level of village to regency. Based on this situatio, the impact extent is classified as 'regional'.*				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	National Labor Force Survey in 2010 stated that most of the population of Teluk Bintuni Regency depend on the agriculture, hunting, farming and fisheries as 42%, 19% service sector, 11% trading sector 11% and 28% others. In the Fakfak Regency, livelihood pattern which is almost similar to Bintuni, the majority of the population in the regency working in agriculture and fisheries in the amount of 1,782 people, while other types of work, including work in the local government offices, 3,456 civil servants in in 2009, working as an Indonesian military and police officers as much as 474 lives in 2010. *LNG Plant Activities in operation phase is predicted to result changes in livelihood of local community in the villages surrounding Tangguh LNG operation site during long term period of time (± 25 years) in which the impact extent is at the level of village to regency. However, the job opportunities and business opportunities will be tailored to the operation phase of Tangguh LNG. The impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on a survey study of community's income by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital. In addition, at this time, community has limited capacity to obtain job opportunities and business opportunities offered by Tangguh LNG. Thus, the sensitivity of the impact is 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community have high expectation to obtain economic benefit from the operation activities in LNG Plant. Nevertheless, However, the limited capacity of the community to achieve these expectations, so that the impact severity is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of changes in livelihood pattern as a derivative impact from the LNG Plant activities in operation phase is classified as 'medium' because the job opportunities and business opportunities for local community predicted likely to occur.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact of changes in the livelihood pattern of community as a result of the LNG plant activities in operation phase is 'major', because of gap between community expectations and capacity is classified as vulnerable. However, the local community has plenty big opportunity to gain economic benefit in the form of job and business opportunities. Thus, the impact is critical ('major') and must be managed.				

Post Operation Phase – Impact Prediction

The workforce recruitment activities also have direct or primary impacts in the form of job opportunities and local business growth. Both impacts lead to secondary derivative impacts in the form of changes in level of income, which eventually will lead to tertiary impacts in the form of changes in livelihood patterns. Significant in-migration of workers during the operation phase will affect the communities' livelihood which part is caused by the shift of traditional livelihoods to employments at the Tangguh LNG Expansion Project, in particular the construction of the LNG Plant and its supporting facilities.

Post Operation Phase – Impact Evaluation

The workforce demobilization and decline in business activities during the post-operation phase of LNG Plant activities is predicted to cause unemployment of the local workers, who will then look for other livelihood sources. This impact also leads to decreased business opportunities and is a 'negative' 'derivative' affects the changes in livelihood patterns of the local communities'. Changes in livelihood patterns are predicted to occur in villages surrounding Tangguh LNG operation site, so that the magnitude of impact is classified as 'local'.

The LNG Plant activities in post-operation phase will last for a long term if the majority of local communities become employees of Tangguh LNG and depend their life only on the company so that if the workers' skill of the Indigenous People* cannot compete for jobs in other companies then most likely they will not have other livelihoods. On the other side, the natural resources that previously supported their lives may have greatly decreased in productivity. Accordingly, it will lead to a high vulnerability.

Table III-134 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Livelihood Patterns

Impact	*The workforce demobilization and decline in business opportunities in the LNG Plant activities in post-operation is predicted to cause local workers who lose their jobs, so they will look for other sources of livelihood.*				
Nature of Impact	**Negative**	**Positive**			
	The workforce demobilization and decline in business opportunities are 'negative' impacts to changes in livelihood patterns of local community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The workforce demobilization and decline in business opportunities for Indigenous People are predicted to result a derivative impact of the changes in livelihood patterns of local community.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant activities in post-operation phase will last for long term period of time. It is predicted that the impact of changes in livelihood patterns of Indigenous People at the end of operation phase of Tangguh LNG and will inherent in 5 years period of time.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The changes in livelihood patterns are predicted to occur in the villages surrounding Tangguh LNG operation site, so the impact extent is classified as 'local'.				
Impact	**Negligible**	**Small**	**Medium**	**Large**	

Magnitude	*National Labor Force Survey in 2010 stated that most of the population of Teluk Bintuni Regency depend on the agriculture, hunting, farming and fisheries as 42%, 19% service sector, 11% trading sector 11% and 28% others. In the Fakfak ices, 3,456 civil servants in in 2009, working as an Indonesian military and poliRegency, livelihood pattern which is almost similar to Bintuni, the majority of the population in the regency working in agriculture and fisheries in the amount of 1,782 people, while other types of work, including work in the local government offce officers as much as 474 lives in 2010.* *LNG plant Activities in operation phase is predicted to result changes in livelihood of local community in the villages surrounding Tangguh LNG during long term period of time ((± 25 years) in which the impact exteny is at the level of village to regency. However, the job opportunities and business opportunities will be tailored to the operation phase of Tangguh LNG. The impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the Post-Operation phase, it is predicted that the composition of Indigenous People is dominated by migrants since local community is lack of investment skill. However, the local contractor has a dependency on Tangguh LNG activities, so if there is a decline of business activity in the Tangguh LNG, then it is predicted to have an impact on local contractor productivity who also declined by the end of the Tangguh LNG operation phase. However, given the estimated capacity of the community getting better at adjusting workforce qualifications in other companies, as well as to do business in a larger scale, the impact sensitivity is classified as 'moderate'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community and local government expect the economic multiplier effect of the operation phase of Tangguh LNG to occur from village level to regency level. The workforce demobilization and decline in business opportunities are implemented gradually in the long term period that is predicted to affect to the local worker and contractor in which their local businesses depend on Tangguh LNG. The impacts are predicted to create a derivative impact in ther form changes in livelihood patterns. By considering this, the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact of changes in livelihood patterns as derivative impact from LNG Plant activities in post operation phase is classified as 'medium' because the changes in livelihood patterns as a result from workforce demobilization and decline in business opportunities for local community is likely to occur.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	In the Post-Operation phase, the workforce demobilization and decline in business activities in Tangguh LNG are predicted to occur gradually in the long term period of time. This is also predicted to result impact to local workers and contractor's business activities and finally impact to the changes in livelihood patterns. On the other side, there is a dependency of local contractor to the Tangguh LNG activities. Thus, the impact is significant or classified as 'major', and need to be managed prior to the end of operation phase of Tangguh LNG.				

Evaluation results described in the impact evaluation Table indicates that the Workforce Recruitment and Demobilization Activities are classified as a 'major' or significant impact on the economic environmental component of the changes in livelihood patterns.

3.3.3.6 Changes in Livelihood Patterns (Income per Capita, Household Income, Expenditure)

a. Environmental Baseline

Construction Phase

The level of income of community can be also identified through the approach of the level of expense of community. Central Bureau of Statistics of Fakfak Regency (2012) stated that the community income level based on the level of spending for a decent life in 2009, 2010 and 2011 are respectively Rp 1.865.014,00; Rp 1.796.905,00; and Rp 2.209.354,00.

Nevertheless, field observations indicate that a significant change in level of income of community due to local workers working in the Tangguh LNG Train 1 and 2 Expansion Project. Data in **Table III-106** indicates that highest income or the average communities' income level per year is of the Tangguh LNG employees, in particular in the Tanah Merah and Saengga Villages. Results of the Social Economic Survey conducted by UGM in 2009 in particular in the villages (Tanah Merah, Saengga, and Onar) surrounding Tangguh LNG operation site also states that there are no significant differences of the average income of traders in the three areas, however fishermen of the fisheries sector in Saengga earn more, not different with Onar. This is because fishing efforts in the two areas are commercially managed, while in Tanah Merah the majority of fishermen are subsistence.

Table III-123 also indicates that in the agriculture sector, farmers in Tanah Merah earn the most (Rp 12.053.395,00 per year), not much different from Saengga (Rp 10.341.348,00 per year), whereas in Onar production from the agricultural sector is only used to meet the needs of their own living. This is because the intervention of agricultural programs conducted in Tanah Merah and Saengga is higher compared to Onar and have proven to provide benefits for the community.

Table III-135 Average Income of Workers According to Occupation Sectors in Tanah Merah, Saengga and Onar in 2009 (Rp...000,00 per year)

Occupation Sector	Average Income per Year of Workers in Villages (x Rp 1.000,00)		
	Tanah Merah	Saengga	Onar
Tangguh LNG employees	30,955	32,350	11,143
Civil Servant (PNS)/Military (TNI)/Police (Polri)/Private Company (swasta)	17,410	17,347	15,043
Trading/UKM	29,712	25,000	23,600
Fishery	1,577	21,748	19,925
Agriculture	12,053	10,341	5,972

Source: UGM Social Economic Survey 2009

UGM economic survey results in 2009 indicate a decline in the fisheries income in Tanah Merah, Saengga, and Onar Villages from 2002 to 2009. Despite the decline in level of income from fisheries sector, however an increase in the total household income and income per capita occurred from 2002 to 2009, in particular for the Tanah Merah and Saengga Villages. On the contrary, in the Onar Village the two aspects/components still declined in line with the decline in level of income from fisheries sector. One of the causes of this condition is the effect of the number of people in the three villages who work at Tangguh LNG, as there is a tendency that in villages more people are working in the company, the household income of the village is higher compared to villages with less people working for the company. This can obviously be observed in **Table III-107**, in which the number of people who have livelihoods as employees in Tangguh LNG in the Tanah Merah, Saengga, and Onar Villages are respectively 37 persons, 31 persons and 3 persons.

Table III-136 Changes in Household Income in Tanah Merah, Saengga and Onar in 2009 (Rp...000,00 per year)

Component	Tanah Merah		Saengga		Onar	
	2002	2009	2002	2009	2002	2009
Income						
Fisheries income	3,493.2	394.3	8,446.8	7,249.4	14,401,2	13,099.0
Non-fisheries income	11,733.6	33,625.4	9,865.2	23,412.0	9,238.8	2,451.2
Total household income	15,226.8	34,019.7	18,312.0	30,661.4	23,640.0	15,550.2
Delta of household income	55.2		40,3		-52.0	
Income per capita	3,288.8	5,491.9	4,229.3	5,005,6	6,025.9	4,983.4
Delta income per capita	40.1		15.5		-20.9	
Total households	**127**	**108**	**94**	**110**	**39**	**64**
Total population	**588**	**667**	**407**	**655**	**153**	**337**

Source: UGM Social Economic Survey 2009

The level of income of community in the north shore and south shore of the Bintuni Bay are different, including the communities being the performers of the economic activities. Survey results on household income conducted by PSKK UGM (2011) in the Bintuni Bay in 2012 found differences between the DAVs in the South areas and DAVs in the North areas that have very different patterns. The trade sector in the North areas is mostly performed by the Indigenous People, while in the South areas are mostly by migrants. Business differences between traders developed by the Indigenous People and migrants are in the business scale. An example of the highest kiosk income in the Weriagar Village that is developed by migrants is Rp. 26 million per month (gross income), whereas the highest income of the Indigenous People is Rp. 1 million per month.

Survey results also found that the presence of Tangguh LNG provides jobs for the communities in the surroundings. The company commitment to employ local people in its operations activities is clearly visible and the benefits perceived. The majority of people in the Babo area, South DAV's and North DAV's are working in the company. While non-DAV's areas located outside the administrative operations area of the company is not much absorbed by Tangguh LNG. Future expectation is related to the increased welfare of family of Tangguh LNG employees, at least there are fixed income, further increasing the communities' welfare.

b. Impact Prediction

Construction Phase – Impact Prediction

The workforce recruitment and demobilization activities for the construction of the LNG Plant in the construction phase are likely to involve many local workers, in particular for construction work that do not require expertise and special skills. Accordingly, these activities will significantly affect the changes in level of income of community due to employment salary during the construction phase of the Tangguh LNG Expansion Project.

Workforce recruitment also leads to the occurrence of 'direct' impacts on local businesses conducted by the local people by interaction with this project. Therefore, the impact of the increased community income is a derivative impact of the direct impact from workforce recruitment and demobilization, fishery activity disturbance and local business growth.

Similarly are the workforce demobilization activities after the construction and post-operation phases, which will significantly affect the income level of local workforce, which is a direct derivative impact of the unemployment due to the workforce demobilization, fishery activity disturbance and livelihood pattern.

Construction Phase – Impact Evaluation

The LNG Plant construction activities are predicted to lead to changes in income level of the local community. This is a derivative impact of the workforce recruitment and demobilization, business opportunities for the local people and fishery activity disturbance.

The impact of workforce recruitment and business opportunities are positive impacts, while the impact of workforce demobilization and fishery activity disturbance are negative impacts for the local community' income. The LNG Plant construction is predicted to last for approximately 5 years. During this time, the impact on the changes of the community income level will occur for a 'short term'.

Tangguh LNG construction activities are predicted to provide changes in level of income that is relatively significant for the local people, however this will only last for a short term and in local spread coverage.

Based on the study on household income survey in Bintuni Bay in 2012 by PSKK UGM, in general the local people are able to meet their daily household needs. However, they are not able yet to set aside part of their income to save and invest as business capital.

In the survey report of PSKK UGM (2011), the expectations of people at the north shore of the Bintuni Bay to become Tangguh LNG employees are relatively high. This condition will lead to vulnerability that is classified as high. However, the limited capacity of the people to achieve the expectations coupled with fishery activity disturbance to fishermen in the villages surrounding Tangguh LNG operation site cause that this issue is significant.

Opportunities because of changes in level of income as a derivative impact of the LNG Plant construction activities in the form of workforce recruitment and demobilization, business opportunities for the local people and fishery activity disturbance to fishermen in the Tanah Merah and Saengga Villages are predicted to occur.

Table III-137 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Level of Income (Income per Capita, Household Income, Expense)

Impact	*The LNG Plant activities in construction phase are predicted to cause changes in level of income of local community. This is a derivative impact from workforce recruitment and demobilization, business opportunities for local community and fishery activity disturbance.*				
Nature of Impact	**Negative**	**Positive**			
	Workforce recruitment and demobilization and business opportunities are 'positive' impact, while the impact of workforce demobilization and fishery activity disturbance result 'negative' impact to the community's level of income.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Workforce recruitment and demobilization, business opportunities for local community and fishery activity disturbance is predicted to create a derivative impact in the form of changes in the level of income of community.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant activities in construction phase is predicted to last for ± 5 years. Since the impact of changes in level of income occurs less than a year, the impact duration is classified as short term period of time.				
Impact Extent	**Local**	**Regional**	**Global**		
	The LNG Plant activities in construction phase is predicted to create job opportunities and business opportunities for local community in the villages, however, the fishery activity disturbance for fishermen in the villages surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The LNG Plant activities in construction phase is predicted to result significant changes in level of income for local community. However, this impact only occur in short time period of time and is classified as ‚local' impac magnitude.				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The UGM survey conducted in 2011 showed that the average household income of the community in the villages was intervened by the Tangguh LNG social programs reach 3,387,391 rupiahs.				
	Based on a survey study of average household income by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The vulnerability impacts are 'high', because of the high expectations of the community to obtain economic benefits from the LNG Plant activities in construction phase, but the limited capacity of the community to achieve these expectations coupled with the fishery activity disturbance to fishermen in villages surrounding Tangguh LNG operation site influence this issue is quite significant.				

Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of changes in income as a derivative impact of the LNG Plant activities in construction phase, such as workforce recruitment and demobilization, business opportunities for local community, and fishery activity disturbance to fishermen in Tanah Merah and Saengga villages are predicted to be inevitable. Thus, the impact likelihood is classified as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact of changes in level of income of community as a result of LNG Plant activities in construction phase is classified as 'major'. It is because the severity level isi 'high' with the chance of changes in level of income is also 'high', so the impact is significant ('major') and need to be managed.				

Evaluation results as described in the impact evaluation Table indicates that the Workforce recruitment and Demobilization are classified as a 'Major' impact or important impact of the environment component of economic changes in the community level of income.

<u>Operation Phase – Impact Prediction</u>

The impact on the income level of community changes is a tertiary derivative impact of the derivative impact in the form of job and local business growth, which are direct impacts of the workforce recruitment and demobilization activities in the operations phase. Workforce recruitment also leads to a direct impact on the local business growth conducted by the local community due to interaction with the project, In addition with the operation period of ± 25 years. In the operation phase, the LNG Plant activities will require a workforce of 1.500 people. The workforce working in this operation phase (migrants, local community and Indigenous People*) will affect changes in level of income where they live due to the company strategy that eventually more workers will live outside the fence.

<u>Operation Phase – Impact Evaluation</u>

The LNG Plant operation activity is predicted to cause impacts on the changes of the income level of local community, which is a derivative impact of job opportunities and business opportunities of the local community. The impact of job opportunities and business opportunities are positive impacts for the changes in level of income of local community and is a derivative impact of the job opportunities and business opportunities of the local community.

The LNG Plant activities in operation phase will last for approximately 25 years since the beginning of the operation phase. Therefore, the impact period is classified as long-term and is predicted to create job opportunities and business opportunities for the local communities at the village up until the regency levels so that it is assessed to have a regional impact of spread.

Field observations indicate that at present the community has a limited capacity to obtain job opportunities for positions with specific skills and knowledge up until expert levels. On the other side, the local community has high expectations to obtain economic benefits (including income) from the LNG Plant operations activities; however, the communities' limited capacity to achieve the expectations causes that the vulnerability of impact is classified as 'high'. The opportunity of changes in income level as a derivative impact of the LNG Plant operation activity is very likely to occur.

Table III-138 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Level of Income (Income per Capita, Household Income, Expense)

Impact	*The LNG Plant activities in operation site, the impact of changes in the level of local people's income are derived from the impact of job opportunities and business opportunities for local community.*				
Nature of Impact	**Negative**	**Positive**			
	The job opportunities and business opportunities are positive impacts for the income of local community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The impact of changes in income level of local community is a derivative impact of job opportunities and business opportunities for local community.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant activities in operation phase will last for approximately 25 years since the operation phase begun. Due to the impact of changes in income level experienced by local community more than 5 years, then impact duration is 'long term' period of time.				
Impact Extent	**Local**	**Regional**	**Global**		
	LNG Plant activities in operation phase is predicted to create job opportunities and business opportunities for local community in the level of village to regency, so the impact extent is clasified as 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The UGM survey conducted in 2011 showed that the average household income of the community in the villages was intervened by the Tangguh LNG social programs reach 3,387,391 rupiahs. *LNG Plant activities in operation phase will result the changes in income level of local community in the villages surrounding Tangguh LNG operation site in the long term period (±25 years) in which the impact extent from village to regency level/ Nevertheless, the job opportunities and business opportunities will comply with the needs of operation activities of Tangguh LNG. Thus, the impact magnitude is classified 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on a survey of average household income by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital. In addition, at this time, the community also has the limited capacity to gain skilled job opportunities. Thus, the impact sensitivity is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community have high expectation to obtain economic benefit from the LNG Plant activities in operation phase. Nevertheless, However, the limited capacity of the community to achieve these expectations, so that the impact severity is 'high'.				
Impact	**Very Small**	**Small**	**Medium**	**High**	

Likelihood	*The impact likelihood of changes in income as a derivative impact of the LNG Plant activities in operation phase is classified as 'medium', because job opportunities and business opportunities for local community are possible to occur.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact of changes in level of income as a result of LNG Plant activities in construction phase is classified as 'major' because there is a vulnerable gap between the expectation and capacity of local community. However, the local community has big opportunity to get economic benefit in the form of job and business opportunities. Thus, the significance impact is classified as 'major' and nedd to be managed.				

Evaluation results as described in the impact evaluation Table indicates that the Workforce recruitment and Demobilization Activities are classified as 'major' impacts or important impacts against the environment component on economic changes in level of income.

Post Operation Phase – Impact Prediction

The demobilization of 1,500 workers during the post-operation phase will lead to derivative impacts in the form of decreased level of income of community, which will affect the business activity decline due to the decreased demands for goods and services from Tangguh LNG. This impact is also predicted to lead to a derivative impact on the income level of the workers and local contractors originating from villages in the surrounding Tangguh LNG operation site. The impact of decreased income level will ultimately lead to a tertiary derivative impact in the form of: decreased access to education, decline in access to healthcare and changes in livelihood patterns.

Post Operation Phase – Impact Evaluation

The impact of decline in level of income of community are secondary derivative impact of the workforce demobilization and decreased business activities, so that it has negative impacts and is also predicted to affect level of income of local community in villages surrounding Tangguh LNG operation site.

Tangguh LNG post-operation activities are predicted to cause negative impact of changes in level of income of local community in villages surrounding Tangguh LNG operation site in the long term and have local impact of spread level as the impact spread occurs from the village up until the regency levels. Nevertheless, the gradual decreased business activities of Tangguh LNG in the long term are predicted to affect local contractors whose business activities much depend on Tangguh LNG. The impacts are predicted to cause derivative impacts on the decline in level of income of community so that it will lead to a high impact severity.

Table III-139 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Level of Income (Income per Capita, Household Income, Expense)

Impact	*Workforce demobilization by the Tangguh LNG contractor and decline in business activities caused by the declining demand of goods and services from Tangguh LNG are predicted to cause a derivative impact toward the level of income of the local workers and contractors derived from the villages surrounding Tangguh LNG operation site.*

Nature of Impact	**Negative**	**Positive**			
	The decline in level of income is a derivative impact of workforce demoblization as well as the decline in business activities is classified as 'negative' impact.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The decline in level of income is a derivative impact of workforce demoblization and decline in business activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant activities in post-operation phase will last for long term period of time. It is predicted that the impact of changes in level of income of local community at the end of operation phase of Tangguh LNG and will inherent in 5 years period of time.				
Impact Extent	**Local**	**Regional**	**Global**		
	Workforce demobilization and decline in business activities are predicted to affect the income of local community in surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The UGM survey conducted in 2011 showed that the average household income of the community in the villages was intervened by the Tangguh LNG social programs reach 3,387,391 rupiahs. *LNG Plant activities in post-operation phase will result negative changes in income level of local community in the villages surrounding Tangguh LNG operation site in the long term period in which the impact extent from village to regency level. This is due to the mworkforce demobilization and decline in business opportunities running gradually in accordance with the need of operation activities of Tangguh LNG. Thus, the impact magnitude is classified 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the Post-Operation phase, it is predicted that the composition of Indigenous People is dominated by migrants. And at this phase, the local community has had the ability to invest well. However, the local contractor has a dependency on Tangguh LNG activities, so if there is a decline of business activity in the Tangguh LNG, then it is predicted to have an impact on local contractors. By considering this, the sensitivity of the impact is 'high'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community and local government expect the economc multiplier effect of the Tangguh LNG activity to occur from village to regency level. A decline in business activity in the Tangguh LNG is gradual long-term impact on the predicted local contractor business activities that depends a lot on the Tangguh LNG. These impacts are predicted to cause a derivative impact to the decline in income level of community. Based on these considerations, the impact of the severity is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of decline in income level as a derivative impact of workforce demobilization and decline in business activities is likely to occur. Thus, the impact likelihood is classified of 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	In the Post-Operation phase, the workforce demoblization and decline in business activities in Tangguh LNG are predicted to occur gradually in the long term period of time. These are also predicted to result impact to local contractor's business activities. On the other side, there is a dependency of local contractor to the Tangguh LNG activities. Thus, the impact is significant or classified as 'major', and need to be managed prior to the end of operation phase of Tangguh LNG.				

Evaluation results described in the impact evaluation Table indicates that the Workforce recruitment and demobilization activities are classified as a 'major' impact or significant impact on the environmental component of economic changes in level income of the community.

3.3.3.7 Assimilation and Acculturation

a. Environmental Baseline

Construction Phase

Acculturation is a social process that arises if there is a mixing of two or more cultures that meet and affect one another. In acculturation, part absorbs selectively little or many foreign culture elements, part are trying to resist the influence. Meanwhile, assimilation is a form of social process characterized by efforts to reduce differences between people or groups of humans.

The phenomenon that acculturation and assimilation occur in the surrounding of the Bintuni Bay areas is the presence of intermarriage between the local people and migrants from outside the Bintuni Bay areas. A number of the intermarriage occurred long before the Tangguh LNG Train 1 and 2 Expansion Project was constructed and operated. This is because the Bintuni Bay areas are open areas to development, either at the north shore or south shore, which is encouraged by an increase in government activities, shrimp catching and processing companies, HPH activities and other economic activities.

One of the examples of the acculturation and assimilation processes in this area is intermarriage, which is according to the study of the Cenderawasih University (UNCEN) (2003), are classified in nine categories. The nine categories are namely: (1) Father is an Indigenous People of Bintuni and Mother is an Indigenous People of Bintuni; (2) Father is an Indigenous People of Bintuni & Mother is Indigenous People of Papua/non-Bintuni; (3) Father is Indigenous People of Bintuni and Mother is non-Papua; (4) Father is Indigenous People of Papua/non-Bintuni and Mother is Indigenous People of Bintuni; (5) Father is Indigenous People of Papua/non-Bintuni and Mother is Indigenous People of Papua/non-Bintuni; (6) Father is Indigenous People of Papua/non-Bintuni and Mother is non-Papua; (7) Father is non-Papua and Mother is an Indigenous People of Bintuni; (8) Father is non-Papua and Mother is Indigenous People of Papua/non-Bintuni; and (9) Father is non-Papua; Mother is non- Papua. In grouping for the purpose of recruiting workforce based on assimilation, this ethnic is grouped into three, namely Indigenous People of Bintuni and Papua as well as non-Papua.

On the **Table III-128** indicate inhabitants of 6 villages in the Teluk Bintuni Regency and 1 village in the Fakfak Regency who conduct ethnic assimilation and are grouped into three, namely: Indigenous People of Bintuni and Papua as well as non-Papua. Inhabitants of the Weriagar Village are the largest of ethnic assimilation namely by 9.1% of 547 inhabitants surveyed.

Table III-140 Inhabitants by Ethnic Assimilation from Seven Villages in the Bintuni Bay Area – Berau in 2003

No	Ethnic	Percentage of Inhabitants in Seven Villages Conducting Ethnic Assimilation (%)							Total
		Weriagar	Mogotira	Tomu	Ekam	Taroy	Tofoi	Otoweri	
1	Indigenous People of Bintuni	89.8	91.9	94.8	96,6	99.4	45.4	83.5	75.1
2.	Indigenous People of Papua	1.1	4.6	0.2	2,0	0.3	15.4	14.2	7.5
3.	Non Papua	9.1	3.5	5.0	1.4	0.3	39.2	2.4	17.3
Total		**100.0**	**100.0**	**100,0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
N		**547**	**518**	**482**	**353**	**339**	**1.471**	**212**	**3,922**

Source: UNCEN (2003)

There are other examples of assimilation and acculturation in the surroundings of the Bintuni Bay areas are. Firstly, in Tanah Merah, marriage events between Indigenous People and migrants who adopt the marriage procession procedure with the cultural background of the bride and groom. Secondly, the presence of Indigenous People who live side by side with migrants in villages surrounding Tangguh LNG operation site who adopt the migrants adopt good matters and applied it in their daily life patterns (e.g. making family bathrooms and toilets, household and environmental surrounding sanitation and other proper matters that influence life, such as the exchange of food).

On the other side, there are assimilation and acculturation that cause stress and negatively affect the values and social norms of the Indigenous People*. For example, the in-migration during the construction of Tangguh LNG leads to prostitution activities in a number of villages, in particular in the surrounding of the Tangguh LNG location, decline in social norms and values that may lead to the marginalization of the Indigenous People* identity; and Indigenous People* who are able to make local liquor by imitating migrants. For example, in Weriagar are Indigenous People* who are able to make local liquor from nipa palm sap, which making is obtained from migrants from NTT.

The expansion and operations of the Tangguh LNG Train 1 and 2 encouraged increased potential for assimilation and acculturation processes. Field observations indicate that a number of company employees and Government officials conduct mixed marriages with migrants from either Papua or non-Papua such as from Bugis, Makassar, Java, Sulawesi, and Ambon.

According to PSKK UGM (2009) meant by the vulnerable population is the population at risk of disorders in life it there is no concern of other parties, either the family or other people in the surroundings. Disorders in life referred to is sufficiency in daily needs (economy) and recognition/ attention from the environment. This vulnerable community groups require concern of other parties. Vulnerable community groups of the population are in poor households (< Rp 234.000,00 based on the poverty line of Central Bureau of Statistics of Papua). Population of this group who are identified are the elderly (seniors), female heads of households, disabled people and heads of households who do not work.

Based on the survey conducted by PSKK UGM in 2009 there are 5 vulnerable people who are all elderly inhabitants. They are spread-out in Tanah Merah (two persons), Saengga (one person), and Onar (two persons). The presence of these elderly is classified as vulnerable because poor households will prioritize basic needs rather than providing recognition and attention to them.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

The impact of assimilation, acculturation and changes in social norms and values of the Indigenous People* and migrants are secondary derivative effects of demographic impacts (migration, structure and population growth) during the workforce recruitment and demobilization activities. The duration of the construction phase is five years. The in-migration to meet the needs of approximately 10.500 people is likely to result impacts on the acculturation and assimilation between migrants and local community. In addition, it can also creates pressure on the social values and norms of the Indigenous People* which ultimately will result in identity shifts of the Indigenous People* in the surroundings of the Bintuni Bay and Berau Bay areas. Meanwhile, the many incoming migration is also predicted to affect the composition of the number of migrants and Indigenous People* in a number of villages, while the population percentage of the natives tend to decrease. As the census result of PSKK UGM 2011 indicates that the number of percentage of the Indigenous People* at present reach 55%, a decrease compared to data of 2003 which is 71%, while it is predicted that the percentage will continue to decline. Accordingly, the Indigenous People* in villages surrounding Tangguh LNG operation site have the potential to be marginalized.

Construction Phase – Impact Evaluation

The impact of assimilation and acculturation, changes in social norms and values of the Indigenous People* as derivative impact of the influx of migrants from outside the area, changes in the population structure and population growth are caused by the availability of job opportunities and business opportunities. Although the impact is classified as short-term (only last for 5 years) during the construction phase, it still affects the shifts of social norms and values due to the interaction, assimilation and acculturation processes with migrants that may lead to a decrease in the values so that it is predicted that it will put pressure on the Indigenous People* identity.

The assimilation and acculturation process also occur due to interactions between migrants and Indigenous People* which may be relatively intensive in the villages and are likely to occur up until district capitals and regencies. Based on previous experiences, the in-migration during the Tangguh LNG construction led to the growth of prostitution in a number of villages. The introduction of the Indigenous People* to prostitution activities affect the changes of social norms and values of the Indigenous People*.

On the other hand, the in-migration bringing along new social norms and values will face the social norms and values of the Indigenous People*. It is predicted that this will lead to cultural discrepancies between migrants and Indigenous People*. Assimilation and acculturation will occur and it is predicted to cause negative pressure as it is vulnerable to the shifting identity of the Indigenous People*. Meanwhile, in-migration is also potential to cause marginalization of the natives. Census data of PSKK UGM 2011 indicates that at present the percentage of the Indigenous People* reach 55%, a decrease compared to data of 2003 that reached 71% and the percentage is predicted to continue to decrease.

Table III-141 Impact Evaluation – LNG Plant Activities in Construction Phase against Assimilation and Acculturation

<table>
<tr><td>Impact</td><td colspan="5">LNG Plant activities in construction phase cause the assimilation and acculturation, changes in social norms and values of Indigenous People* in the villages surrounding Tangguh LNG operation site as a derivative impact of in-migration from outside, changes in population structure and growth that is caused by job and business opportunities.</td></tr>
<tr><td rowspan="2">Nature of Impact</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Indigenous People* is predicted to experience social norms and values as a result of interaction, assimilation and acculturation with migrants which may cause changes in the values that is predicted to create pressure on the Indigenous People* identity.</td></tr>
<tr><td rowspan="2">Type of Impact</td><td>Direct Impact</td><td>Derivative Impact</td><td>Indirect Impact</td><td>Cumulative Impact</td><td>Residual Impact</td></tr>
<tr><td colspan="5">This impact is a derivative impact of in-migration into the villages as a result of job opportunities and business opportunities</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">The LNG Plant in construction activities is predicted to last then 5 years. During this period, the assimilation, acculturation, changes in social norms and values of Indigenous People* occur. Thus, the impact duration is classified as ‘short term’.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">The assimilation, acculturation, changes in social norms and values of Indigenous People* are predicted to occur in the villages surrounding Tangguh LNG operation site as a main purpose of the migrants during the construction phase of LNG Plant. Thus, the impact extent is classified as ‘local’.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Small</td><td>Medium</td><td>Large</td><td></td></tr>
<tr><td colspan="5">Based on the elaboration of UGM data survey, there is an increase in total of population composition compare to Indigenous People*. In 2003, the Indigenous People* and migrants composition reach to 71% compared to 29%. The comparation increased significantly in 2012 at 59% Indigenous People*, compared to 41% migrants.

It is assumed that there will be workforce recruitment of the contractor of LNG plant construction in large numbers during the construction phase (5 years). While the business opportunities will also be opened to local community in the villages to supply foodstuff and daily necessities for workers. The economic benefits are predicted to attract outsiders to settle in villages surrounding Tangguh LNG operation site. Assimilation and acculturation between migrants and Indigenous People* are internsively implemented in villages and is expected to have an impact on changes in social norms and values of Indigenous People*. Assimilation and acculturation occurs through the interaction between the Indigenous People* to the migrants. One of them is the interaction of prostitution. Based on experience, the incoming of migrants during the Tangguh LNG construction resulted in the growth of prostitution in several villages. Introduction to Indigenous People* in prostitution activities have an impact on changes in social norms and values of Indigenous People*. Thus, the magnitude of the impact is categorized as ‘medium’.</td></tr>
</table>

Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Changes in population structure and growth because of migration will create pressure on the social norms and values that are still adopted by Indigenous People. At present, although the community still complies with the local customs and tradition, the community has started to apply technology advance introduced by the migrants. Thus, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	At present, Indigenous People still adopt traditional values strongly, the cultural ceremony is still implemented routinely to appreciate their cultural belief. On the other side, the in-migration brings the social norms and values will encounter with the social norms and values of Indigenous People*. This is predicted to cause the gap between culture of migrants and Indigenous People*. The assimilation and acculturation will occur and be predicted to result the pressure on Indigenous People* identity. Thus, the impact severity is classified as 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	At this time, Indigenous People still adopt traditional values strongly; the cultural ceremony is still implemented routinely to appreciate their cultural belief. On the other side, the in-migration brings the social norms and values will encounter with the social norms and values of Indigenous People*. This is predicted to cause the gap between culture of migrants and Indigenous People*. The assimilation and acculturation will occur and be predicted to result the pressure on Indigenous People* identity. Thus, the impact severity is classified as 'medium'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The process of assimilation, acculturation and changes in social norms and values of Indigenous People are categorized as 'major' impact because there is a gap between culture of migrants and Indigenous People* that will pressure on Indigenous People* identity significantly. Meanwhile, the purpose of in-migration opportunity is various between north shore, south shore, Bintuni Bay and Fakfak. Based on the census data of PSKK UGM in 2011 showed that the percentage of Indigenous People* currently at 55%, lower than the data in 2003 which reached 71%, and the percentage is predicted to continue to decline. Thus, the Indigenous People* in the villages surrounding Tangguh LNG operation site is potential to experience marginalization. Therefore, the assimilation and acculturation as well as changes in social norms and values of Indigenous People* are classified as significant ('major) and need to be managed.*				

<u>*Operation Phase – Impact Prediction*</u>

Impacts of assimilation, acculturation and changes in the social norms and values of the Indigenous People* and migrants are secondary derivative impacts of demographic impacts (migration, structure and population growth) during the workforce recruitment and demobilization activities. The implementation period of the operations phase is ± 25 years since the beginning of the operations phase. On the other side, the workforce requirement of 1.500 people will result in-migration that very likely affect the acculturation and assimilation between the migrants and local community. In addition, it also put pressure on the social values and norms of the Indigenous People* which ultimately will lead to continued shifts of identities of the Indigenous People* in the surroundings of the Bintuni Bay and Berau Bay areas. Most likely assimilation and acculturation occurring during the construction will continue during the operations, especially if many migrant workers do not return to their home villages.

Operation Phase – Impact Evaluation

Assimilation and acculturation will occur between migrants and the Indigenous People*, which are predicted to significantly affect the changes of social norms and values of the Indigenous People* in the long term (± 25 years). During this phase, the contractors supporting Tangguh LNG operation activities will operate their business activities outside the fence at the village up till the regency levels. The activities will attract migrants to obtain economic benefits directly or indirectly either as contractor workers, open support businesses or supply business to contractors. In this case, the workers and business performers will intensively direct interact with the community.

This prolonged interaction will lead to changes in social norms and values of the Indigenous People*. This impact is categorized as a 'major' impact, due to the social cultural discrepancy between the migrants and Indigenous People* which is predicted to put a significant pressure in the long term against the social and cultural identity of the Indigenous People*.

Table III-142 Impact Evaluation – LNG Plant Activities in Operation Phase against Assimilation and Acculturation

Impact	*LNG Plant activities in operation phase cause the assimilation and acculturation, changes in social norms and values of Indigenous People* in the villages surrounding Tangguh LNG operation site as a derivative impact of in-migration from outside, changes in population structure and growth that is caused by job and business opportunities.*				
Nature of Impact	**Negative**	**Positive**			
	Indigenous People is predicted to experience social norms and values as a result of interaction, assimilation and acculturation with migrants which may cause changes in the values that is predicted to create pressure on the Indigenous People* identity.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	This impact is a derivative impact of in-migration into the villages as a result of job opportunities and business opportunities in the operation phase of Tangguh LNG.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant in operation activities is predicted to last then ± 25 years since the operation phase begun. Thus, the impact duration is classified as 'longterm' because the impact lasts more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The job opportunities and business opportunities will be opened started from village to regency level. In this phase, the contractor in the operation phase of Tangguh LNG will operate the activities outside the LNG Plant fence. Thus, the nature of impact is 'regional'.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the elaboration of UGM data survey, there is a increase in total of population composition compare to Indigenous People. In 2003, the Indigenous People* and migrants composition reach to 71% compared to 29%. The comparation increased significantly in 2012 at 59% Indigenous People*, compared to 41% migrants.* *Job opportunities and business opportunities will be opened started from village to regency level. At this phase, the contractor of operation activities of Tangguh LNG will operate the business activities outside the fence started from village to regency level. The activities will attract migrants to get economic benefit directly or indirectly either as contractor employees, business actors who open the supporting business or business supply to the contractors. In this case, the employees and business actors will deliver direct interaction intensively with the community.* *Assimilation and acculturation will occur between migrants and Indigenous People* in which predicted to result changes in social norms and values of Indigenous People* in the long term period of time (± 25 years). Thus, the magnitude of the assimilation, acculturation, changes in social norms and values are classified as 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Changes in population structure and growth because of migration will create pressure on the social norms and values that are still adopted by Indigenous People. At this time, although the community still complies with the local customs and tradition, the community has started to apply technology advance introduced by the migrants. Thus, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	At this time, Indigenous People still adopt traditional values strongly; the cultural ceremony is still implemented routinely to appreciate their cultural belief. On the other side, the in-migration brings the social norms and values will encounter with the social norms and values of Indigenous People*. This is predicted to cause the gap between culture of migrants and Indigenous People*. The assimilation and acculturation will occur and be predicted to result the pressure on Indigenous People* identity in the long term period of time. Thus, the impact severity is classified as 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of changes in social norms and values as a result of the assimilation and acculturation between migrants dand Indigenous People absolutely occur. It is because the migrants will settle in the villages to regenct as well as direct interaction intensively with the Indigenous People*. Thus, the impact likelihood is classified as 'high'.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The changes in social norms and values of Indigenous People is categorized as the major impact because of the socio-cultural gap between migrants and Indigenous People* which will create pressure on the socio-cultural identity of Indigenous People* significantly.* *Meanwhile, the likelihood of changes in social norms and values are quite high because the assimilation and acculturation between migrants and Indigenous People* are fairly intensive. Thus, the impact of changes in social norms and values are significant ('major') and must be managed.*				

Post-Operation Phase – Impact Prediction

The workforce demobilization activities during the LNG Plant post-operation are predicted to lead to primary impacts in the form of vulnerable community groups and also impacts on assimilation and acculturation, changes in social norms and values of the local and Indigenous communities and the presence of the Indigenous people.

During the post-operation phase, it is predicted that the vulnerable community group will increase due to the aging of the elderly (seniors) or because many workers do not have sufficient income to meet, their daily needs. Survey results of PSKK UGM 2009 found that a number of people are classified as elderly, i.e. in Tanah Merah (two persons), Saengga (one person) and Onar (two persons). Certainly, during the post-operation period in 2049, the number of the elderly is predicted to increase.

On the other side, the percentage of Indigenous People in villages in the surrounding Tangguh LNG operation site is likely to increase compared to the operation period. This is because migrants and their families leave the Bintuni Bay area's to look for livelihoods elsewhere. However, if the majority still settles in this area, then assimilation and acculturation processes will occur, changes in social norms and values of the local and native people will be stronger.

Post-Operation Phase – Impact Evaluation

The assimilation and acculturation of the Indigenous People* and migrants occurred long before the post-operation phase, it even occurred during the construction which will probably will become a new culture in the Bintuni Bay areas. The workforce demobilization and decline in business activities are predicted to lead that many workers and local contractors will leave the villages in the surrounding Tangguh LNG operation site.

The Indigenous People* who experienced assimilation and acculturation then encountered a situation in which migrants leave the villages by leaving their cultures that already assimilated with the Indigenous People*. Without strong cultural footholds the Indigenous People* who already assimilated and are acculturated are predicted to experience uncertainties on the values and norms they should comply to. Should they return to their original culture, which may be forgotten, or follow the culture and traditions introduced by the migrants. However, since this impact is a long-term impact, it is predicted that new values and norms will be formed by the Indigenous People* and migrants. This certainly raises a low impact sensitivity because most likely the Indigenous People* and migrants will apply the new formed values and norms.

This impact is a tertiary derivative impact of the workforce demobilization and decreased business, which then decreases the impact on the changes in population structure. The LNG Plant post-operation activities will take place for a long term.

The Indigenous People* are predicted to experience assimilation and acculturation with migrants for relatively a long time. During this process, it is predicted that new values and norms will be formed by the Indigenous People* and migrants. The sensitivity of impact of receptors is classified as 'low' because it is predicted that the Indigenous People* and migrants already apply new values and norms every day as the result of assimilation and acculturation.

During the post-operation phase, in the long term, part of the people in the villages will gradually move to other places. This will lead to uncertainties for the Indigenous People* in the villages. However, it is predicted that the values and norms of the

Indigenous People* already experience assimilation and acculturation with migrants in the long term, so that new functional values and norms are formed and are applied in the daily life of the people. Accordingly, the vulnerability of the impact is classified as 'low'.

Table III-143 Evaluation of Impact – LNG Plant Activities during the Post-Operation Phase against Assimilation and Acculturation

Impact	*The post-operation activities LNG Plant of is predited to cause changes in social cultural and values of Indigenous People*, which is a derivative impact from the changes in population structure.*				
Nature of Impact	**Negative**	**Positive**			
	The assimilation and acculturation of Indigenous People have taken place since before the post-operation phase started. The workforce recruitment and decline in business activities is predicted to cause many local employess and contractor leave their villages surrounding Tangguh LNG operation site. Indigenous People* who have experienced assimilation and acculturation then encountered with a situation where by leaving their culture that have been assimilated by the Indigenous People*. Without a strong foothold, Indigenous People* who have experienced assimilation and acculturation predicted to be the uncertainty of values and norms that should they profess whether returned to their original culture, which may have been forgotten, or follow the culture and customs that brought by migrants*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	This impact is a tertiary derivative impact of workforce demobilization and decreased business, which then decreases the impact on changes in population structure.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant post-operative activities will occur for a long term, because it is predicted that the assimilation and acculturation impact of the Indigenous People and migrants after the Tangguh LNG operation period will adhere for a period of more than 5 years.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The assimilation and acculturation process will significantly affect the villages in the Tangguh LNG operation area, so that the Impact Extent is 'local'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on data elaboration of UGM survey, there is an increase in the composition of migrants compared to the Indigenous People. In 2003, the composition of the Indigenous People* and migrants reached 71% compared to 29%. This comparison then increased significantly in 2012, by reaching 59% for the Indigenous People*, compared to 41% for the migrants.* *People moving will occur gradually in the long term and will be particularly experienced by the people settling in the villages. People moving significantly, in particular the migrants from the villages to seek employments elsewhere is predicted to leave cultural uncertainties for the Indigenous People* who already assimilated and acculturated with the migrants in a long term related to the norms and values that they should comply to. By considering above matter then the Impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Indigenous People is predicted to encounter assimilation and acculturation with migrants in the long term period of time. During the process is predicted to create new norms and values by Indigenous People* and migrants. The sensitivity is classified as 'low' since it is predicted that the Indigenous People* and migrants have praticed new norms andd values as a result of assimilation and acculturation in everyday life.*				

<table>
<tr><td rowspan="2">Impact Severity</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">In the post-operation phase, most of the community in the villages moving from one to another place gradually in the long term period of time. This situation leaves uncertainty to Indigenous People* who live in the village, However, it is predicted that the norms and values of Indigenous People* have practiced assimilation and acculturation with migrants in the long term period of time, so it creates new norms and values that are functional and implemented in their daily life by the community. Thus, the impact severity is classified as 'low'.</td></tr>
<tr><td rowspan="2">Impact Likelihood</td><td>Very Small</td><td>Small</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">The impact likelihood of assimilation, acculturation, and changes in socio-cultural norms and values as a result of community movement from one to another place are possibly to occur. Thus, the chances of assimilation, acculturation, and changes in socio-cultural norms and values are classified as 'small'.</td></tr>
<tr><td rowspan="2">Impact Significance</td><td>Negligible</td><td>Minor</td><td>Moderate</td><td>Major</td><td>Critical</td></tr>
<tr><td colspan="5">The nature of impact is negligible by considering that assimilation and acculturation processes have been practiced more than 25 years. During the span of time, it is predicted that new norms and values are complied with by the local communities (Indigenous* and migrants) in their daily life. When part of the community leaves the villages, it is predicted that the majority of values and norms still continue, in particular if it is functional in their daily lives. Accordingly, the impact is unimportant ('Negligible'), however it still needs to be managed prior to the end of Tangguh LNG operation period.</td></tr>
</table>

3.3.3.8 Community Perception

a. Environmental Baseline

<u>*Construction Phase*</u>

The population structure of the Teluk Bintuni Regency based on the age group indicates that the non-productive age population (< 14 years and > 64 years) in the Bintuni Bay is 35.57%, while the population of productive age (14 to 65 years) is 64.43%. The dependency ratio of the non-productive and the productive age population is 55.22%. Similarly, the population structure in the Fakfak Regency, based on Central Bureau of Statistics of the Fakfak Regency (2011) indicates that the non-productive age population (<14 years and >64 years) is 36.64%. While the productive age population (14 years to 65 years) is 64.36%. This indicates that the dependency ratio between the non-productive and the productive population is 57.83%. Data indicates that in the two regencies the productive age population bears the burden of the non-productive age population.

During the Tangguh LNG Expansion Project, in particular during the construction phase, workers in large numbers will be temporary mobilized to the Tangguh LNG site. In the construction phase, there will be a camp for providing accommodation for approximately 10.500 construction workers. The camp facility also includes health and other facilities according to the needs of the workers.

During the construction period, sea transportation will be required to support mobilization of workforce, material and equipment. Possibly, ships required in the construction phase will include supporting vessel, tug boats, material barges, and LCTs. During the operation, sea transportation will be required to support workforce mobilization, logistics transportation, as well as LNG and condensate transport activities.

During the construction of Tangguh LNG facilities, the sea transportation frequency in the bay will dramatically increase and will affect fishing activities and sea transportation accessibility disturbances. This will lead to a large impact on the community perception and shall be managed properly.

The LNG Plant activities of the Tangguh LNG Expansion Project affects the activities and economic development of the Teluk Bintuni Regency area up until the Fakfak Regency in general, and in particular districts or villages immediately adjacent to the location of Tangguh LNG. Workforce recruitment activities during the construction may lead to derivative impacts on other economic components such as changes of the local business growth (financial institutions and entrepreneurs); changes in level of income (income per capita, household income and expenditure).

The workforce recruitment and mobilization activities for the construction of the LNG Plant will significantly affect the local business growth. The impact will in particular occur to villages in the surrounding Tangguh LNG operation site or transit villages of the workers such as Kokas and Irarutu III.

The LNG Plant operation activities will raise the communities' expectation related to job opportunities, business opportunities, and changes in level of income and livelihood pattern. However, not all communities' expectation can be implemented or materialized. This is closely related to the opportunities, qualifications and skill levels possessed. The unfulfilled expectations of the communities could potentially lead to negative perceptions against the Tangguh LNG operations activities.

During the LNG Plant post-operation activities, workforce demobilization will occur. This is then followed by decreased business activities. The workforce demobilization may cause that the local communities lose income sources and in a wider scale will affect the economy of the villages/districts/orchards.

The post-operation phase will lead to a number of negative affects to the local people, such as the loss of income sources and losing the chance to benefit from other (business) economic opportunities. Accordingly, the Tangguh LNG post-operation activities will lead to negative perceptions among the local communities.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Approximately 10.500 construction workers will be recruited in the expansion of the LNG Plant. This condition will affect the communities' perceptions and increase the communities' expectations to be employed, in particular during the workforce recruitment activities and the mobilization process. The communities' negative perception will occur due to the high expectation to obtain economic benefits from the LNG Plant construction activities. However, at the other side, only a small part can be absorbed due to the qualification and skills possessed.

The LNG Plant construction activities will cause concern to the communities. This is closely related to fishery activity disturbance, sea transportation accessibility disturbance and seawater intrusions due to groundwater abstraction. All the concerns are potential to lead to negative perceptions, so that correct understandings regarding construction activities of the LNG Plant should be built among the community.

Construction Phase – Impact Evaluation

Table III-144 Impact Evaluation – LNG Plant Activities in Construction Phase against Community Perception

Impact	*The LNG Plant construction activities are predicted to lead to community perception that are derivative impact of the affects of recruitment, business opportunities, changes in level of income, fishery activity disturbance, sea transportation acessibility disturbance and seawater intrusion.*				
Nature of Impact	**Negative**	**Positive**			
	The community perception related to the gap of community expectation to obtain job opportunities and business opportunities; the loss of livelihood and decline in level of income as a result of fishery activity disturbance is classified as 'negative' impacts.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The community perception is a result of a derivative impact of job opportunities, business opportunities, decline in level of income, fishery activity disturbance and seawater intrusion.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant construction activities are predicted to occur during more or less 5 years. During the time, community perception is still continued, so the impact duration, socially, is classified as ,short term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Community perceptions related to job opportunities and business opportunities are predicted to arise in the villages to regency levels. While the community perception related to level of income, fishery activity disturbance and sea transportation accessibility disturbance as well as seawater instrusion are predicted to arise in Tanah Merah and Saengga Villages.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, there are kinds of perception growing in the community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Community perception related to job opportunities, business opportunities, changes in level of income and livelihood pattern, fishery activity disturbance and sea transportation accessibility disturbance will appear repeatedly during the construction phase. The perceptions arise from government officials and community living in the villages surrounding Tangguh LNG operation site. Nevertheless, the construction activities will last for short term period of time, so the impact magnitude is at the 'medium' level.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on a survey study of community's income by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital as well as access to public services with good quality. Community also has high dependency on fishing activities to meet their daily needs; and sea transportation accessibility to move on to another place. On the other hand, the community living in the regency expect to obtain economic benefit equal to Indigenous People living in the villages surrounding Tangguh LNG operation site. Thus, the impact sensitivity is classified as 'medium'.*				
Impact	**Very Low**	**Low**	**Medium**	**High**	**Very High**

Severity	*The community perception is arised because of the high expectation of community to gain economic benefit from LNG Plant construction activities, and related to fishery activity disturbance and sea transportation accessibility disturbance of the community. However, the community have limited capacity to capture the economic benefit; and community have different understanding with Tangguh LNG related to LNG Plant activities. Thus, the impact severity is classified as 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of community perception as a derivative impact of job opportunities, business opportunities, changes in level of income and livelihood pattern, fishery activity disturbance are predicted to occur. Thus, the impact likelihood is classified as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The community perception as a derivative impact of job opportunities, business opportunities, changes in level of income and livelihood pattern, fishery activity disturbance and seawater instrusion is classified as 'major'. Since the impact severity is high, the chance of community perception s also high. Thusm the impact is classified as significant ('major') and need to be managed.				

Operation Phase – Impact Prediction

The community perception is predicted to continually increase in line with Tangguh LNG operations activities. This perception develops with the occurrence of the communities' expectation to obtain larger benefits and the discrepancy of community expectation related to activities conducted by Tangguh LNG.

In general, the various issues that are predicted to trigger the perception are divided into two groups. First, community perception is an impact of Tangguh LNG activities such as job opportunities, business opportunities, fishery activity disturbance, sea transportation accessibility disturbance and seawater intrusions. This is the responsibility of Tangguh LNG to manage. Secondly, the perception is caused by the increased community expectation to obtain larger benefits from Tangguh LNG. The benefits include education program, health program, increased community income program, entrepreneurship programs and human resource development program, revenue sharing (DBH), adat compensations, gas and electricity allocations for community, housing development, division of areas, expansion of area coverage of social programs and infrastructure improvements on a large scale.

The accumulation of the communities' perceptions can be categorized as a major impact. This is related to the complexity of the various people perception substances occurring, such as previously described, and the relatively long duration of operations of Tangguh LNG (+25 years since the operations phase starts). Accordingly, a specific social management plan is required to manage the perception so as not to accumulate in social tensions.

Operation Phase – Impact Evaluation

Table III-133 below will explain in more detail the significance of the impact of community perception for Tangguh LNG activities.

Table III-145 Impact Evaluation – LNG Plant Activities in Operation Phase against Community Perception

Impact	*The LNG Plant operation activities are predicted to cause community perception that are due to "derivative" impacts of Tangguh LNG activities including job opportunities, business opportunities, fishery activity disturbance and sea transportation accessibility disturbance and seawater intrusion.* *The perception also occurs due to the increased expectation of the communities for education program, health program, increase in level of income of community program, entrepreneurship program, papuan development program, revenue sharing, adat compensation, gas allocation, electricity for the communities, housing development, regional expansion, expansion of social program coverage areas, and infrastructure improvement on a large scale.*				
Nature of Impact	**Negative**	**Positive**			
	The community perception occurs related to the accumulation of social impact issues of Tangguh LNG activities and the communities' expectation, which if not properly managed it will lead to social tensions.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The community perception occurs as a derivative impact of the accumulation of social impact perceptions on Tangguh LNG activities including job opportunities, business opportunities, fishery activity disturbance and sea transportation accessibility disturbance and seawater intrusion, as well as the increased expectation of the communities for education program, health program, increase in level of income of community program, entrepreneurship program, papuan development program, revenue sharing, adat compensation, gas allocation, electricity for the communities, housing development, regional expansion, expansion of social program coverage areas, and infrastructure improvement on a large scale.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant operation activities will last for approximately 25 years since the operation phase begun, so that the impact period is classified as long term, because the community perception occurring to the local communities will last for more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The community perception related to social impacts and expectations for Tangguh LNG is predicted to be spread out from the coastal villages up till the highlands and cities of the Teluk Bintuni and Fakfak regencies, even to the capital city of West Papua. In this case the issues on the expectation for Tangguh LNG will also spread to become joint issues in particular of the communities in the Bintuni Bay and Berau Bay areas and in general in West Papua.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, there are many perceptions developing in the community related to Tangguh LNG activities. Apart from that, the growing of community expectation related to the role and contributions of Tangguh LNG in the various aspects of social, economic, political and community culture. *Community perception related to the impact of Tangguh LNG activities, and which are outside the authority of Tangguh LNG are predicted not to emerge everyday, however at particular moments during activities of the community and local government. It is also predicted that the spread of the community perception occur from the villages up till the regency levels in the long term (approximately 25 years), so that the impact magnitude is classified as 'large'.*				
Impact	**Low**	**Medium**	**High**		

Receptor Sensitivity	*Census data of PSKK UGM in 2011 indicates that the percentage of Indigenous People* at present reach 55%, a decrease compared to data in 2003 that reached 71%, and it is predicted that in the future the percentage will continually decrease.* *On the other side, there is a gap in the communities' ability to manage the resources owned, and a high skill gap between the Indigenous People* and workers of Tangguh LNG. Based on the survey study on the communities' income by PSKK UGM in 2012, the local people are in general already capable to meet their daily household needs. However, they are not yet able to set aside part of their income for savings and invest it as business capital. Apart from that, at present the communities also have limited capacities to capture job opportunities and business opportunities offered by Tangguh LNG, which will result that the position of the Indigenous People* will be more difficult in economic competition with the migrants. Accordingly, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The local communities have high expectation to obtain economic benefits from the LNG Plant operation, however with the limited communities' capacity to achieve the expectations, and the high percentage of migrants cause that the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of community perception as derivative impact of the Tangguh LNG operation activities is classified as high, because the job opportunities and business opportunities for the local communities are predicted to certainly occur.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The community perception as derivative impact of Tangguh LNG activities accumulative impact and the communities' expectations are classified as 'major'. This is because the perceptions have a high vulnerability for the people living in coastal villages, up till people in the regency and province levels. Apart from that, the community perception occurring is predicted to be inclined to have complex substances that may affect the communities in a wide scope as well as Tangguh LNG activities. Accordingly, the impact is important ('major') and should be managed.				

Post-Operation Phase – Impact Prediction

During the post-operation phase, the community perception predicted to develop will be related to job opportunities and business opportunities of Tangguh LNG that is no longer available due to the completion of the Tangguh LNG operations phase. However, at that time (approximately 25 years after the beginning of operation), the communities are predicted to have the ability to develop their economy independently. The communities are predicted to have the capacity and better education to be able to work in other companies as well as managing businesses in larger scales.

Post-Operation Phase – Impact Evaluation

The following **Table III-134** explains briefly on the prediction of the community perception developments during the post-operation phase.

Table III-146 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Community Perception

Impact	*The community perception is a derivative impact of the workforce demobilization, decline in business activities, changes in level of income and livelihood patterns during the post-operation phase.*			
Nature of Impact	**Negative**	**Positive**		
	The negative perception of the communities occur due to the workforce demobilization, decline in business activities, decline in communities' level of income and changes in level of income.			

Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The community perception is a derivative impact of the workforce demobilization, decline in business activities, and decline in communities' level of income.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant activities in post-operation phase will last for a long term, because it is predicted that the community perception occurring in the local communities is related to the activities, after the Tangguh LNG operation period ends it will adhere for a period of more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The community perception related to the workforce demobilization and decline in business activities is predicted to occur in the villages up till regency level, while community perception related to changes in level of income and livelihood patterns will occur in villages surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, there are many perceptions developing in the community related to Tangguh LNG activities. Apart from that, the growing of community expectation related to the role and contributions of Tangguh LNG in the various aspects of social, economic, political and community culture. *Community perceptions related to the impact of workforce demobilization, decline in business activities, changes in level of income and livelihood pattern are predicted to not continuously occur. However, the perception scale is predicted to arise in the villages up to regency. Thus, the impact magnitude is categorized as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the post-operation phase, it is predicted that migrants dominate the population composition. In this phase, local community has good capability to invest. However, the local employee and contractor have dependency on Tangguh LNG. Therefore, if there is a decline in business activities in Tangguh LNG, this will affect the local contractor. The impacts further are predicted to cause community negative perception related to Post Operation of Tangguh LNG. By considering this, the impact sensitivity is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community and local government expect the economic multiplier effect of the Tangguh LNG activities to occur from village level to regency level. The workforce demobilization and decline in business opportunities are implemented gradually in the long term period that is predicted to affect to the local worker and contractor in which their local businesses depend on Tangguh LNG. The impacts are predicted to create a derivative impact in ther form of community perception related to Post Operation of Tangguh LNG. By considering this, the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of community perception related to loss of job opportunities and business opportunities from Tangguh LNG as derivative impact of the LNG Plant activities in post-operation phase is classified as 'medium', because the negative perception arising from workforce demobilization and decline in business opportunities for local communities are predicted to possibly to occur.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	In the Post-Operation phase, the workforce demoblization and decline in business activities in Tangguh LNG are predicted to occur gradually in the long term period of time. These are also predicted to result impact to local contractor's business activities. On the other side, there is a dependency of local contractor to the Tangguh LNG activities. Thus, the impact causes negative perception of community to Post Operation activities of Tangguh LNG. Thus, the impact is significant ('major'), and need to be managed prior to the end of operation phase of Tangguh LNG.				

3.3.3.9 Social Tension

a. Environmental Baseline

Construction Phase

The Tangguh LNG Expansion Project coupled with the need for a number of workers already incurred negative perceptions amongst the local people. This is an impact of the communities' or ethnic group high expectations in general to obtain benefits of Tangguh LNG, such as employment, education, health and income increase programs. In addition, the LNG Plant construction activities emerge concerns in the community. This is closely related to the fishery activity and sea transportation accessibility disturbances.

Meanwhile, the LNG Plant activities during the operation phase consist of demobilization recruitment which is estimated as many as 1.500 workers and additional workforce of approximately 500 – 1.000 people will be required for the operation and maintenance of facilities. In terms of workforce recruitment and mobilization activities for the construction of the LNG Plant, it will affect the local growth business. This phenomenon will mainly occur in villages surrounding Tangguh LNG operation site or transit villages of the workers such as in Kokas and Irarutu III.

The workforce demobilization activities during Tangguh LNG post-operation period is predicted to incur derivative impacts on economic components such as: changes in the local businesses growth (financial institutions and entrepreneurs); changes in the level of income (income per capita, household income, and expenditures). Other impacts are increased unemployment in villages surrounding Tangguh LNG operation site. It is referred to that in general, the Tangguh LNG post-operation activities have the potential to cause various economic and social issues on the local people.

Social tension incurred is direct derivative impacts of the local communities' perceptions caused by the workforce recruitment and mobilization. The social tensions consist of social envy and social conflicts. In addition, sea transportation activities will also affect the social tensions as direct secondary of the negative perception impacts.

In addition, not all expectation of the community can be actualized or realized. If the expectations are not achieved, it has the potential to incur negative perceptions for the local communities. The impact of social tensions can occur if negative perceptions or envy arises in the communities related to Tangguh LNG operations activities, due to either workforce issues or benefits obtained by the people in villages surrounding Tangguh LNG operation site.

Due to the relatively long operation period of Tangguh LNG (± 25 years since the operation phase begun), if the negative perceptions are not managed then it will have the potential to incur social tensions.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Impacts on social tensions are direct derivative impact of the local community perceptions caused by the workforce recruitment process. Social tensions consist of social envy and social conflicts.

The large scale of the local community or ethnic group expectations in general are to obtain benefits from Tangguh LNG, such as employment, education, health and increased income programs. In addition, construction activities of the LNG Plant also incur concerns of the community, in particular fishery activity disturbance and sea transportation accessibility disturbance of local community.

Social tensions may occur due to accumulated negative perceptions of the communities that are not properly addressed. The impact of community perception is a derivative impact of employment, business opportunities, and changes in level of income as well as fishery activity disturbance and sea transportation accessibility disturbance.

Construction Phase – Impact Evaluation

Table III-147 Impact Evaluation – LNG Plant Activities in Construction Phase against Social Tension

Impact	*The LNG Plant construction activities are predicted to cause social tension impact as a derivative impact of community perception.*				
Nature of Impact	**Negative**	**Positive**			
	Social tension is possibly to occur because of community perception that is accumulative and not managed appropriately, and classified as negative impact. The impact of community perception is a derivative impact from job opportunities, business opportunities, and changes in level of income, fishery activity disturbance and sea transportation accessibility disturbance. The social tension symptoms (such as grievance, protest, confrontation, conflict, etc) are potentially threaten the security and activities of Tangguh LNG construction.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tension is a tertiary derivative impact from community perception which is also a derivative impact from job opportunities, business opportunities, and changes in level of income, fishery activity disturbance and sea transportation accessibility disturbance.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant construction is predicted to last for more less 5 years. During this period, the social tension impact is predicted to occur, because it potentially affects the community local to occur during more than 1 year.				
Impact Extent	**Local**	**Regional**	**Global**		
	The social tension is a derivative impact from community perception related to job opportunities and business opportunities, which are predicted to occur in the villages up to regency levels. However, the community perceptions related to changes in level of income, fishery activity disturbance and sea transportation accessibility disturbance occur in the villages surrounding Tangguh LNG operation site. It is predicted to occur particularly in Tanah Merah and Saengga Villages.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, there are many perceptions developing in the community related to Tangguh LNG activities. Apart from that, the growing of community expectation related to the role and contributions of Tangguh LNG in the various aspects of social, economic, political and community culture. *The impact of community perception scattered in the villages to the regenct does not necessarily lead to social tension, especially the impact takes place in the short term (5 years). Impact predicted to arise when community perception accumulates and is not managed properly. Thus, impact magnitude is classified as 'medium'.*				

Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Based on a survey study of community's income by the PSKK UGM in 2012, the local community in general has been able to meet the needs of everyday households. However, they have not been able to set aside part of their income to save and invest as business capital as well as access to public services with good quality. Community also has high dependency on fishing activities to meet their daily needs; and sea transportation accessibility to move on to another place. On the other hand, the community living in the regency expect to obtain economic benefit equal to Indigenous People living in the villages surrounding Tangguh LNG operation site. Thus, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The community perception is a result of the high expectation of community to gain economic benefit from LNG Plant construction activities, and related to fishery activity disturbance and sea transportation accessibility disturbance of the community. However, the community has limited capacity to capture the economic benefit; and community has different understanding with Tangguh LNG related to LNG Plant activities. Thus, the impact severity is classified as 'high'				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is classified as small because of the accumulative community perception does not necessarily cause social tension. Thus, the impact likelihood is categorized as 'small'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	By considering the impact severity as a result of a high accumulative community perception, as well as the impact likelihood which does not necessarily cause social tension, thus, the impact is signidicant or categorized as 'moderate' and need to be managed.				

<u>*Operation Phase – Impact Prediction*</u>

The community perception is predicted to increase in line with the implementation of the Tangguh LNG operation activities. In general, the community perception can be grouped into two. First, community perceptions arising from Tangguh LNG activities, such as employments, business opportunities, fishery activity disturbance and public transportation as well as sea water intrusions, in which the management of the impacts is the responsibilities of Tangguh LNG. Secondly, the perception is caused by the increased community expectation to obtain larger benefits from Tangguh LNG. The benefits include education program, health program, increased community income program, entrepreneurship programs and human resource development program, revenue sharing (DBH), adat compensations, gas and electricity allocations for community, housing development, division of areas, expansion of area coverage of social programs and infrastructure improvements on a large scale.

Perceptions in above context are potential to lead to social tensions symptoms if continuously accumulated. This also has the potential to occur considering the long period of the Tangguh LNG operation (± 25 years since the operations phase begun), and the various complex issues that occur as described above. Symptoms of social tensions (such as complaints, protests, confrontations, conflicts, etc.) are predicted to have the potential to disturb the security and continuity of the LNG Plant operations activities, either directly or indirectly.

Operation Phase – Impact Evaluation

Table III-136 below will explain in more detail the significance of the impact of increased social tension for Tangguh LNG activities.

Table III-148 Impact Evaluation – LNG Plant Activities in Operation Phase against Social Tension

Impact	*The LNG Plant operation activity is predicted to cause social tension impacts, which are derivatives of the community perception impacts.*				
Nature of Impact	**Negative**	**Positive**			
	Social tensions may occur due to accumulated community perceptions. The social tension symptoms (such as complaints, protests, confrontations, conflicts, etc.) have the potential to disturb the security and continuity of the LNG Plant operation activities. Therefore, increased social tensions are classified in negative impacts.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tensions are tertiary derivative impacts of community perception that are also derivatives of the impact of job opportunities, business opportunities, changes in level of income and livelihood patterns, as well as economic competitions related to changes in demographic. In addition, social tensions are predicted to have the potential to occur due to community perception related to the increased peoples' expectation to obtain larger benefits from Tangguh LNG, such as education program, health program, increased community income program, entrepreneurship program, Papuan development program, revenue sharing funds (DBH), adat compensation, gas allocation, and electricity for the community, housing development, regional expansions, expansion of social program coverage areas, and infrastructure improvements on a large scale.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant operation activities will last for approximately 25 years since the operation phase begun, so that the impact is relatively of a long term, as the potential of social tensions impact that may occur in the local community will possibly last for more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	Social tensions such as complaints, protests, confrontations, horizontal conflicts, etc. related to the community perception that occur due to impacts of Tangguh LNG activities, as well as arising from increased communities' expectation to obtain larger benefits from the presence of Tangguh LNG are predicted to occur in the villages up till the regency levels. Accordingly, the impact extent is 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, there are many perceptions developing in the community related to Tangguh LNG activities. Apart from that, the growing of community expectation related to the role and contributions of Tangguh LNG in the various aspects of social, economic, political and community culture. *The impact of community perception scattered in the villages to the regency does not necessarily lead to social tension, especially the impact takes place in the short term (± 25 years since the operation phase begun). Impact predicted to arise when community perception are accumulated and not managed properly. Thus, impact magnitude is classified as 'medium'.*				
Impact	**Low**	**Medium**	**High**		

Receptor Sensitivity	*Census data of PSKK UGM in 2011 indicates that the percentage of Indigenous People* at present reach 55%, a decrease compared to data in 2003 that reached 71%, and it is predicted that in the future the percentage will continually decrease.* *On the other side, there is a gap in the communities' ability to manage the resources owned, and a high skill gap between the Indigenous People* and workers of Tangguh LNG. Based on the survey study on the communities' income by PSKK UGM in 2012, the local people are in general already capable to meet their daily household needs. However, they are not yet able to set aside part of their income for savings and invest it as business capital. Apart from that, at present the communities also have limited capacities to capture job opportunities and business opportunities offered by Tangguh LNG, which will result that the position of the Indigenous People* will be more difficult in economic competition with the migrants. Accordingly, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community have high expectation to gain economic benefit from the LNG Plant operation activities, however, they have limited capacity to achieve the expectation; and high proportion of migrants influence a 'high' impact severity.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is classified as small because of the accumulative community perception does not necessarily cause social tension. Thus, the impact likelihood is categorized as 'small'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	By considering the impact severity as a result of a high accumulative community perception, as well as the impact likelihood which does not necessarily cause social tension, thus, the impact is signidicant or categorized as 'moderate' and need to be managed.				

<u>Post-operation Phase – Impact Prediction</u>

During the post-operation phase, the perception that is predicted to develop in the community is the perception on loss of job opportunities and business opportunities from Tangguh LNG, related to the end of the Tangguh LNG operation period. Although at that time the people are predicted to have proper capacities to fill jobs in other companies, as well as developing businesses in larger scales, however the community perception still have the potential to develop into symptoms of social tensions. This occurs if the community perceptions continue to accumulate that may lead to tension symptoms such as protests, demonstrations, conflicts, etc.

<u>Post-Operation Phase – Impact Evaluation</u>

Table III-137 tries to briefly describe the predictions on social tensions occurring due to the accumulation of community perceptions related to the Tangguh LNG activities approaching its post-operation period Table III-149 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Social Tension

Table III-150 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Social Tension

Impact	*The increased social tension is a derivative impact of community perception because of workforce demobilization and decline in local business in the Post-Operation phase of LNG Plant activities.*				
Nature of Impact	**Negative**	**Positive**			
	Social tension is possibly to occur because of community perception that is accumulative and not managed appropriately, and classified as negative impact. The social tension symptoms (such as grievance, protest, confrontation, conflict, etc) are potentially threatened the security and activities of LNG Plant operation.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tension is a tertiary 'derivative impact' of community perception as well as job opportunities, business opportunities, and changes in level of income and livelihood pattern.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant activities in post-operation phase will last for long term period of time because of the potential social tension possibly to occur. It is related to the community perceptions at the end of post-operation phase of Tangguh LNG and will inherent in 5 years period of time				
Impact Extent	**Local**	**Regional**	**Global**		
	Community perceptions related to job opportunities and business opportunities are predicted to arise in the villages to regency levels. While the community perception related to changes in level of income and livelihood pattern are predicted to arise in the villages surrounding Tangguh LNG operation site. Thus, the impact extent of social tension as a derivative impact of community perception is 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there are various perceptions growing in the community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Community perception spread out in the villages to regency level does not necessarily create social tension, although the impact occurs in the long term period of time. The impact is predicted to occur when the perception is accumulative and not managed properly. Thus, the impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	In the post-operation phase, it is predicted that migrants dominate the population composition. In this phase, local community has good capability to invest. However, the local employee and contractor have dependency on Tangguh LNG. Therefore, if there is a decline in business activities in Tangguh LNG, this will affect the local contractor. The impacts further are predicted to cause negative community perception related to Post Operation of Tangguh LNG that is potentially to create social tension if it is not managed properly. By considering this, the impact sensitivity is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Local community and local government expect the economic multiplier effect of the Tangguh LNG activities to occur from village level to regency level. The workforce demobilization and decline in business opportunities are implemented gradually in the long term period that is predicted to affect to the local worker and contractor in which their local businesses depend on Tangguh LNG. The impacts are predicted to create a derivative impact in ther form of community perception related to Post Operation of Tangguh LNG that potentially creates social tension. By considering this, the impact severity is classified as 'high'.				
Impact	**Very Small**	**Small**	**Medium**	**High**	

Likelihood	*The impact likelihood of social tension is classified as small, because the perceptions do not necessarily change into social tension coupled wih the grievanve mechanism is still continued in the community up to present.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	In the Post Operation phase, workforce demobilization and decline in business opportunities are implemented gradually in the long term period that is predicted to affect to the local workers and contractors in which their local businesses depend on Tangguh LNG. The impacts are predicted to create negative community perception related to Post Operation of Tangguh LNG that if it is not managed properly will creates social tension. Thus, the impact is classified as significant ('moderaate') and need to be managed prior to the end of Tangguh LNG operation.				

3.3.3.10 Changes in Cultural Heritage

a. Environmental Baseline

Operation Phase

At present, the Indigenous People* still strongly adhere to their traditional values, traditional ceremonies are still performed regularly to respect their beliefs. Cultural heritage can be in a sacred aspect and traditional institutions. The two forms of cultural heritage are dynamic, always changing from time to time. For example, traditional institutions in the Teluk Bintuni and Fakfak regencies, the regional cultural history indicates traditional institutional strengthening such as the upper class system, the resource management system that is known as the *sasi* system, sacred stories related to kinship and sacred locations.

b. Impacts Prediction and Evaluation

Operation Phase – Impact Prediction

The impact on the changes of cultural heritage is a derivative impact of socio-cultural norms and values of the Indigenous People*. Assimilation and acculturation between migrants and the Indigenous People* are predicted to last quite intensively in villages surrounding the Bintuni Bay for a long term (± 25 years since the operations phase begun). The process is predicted to affect the socio-cultural norms and values changes of the Indigenous People* who are spread-out in villages. Furthermore, the derivative impact of the cultural heritage will occur such as ceremonies and the use of local languages, etc.

Census results of PSKK UGM in 2011 indicates that at present, the percentage of the Indigenous People* reach 55%, decreased compared to data of 2003 that reached 71%, and the percentage is predicted to continually decline. The decrease is predicted to affect the socio-cultural norms and values changes and the subsequent impact is to reduce or even invalidate the cultural heritage of the local people. Changes in cultural heritage are predicted to occur, either physically (sacred places, graveyards, caves, etc.) or non-physical heritage (folklore, traditions, dances, etc.) which tend to be ignored in line with the shrinking composition of the native population. There is the possibility that the local communities do not care anymore for their original cultures and the migrants also ignore or even damage the existing cultural heritage. Meanwhile, the cultural heritage should be protected and preserved in order to maintain the social identity of a community group. Based on this consideration, it can be said that LNG activities will affect the erosion of the cultural heritage and the impact that occurs is major and should be managed to ensure the preservation of culture as a form of social identity of the local communities.

Operation Phase – Impact Evaluation

To understand and assess whether the LNG Plant operation affect the changes to the cultural heritage, can be observed from the following **Table III-138** on Evaluation of Impact:

Table III-151 Impact Evaluation – LNG Plant Activities in Operation Phase against Cultural Heritage

Impact	*The LNG Plant operation activities is predicted to cause changes in culture heritage as a result of derivative impact of changes in socio-cultural norms and values of Indigenous People*.*				
Nature of Impact	**Negative**	**Positive**			
	Indigenous People is predicted to experience changes in socio-cultural norms and values as a result of social interaction, assimilation and acculturation process with migrant that can lead to the decreased social identity. Thus, this impact is classified as 'negative'.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	This impact is a tertiary derivative impact from the changes in social norms and values as a result of social interaction between Indigenous People and migrants.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	LNG Plant activities in operation phase last for ± 25 years since the operation phase begun, so the duration of impact is classified as long term since the impact of changes in cultural heritage of Indigenous People will occur more than 5 years.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact on changes of the cultural heritage due to the changes in socio-cultural norms and values of the Indigenous People which is a derivative of the assimilation and acculturation process, is predicted to occur in villages surrounding Tangguh LNG operation site. Accordingly, the impact is 'local'.*				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, Indigenous People still adhere traditional values strongly. The traditional values are applied in their behaviors, norms, values, various adat practices and sacred objects (such as Batu Kumapa and Sacred Houes inside LNG Plant area). Nevertheless, based on the elaboration of UGM data survey, there is a increase in total of population composition compare to Indigenous People*. In 2003, the Indigenous People* and migrants composition reach to 71% compared to 29%. The comparation increased significantly in 2012 at 59% Indigenous People*, compared to 41% migrants. It is predicted to potentially decrease the value of cultural heritage of Indigenous People*.* *Assimilation and acculturation between migrants and Indigenous People* are predicted to occur intensively in the villages in the long term period of time (± 25 years since the operation phase begun). The process is predicted to impact on the changes in social norms and values of Indigenous People*. Then, it leads to changes in cultural heritage such as local language use and others. Thus, the impact magnitude is classified as medium.*				
Impact	**Low**	**Medium**	**High**		

Receptor Sensitivity	*At present, part of Indigenous People* still obey their local customs, including cultural ceremony, local costum, and local language use. However, the community has also started to apply advance technology introduced by the migrants. Thus, the impact of assimilation and acculturation of Indigenous People* with migrants are predicted to potentially decrease the social identity of Indigenous People* that is expected to protect local cultural heritage. Thus, the impact sensitivity is classified as 'medium'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	At present, part of Indigenous People still obey the cultural value strictly, and cultural ceremony held routinely to honour their beliefs. On the other side, the migrants bring their new social norms and values that will meet witj social norms and values of Indigenous People*. It is predicted to cause gap between migrants and Indigenous People*. Assimilation and acculturation are predicted to potentially decrease the social identity of Indigenous People* that is expected to protect local cultural heritage. Thus, the impact severity is classified as 'high'.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact on changes in cultural heritage as a result of assimilation and acculturation is predicted to decrease social identity of Indigenous People. Indigenous People* still consistently practice their traditional custom such as cultural ceremony and local language use. Nevertheless, their beliefs in practicing traditional custom are predicted to be eliminated. The impact likelihood of decreasing of belief on cultural heritage is classified as 'medium'. It is because social identity shifting that is predicted to impact on belief shifting, in which affect on preservation of cultural heritage of Indigenous People* as a ceremonial activity specifically.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	At present, the Indigenous People still strongly adhere to their traditional values, traditional ceremonies and local language use. Since the migrants coming into their area and bring new socio-cultural norms and values, it is predicted to gradually eliminate their belief. Decreasing of belief and practices in cultural heritage is likely to occur, so the impact is significant ('major') and need to be managed.*				

Post-operation Phase – Impact Prediction

The impact on the changes in cultural heritage during the post-operation phase is a derivative impact of the workforce demobilization activities and decreased business activities causing that part of the communities in the villages will move. This condition is predicted to affect the return of values believed by the Indigenous People* as cultural heritage prior to the presence of Tangguh LNG at the Bintuni Bay. Observed from the sensitivity it is classified as 'low', because it is predicted that the Indigenous People* and migrants already apply new values and norms that are more functional in their lives as results of assimilation and acculturation. The intensive assimilation and acculturation process is predicted to occur for a long time, approximately 25 years since the Tangguh LNG operation phase starts and during that period, it is predicted that new values and norms are formed and are adhered to by the local people (natives and migrants) in their daily lives. When part of the communities leave the villages, it is predicted that a great part of the values and norms still remain, in particular if this is functional in their daily lives. Based on this consideration it can be said that the character of impact is negligible.

Post-operation Phase – Impact Evaluation

To determine or assess whether post-operation activities of LNG Plant influence the changes in cultural heritage can be seen in the Impact Evaluation **Table III-139** below:

Table III-152 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Cultural Heritage

Impact	*The LNG Plant activities in post operation phase are predicted to impact on the changes in cultural heritage of Indigenous People*. It is a derivative impact of workforce demobilization and decline in business activities, which cause part of community leavingthe villages.*				
Nature of Impact	**Negative**	**Positive**			
	Part of the communities leaving the villages in the surrounding Tangguh LNG operation site to other locations is predicted to have a 'positive' impact on the return of the values believed by the Indigenous People as cultural heritage prior to the presence of Tangguh LNG at Bintuni Bay.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	This is a tertiary derivative impact of the departure of migrants to their hometowns due to the workforce demobilization and decline in business activities of Tangguh LNG post-operation activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Tangguh LNG post-operation activities will last for a 'long term', because it is predicted that the impact of the local communities' access to public services including education after the Tangguh LNG operation period expires will adhere for a period longer than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact of changes in values that are believed as cultural heritage of the Indigenous People are predicted to affect the communities living in villages surrounding Tangguh LNG operation site (classified as 'local' impact extent).*				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the elaboration of UGM data survey, there is a increase in total of population composition compare to Indigenous People. In 2003, the Indigenous People* and migrants composition reach to 71% compared to 29%. The comparation increased significantly in 2012 at 59% Indigenous People*, compared to 41% migrants.* *Changes in cultural values are predicted to occur gradually in the long term in line when part of the people move to other locations. This impact is predicted to affect the communities staying in the villages; accordingly the Impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The Indigenous People are predicted to experience assimilation and acculturation with migrants during a fairly long period of time. During the process it is predicted that new values and norms are formed within the Indigenous People* and migrants. The sensitivity is classified as 'low' because it is predicted that the Indigenous People* and migrants already applied the new values and norms that are more functional in their lives as a result of assimilation and acculturation.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	During the post-operation phase part of the people in the villages will gradually move to other location in the long term. This will leave uncertainties for the Indigenous People living in the villages to return to the values and norms that they adopted in the past. However, it is predicted that the values and norms of the Indigenous People* already experienced assimilation and acculturation with the migrants in the long term, so that new values and norms are formed that are functional and applied in the daily lives of the people. Accordingly, the impact severity is classified as 'low'.*				
Impact	**Very Small**	**Small**	**Medium**	**High**	

Likelihood	*The impact likelihood of cultural heritage changes due to the departure of migrants may occur, because the Indigenous People* already adopted new values and norms that are more functional in their daily lives due to the assimilation process with migrants.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The character of Impact can be negligible by considering that the intensive assimilation and acculturation process lasted for more than 25 years. Accordingly, during this period it is predicted that new values and norms are adopted by the local people in their daily lives. When part of the population leaves the villages, it is predicted that a large part of the values and norms will still remain, in particular as it is functional in their daily lives. Accordingly, the impact is not important ('negligible'), however it should be managed prior to the expiry of Tangguh LNG operation period.				

3.3.3.11 Decline in Access to Public Services including Education

a. Environmental Baseline

Construction Phase

During the LNG Plant construction activities, school facilities are provided from the PAUD (early childhood education) level or kindergarten up until high school or vocational schools, as there are already villages adjacent to Tangguh LNG construction activities. Primary level education facilities are available in almost every village, besides junior and senior high schools that are available, however only in a few villages. Educational facilities available can be observed in the following **Table III-140**.

The Local Government of Teluk Bintuni Regency has given effort to increase quality of education, such as bringing in assistant teachers from Java, voicing support increased educational infrastructure to various parties, cooperating with universities in Papua or other regions to develop the improved educational quality program. On the other side, Tangguh LNG also develops educational quality development for the communities, for example, Tangguh LNG is committed to develop education in cooperation with the British Council.

Table III-153 Level of Education Facilities Availability in Districts of Teluk Bintuni Regency

No	School	Total of Students	Classroom	Class-Student Ratio	Total of Teacher	Teacher-Student Ratio
Kamundan District						
1	SDN Satu Atap	171	14	12,2	9	19
2	SMPN Satu Atap	93	2	46	6	15,5
Weriagar District						
1	SD YPPK	338	6	56,3	7	48,3
2	SMP Satu Atap	26	2	13	Na	na
Tomu District						
1	SD Inpres HTI Aranday	189	6	31,5	10	18,9
2	SD Inpres Tomu	261	6	43,5	7	37,3
3	SDN Taroy	145	5	24,2	9	16,1
4	SMPN Aranday	142	6	23,7	9	15,8

No	School	Total of Students	Classroom	Class-Student Ratio	Total of Teacher	Teacher-Student Ratio
5	SMA Swadaya Aranday	136	Na	na	19	7,2
Babo District						
1	SD Inpres Babo	284	8	35,5	12	23,7
2	SD Nurul Falaq Asmanu	79	4	19,8	4	19,8
3	SD YPPK Babo	163	7	23,3	7	23,3
4	SMPN Babo	247	8	30,9	17	14,5
5	SMA Persiapan Babo	158	Na	na	16	9,9
Aroba District						
1	SD Inpres Wimbro	145	6	24,2	6	24,2
2	SD YPPK Aroba	113	6	18,8	5	22,6
3	SD YPPK Yaru	54	6	9,0	3	18,0
4	SMP Satu Atap Wimbro	16	1	16,0	N/A	N/A
Sumuri District						
1	SD Inpres Kelapa Dua SP1	201	6	33,5	8	25,1
2	SD Inpres Kelapa Dua SP2	175	7	25,0	8	21,9
3	SD Inpres Tofoi	284	6	47,3	6	47,3
4	SD YPK Onar	96	3	32,0	6	16,0
5	SD YPK Serito	151	6	25,2	6	25,2
6	SD YPPK Saengga	137	6	22,8	8	17,1
7	SMP Perintis Kelapa Dua	108	3	36,0	10	10,8
8	SMP Stellamaris Tofoi	100	3	33,3	6	16,7

Source: Baseline Study, PSKK UGM 2011. SD/SDN: Elementary School, SMP/SMPN: Junior High School, SMA: High School

The education program is also implemented in Fakfak Regency such as in the Bomberay District and particularly in Otoweri and Tomage Villages. The program will be also conducted in Kokas District, i.e. education program in the coastal villages, including Ugar, Taver, Andamata, Fior, Furir, Darembang, Goras, Kokas, Kampung Baru, Petuanan Arguni, Petuanan Sisir, Petuanan Sekar, Petuanan Wertuwar and Kinam Villages. The available education facilities in the Fakfak Regency, in particular the Kokas anchrd Bomberay Villages.

Table III-154 Level of Education Facilities Availabilty in Districts of Fakfak Regency

No	Type of School	School Name
1	Ten Elementary Schools (SD)	1. SDN Fior 2. SDS YPK Kokas 3. SDN Inpres Kokas 4. SDN Inpres Kampung Baru 5. SDN Arguni 6. SDN Forir 7. SDN Inpres Darembang 8. SDN Inpres Ugar 9. SDN Inpres Kinam

No	Type of School	School Name
		10. SDN Inpres Goras
2	Two Junior High School (SMP)	1. SMPN 1 Kokas 2. SMPN 3 Kokas
3	One High School (SMA)	1. SMAN Kokas

Source: Central Bureau of Statistics, Sub-district and Regency in Figure, 2012

In general, the education development program implemented by Tangguh LNG consist of three main focuses, i.e.: 1) strengthening the capacity of policy makers and management of educational services, 2) improve the quality of teaching and learning activities and 3) improve the public awareness on the importance of education.

Results of the educational development programs based on reports of the 2009-2010 period indicates that in schools already receiving support of the educational development program, there are improved qualities on the classrooms as well as improvements on a number of educational infrastructure. In addition, there are significant improvements on the attendance figures of elementary school students from 2007 to 2009.

Referring to Government Regulation Year 2008 regarding Teachers, Article 17 indicates that the minimum national standard ratio of the number of students against teachers is as follows:

a. Kindergarten/RA or the equivalent is 15:1;
b. Elementary School or the equivalent is 20:1;
c. Junior High School or the equivalent is 20:1; and
d. Senior High School or the equivalent is 20:1.

As for the maximum number of students per class can be observed in the Technical Guideline of the Joint Regulation of the Minister of National Education, the State Minister of Efficient State Apparatus and Bureaucratic Reform, the Minister of Internal Affairs, the Minister of Finance and the Minister of Religious Affairs, namely No. 05/X/Pb/2011, No. Spb/03/M.Pan-Rb/10/2011, No. 48 Year 2011, No. 158/Pmk.01/2011, No. 11 Year 2011 regarding the Structuring and Even Distribution of Civil Public Servant Teachers on page 45 regarding organizing the number of students per learning group is as follows:

- Elementary School minimum 20 and maximal 28 students per class;
- Junior High School minimum 20 and maximal 32 students per class;
- Senior High School minimum 20 and maximal 32 students per class; and
- Vocational Schools minimum 15 and maximal 32 students per class.

The educational facilities and public services in the post-operation phase of the LNG Plant activities are predicted to experience a very significant improvement due to the program intervention of the Local Government, either the Teluk Bintuni Regency and Fakfak Regency on the improved educational service quality from the

PAUD/Kindergarten level up till the Junior High School level. It is expected that good schools will increase, either the Elementary Schools, Junior High Schools and Senior High Schools as well as universities in the regency capitals, namely the Bintuni Township and Fakfak Township.

b. Impact Prediction

Construction Phase – Impact Prediction

The LNG Plant construction activities are predicted to cause impacts on decreased access to education which are derivative impacts of the demographic changes (migration, population structure changes and population growth). The LNG Plant construction activities cause job opportunities and economic opportunities. This further attract a large number of migrants to enter and live in villages in the surroundings of the project to obtain the economic benefits. The large number of migrants is predicted to use the educational facilities and other public services to educate their children in local schools. It is predicted that this will further put pressure on the educational facility capacities to be accessed by the Indigenous People*.

Construction Phase – Impact Evaluation

Untuk mengetahui apakah kegiatan kosntruksi Kilang LNG diprakirakan berdampak pada penurunan akses terhadap pendidikan dan layanan publik lainnya dapat dilihat pada **Table III-142** Impact Evaluation berikut ini:

To determine whether the LNG Plant construction activities are predicted to impact the decreased access on education and other public services can be observed in the following **Table III-142** of Evaluation of Impact:

Table III-155 Impact Evaluation – LNG Plant Construction Activities against Decline in Access to Public Service including Education

Impact	*The LNG construction activities are predicted to cause impacts on decreased access towards public services including education, which is a derivative impact of demographic changes (population migration, population structure and population growth).*				
Nature of Impact	**Negative**	**Positive**			
	The impact is 'negative' as the incoming migrants are predicted to cause pressure on the access to public service facilities including education in the villages.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The LNG Plant construction activities lead to job opportunities and business opportunities. This will further attract large numbers of migrants to settle in villages in the surrounding Tangguh LNG operation site to obtain economic benefits. The large numbers of migrants are predicted to use the educational facilities and other public services to educate their children in local schools. It is predicted that this will then decrease the public service facilities capacity including education to be accessed by the local communities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant construction activities will last for approximately 5 years. Due to the decreased impact of the local community access to public services including education that will last for more than one year, socially, the impact duration is classified as 'short term'.				

Impact Extent	Local	Regional	Global	
	Changes in access to public service facilities including education are derivative Impact of demographic changes (migration, structure and population growth). This impact is predicted to occur in villages surrounding the LNG Plant construction activities, accordingly the impact extent is classified as 'local'.			

Impact Magnitude	Negligible	Small	Medium	Large	
	The presence of Tangguh LNG indirectly attracts the entry of migrants and their families in large numbers. This creates difficulties to local communities on accessing various public service means, including education. In 2011-2012, the census data of UGM and data of the Department of National Education indicates that there are approximately 13 schools spread out in villages surrounding the Tangguh LNG areas, with a composition of 10 units of Elementary Schools , 2 units of Junior High Schools and 1 unit of Senior High School. *Changes in access to public service facilities including education occur in the villages up till the districts during the construction period (5 years). The pressure on the access to education and other public services occur when the migrant communities settle and educate their children in the village schools. The enrollment process is usually conformed a new study in once a year. Accordingly, the Impact magnitude is categorized as 'medium'.*				

Impact Receptor Sensitivity	Low	Medium	High		
	At present, the Elementary School educational facilities are available in a number of main villages, the Junior High Schools and Senior High Schools are available in district cities, similarly are other public service facilities that are also available. However, the facilities have a limited capacity. With the incoming migrants, it is predicted that it will cause pressure on the access to education and public services. The receptor sensitivity s is classified as 'moderate'.				

Impact Severity	Very Low	Low	Medium	High	Very High
	Considering the impact magnitude against the access of public service facilities including education it is classified as 'medium' due to the pressure on access to education caused by the incoming migrants. On the other hand, education facilities and other public services in the villages have limited capacities (the receptor sensitivity is 'moderate'), so that the impact severity is classified as 'high'.				

Impact Likelihood	Very Small	Small	Medium	High	
	The impact likelihood of impact pressure on access to public services facilities including education is very likely to occur as it is predicted that there will be an incoming migrants in large numbers. The impact likelihood are classified as 'moderate'.				

Impact Significance	Negligible	Minor	Moderate	Major	Critical
	The incoming migrants in large numbers to villages in the surrounding Tangguh LNG operation site allow significant pressures on the access to public service facilities including education in the villages. On the other side, there are limited educational facilities available in the villages. Accordingly, the impact is important ('major') and should be managed.				

Operation Phase – Impact Prediction

The LNG Plant operation activities are predicted to cause decreased impact on access to education that is a derivative impact of demographic change (migration, changes in population structure and population growth). Changes in access to education are predicted to occur from the village levels up till the district levels in the long term (± 25 years since the operation phase begun). This is due to the many incoming and settling migrants. The migrants and their families will educate their children in the village schools, so that it will lead to pressure on the access to available education.

<u>Operation Phase – Impact Evaluation</u>

To determine the LNG Plant operation activities that are predicted to impact the decreased access on education and other public services can be observed in the following **Table III-143 of E**valuation of Impact:

Table III-156 Impact Evaluation – LNG Plant Operation Activities against Decline in Access to Public Service including Education

Impact	*The LNG Plant operation activities are predicted to impact on declining access to public services including education that is a derivative impact of demographic changes (migration, population structure changes and population growth).*				
Nature of Impact	**Negative**	**Positive**			
	The impact is 'negative' as the incoming migrants is predicted to cause pressure on public service facilities including education in the villages.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Decline in access to public service facilities including education is a tertiary 'derivative impact' of demographic changes occurring during the Tangguh LNG operation activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The LNG Plant operation will last for approximately more than 25 years since the operations phase starts. Due to the decreased local community access to public services including education that will last for more than 5 years, the impact duration is classified as 'Long Term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Changes in access to public service facilities including education is a derivative impact of demographic changes (migration, population structure and growth). This impact is predicted to occur in villages surrounding LNG Plant operation areas, accordingly impact extent is classified as 'local'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The presence of Tangguh LNG indirectly attracts the incoming migrants and their families in large numbers. This leads to the more difficult access of the local communities to various public service means, including education. In 2011-2012, the UGM data census and the data of the Department of National Education indicates that there are approximately 13 schools spread out in villages in the surrounding Tangguh LNG operation site with a composition of 10 units of Elementary Schools, 2 units of Junior High School and 1 unit of Senior High School. *Changes in access to public services including education occur in the villages up till districts during the LNG Plant operation period (± 25 years since the operation phase starts). Pressure on access to education occurs when the migrants and families settle and educate their children village schools, and use the other public service facilities. The student enrollment process usually follows the new school year once a year. Accordingly, the Impact magnitude is categorized as 'moderate'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At present, primary education facilities are already available in parent villages, Junior High Schools and Senior High Schools are available in district cities. However, the facilities have limited capacities and teachers. The influx of migrants is predicted to put pressure on the access to education. The receptor sensitivity is classified as 'moderate'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Considering the impact magnitude of access to public service facilities including education is classified as 'medium', due to the pressure on access to education in the long term caused by the influx of migrants. On the other side, there are limited public service and educational facilities in the villages with limited capacity and teachers (receptor sensitivity is 'medium'), so that the impact severity is classified as 'high'.				

Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood pressure on access to public service facilities including education is very likely to occur as it is predicted that the incoming migrants will be in considerable numbers and for a 'long term'. Accordingly the impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The incoming migrants in large numbers into villages surrounding operation area of Tangguh allow significant pressure on access to public service facilities including education in the villages. On the other hand, there are limited educational facilities are available in the villages. Accordingly, the impact is significant ('major') and should be managed.				

<u>Post-Operation Phase – Prediction of Impact</u>

The LNG Plant activities in post-operation phase are predicted to cause impacts on access to education that is a derivative impact of demographic change (decline in population). Changes in access to education is predicted to occur at the village level up till the district level during the LNG Plant operation period (± 25 years since the operation phase begun). This is because part of the population moves away, leading to loose the teacher pupil ratio, the educational capacity and other public services in the villages. Certainly, this impact is predicted to have a positive impact for the students.

<u>Post-Operation Phase – Impact Evaluation</u>

To determine whether the LNG Plant activities in post-operation phase are predicted to impact the access to education and other public services can be observed in **Table III-144** on Impact Evaluation:

Table III-157 Impact Evaluation - LNG Plant Post Operation Activities against Decline in Access to Public Service including Education

Impact	*LNG Plant post-operation activities are predicted to impact on declining access to public services that is a derivative impact on the demography such as decline in population.*				
Nature of Impact	**Negative**	**Positive**			
	The moving of part of the population will loose the teacher-student ratio, the capacity of education and other public services in the villages, which is a 'positive' impact for the students.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Access to public services including education is a tertiary derivative impact of the demographic changes that occur during the Tangguh LNG post-operation activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Tangguh LNG post-operation activities will occur for a long time, as it is predicted that the change of impact on the local community access to public services including education after the Tangguh LNG operation period ends will adhere for a period of more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	Workforce demobilization will occur in villages surrounding Tangguh LNG operation area so that the impact extent is classified as 'local'.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The existence of Tangguh LNG will indirectly cause the incoming migrants and their families in large numbers. This will lead to the more difficult access of the local community to various public service means, including education. In 2011-2012, the UGM census data and the data of the National Education Department indicates that there are approximately 13 schools spread out in villages surrounding Tangguh LNG operation area, with a composition of 10 units of Elementary Schools, 2 units of Junior High Schools and 1 unit of a Senior High School.				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Approaching the post-operation phase, the public service facilities including education is already properly available in the villages. However, at that time the educational facilities and other public services available are predicted to experience pressures due to the any local communities settling in the villages and access the available educational facilities and other public services. Accordingly, the sensitivity of impact receptors is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	During the post-operation phase communities in the villages will move to other locations to seek employments or open businesses. The relocation of part of the communities is predicted to lead to positive impacts by the loosening of significant pressures on the access to public services including education. Accordingly, the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood on the access to public services including education is classified as medium due to the end of Tangguh LNG operations, accordingly it is predicted that it will not directly cause part of the migrants to leave the villages in the surrounding Tangguh LNG operation areas to return to their place of origin, or seek for economic opportunities elsewhere.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	With the relocation of part of the community to other locations to seek employments or open businesses, it is predicted that it will impact the increase of access to public services including education that can be accessed by the people still settling in the villages. The chances of easing the impact on access to education and public services are very likely to occur. Accordingly, the impact is significant ('major') and should be managed prior to the end of the Tangguh LNG operation period.				

3.3.4 Public Health

3.3.4.1 Changes in Disease Patterns

a. Environmental Baseline

Construction Phase

The disease that affects many people in the Bintuni area is particularlu infectious diseases or communicable diseases such as Acute Respiratory Infection, diarrhea and malaria. The data show that the disease pattern of infectious diseases is more dominant than the non-communicable diseases in Bintuni (Teluk Bintuni in Figures, 2011).

The disease pattern is relatively common in the districts. Diarrhea diseases are also a number of diseases that cause most deaths in 2010 in the region.

The disease pattern in Fakfak Regency is almost the same as Bintuni Bay region. Infectious disease or communicable disease is also dominant in this region, such as ARI (39.23%), malaria (11.09%) and diarrhea (5.13%) based on Fakfak in Figures, 2011.

However, if compared to the data of ten common diseases in 2010 and 2011, there was only a slight change in disease pattern. Malaria was previously ranked at 2nd in 2010, dropped to the 3rd rank of common diseases in 2011. Meanwhile, gastritis rose up to the 4th rank in 2011 after it was ranked 6th of common diseases in Bintuni in 2010.

In 2011 several types of non-communicable diseases begin to appear. In fact, the prevalence of rheumatic diseases ranks at 2nd highest, hypertension ranks at the 8th highest as well as anemia also included in the top ten diseases.

Symptoms of changes in disease patterns from infectious diseases to non-communicable diseases indicate, for instance, changes in health behavior among Fakfak people.

b. Impact Prediction

Construction Phase - Impact Prediction

Workforce recruitment and demobilization for the construction of LNG Plant will increase migration into the project area. Predicted around 10,500 workers would come to the project site at the peak of construction of LNG Plant activities while forecasted two to three times of the number will be job seekers and economic opportunities seekers in the various of villages surrounding Tangguh LNG operation site.

The number of people in the project area is likely to increase rapidly which is possibly changing patterns of disease in the study area, such as new emerging diseases or strains of disease for the local community.

A large population of people who are in the project area as well as social contact increase between migrants and local people (sometimes followed by deteriorated environmental health conditions due to overpopulation) can possibly change disease prevalence in the project area.

This is predicted to result in changes in disease patterns and prevalence of certain diseases such as diseases that are categorized as new emerging disease and other infectious diseases. This has been seen in Fakfak District, where in 2011, the non-communicable diseases have been included in the ten common diseases in Fakfak Regency.

Construction Phase – Impact Evaluation

To determine or assess whether the construction activities have an impact on the disease pattern in the project site and its surrounding can be seen in the following Impact Evaluation Table:

Table III-158 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Disease Pattern

<table>
<tr><td>Impact</td><td colspan="4">A large number of migrants who will enter the Bintuni Bay and Berau Bay region, related to the presence of Tangguh LNG construction, will increase the intensity of their interactions to the local community significantly. It is predicted that it brings health impact, one of which is the changes in disease pattern (particularly malaria and STIs).</td></tr>
<tr><td rowspan="2">Nature of Impact</td><td>Negative</td><td>Positive</td><td></td><td></td></tr>
<tr><td colspan="4">The impact is classified as ‘negaive’ because it will change specific disease pattern and disease incidence increase.</td></tr>
</table>

Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	It is a derivative impact of job opportunities. Job opportunities will attract many migrants wither to work at Tangguh LNG or to seek other economic opportunities. Therefore, this will create direct social interaction between local community and migrants. This interaction is predicted to be able to change disease patterns in the community.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will ± 5 years. Since the changes in disease patterns to local community will last less than 1 year, socially the impact is classified as 'short term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact will not only exist in the project area but also in the level of district and regency. Thus, the impact extent is classified as 'regional'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, diseases that affect many people in the Bintuni Bay and Fakfak region are dominated by infectious diseases or communicable diseases such as Acute Respiratory Infection, diarrhea and malaria. *The project activities will last for ± 5 years (short term), and the impact extent will cover district to regency levels. Interactions between local workforce and migrant workforce in camp potentially transmit diseases among them. Then, the transmission of disease to community possibly occur when crewhange process (local workforce who are back to their place potentially transmit the disease to their family or surroundings). The prevention of disease transmission in camp can be managed through healthcare facilities provided by project. Thus, the impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact receptor is sensitive enough to the changes in disease patterns and prevalences because the healthcare facilities and services are still not sufficiently provided. Since the impact extent is local and community skill to manage the impact (healthcare services) is not appropriate, the impact receptor sensitivity is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Although the impact magnitude is 'medium', the readiness of healthcare faciltiies in the villages is still not sufficiently supported. Therefore the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The possibility of community exposured to new diseases or diseases brought by migrants occurs when crewchange activities (twice a week) takes place. The local workforce will return to their villages which are lack of healthcare facilities and vulnerable to the diseases. The impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	By considering the following conditions: 1. *The healthcare facilities and environmental health of community are in poor condition;* 2. *There are 10,500 workers working in the LNG Plant construction who mostly consist of migrants and are potentially to transmit diseases to local community; and* 3. *Crewchange activities during twice a week in which interaction between workers and local community is possibly to occur.* *Thus, the impact is significant ('major') and need to be managed.*				

Operation Phase – Impact Prediction

In the operation phase, there will be supporting contractors of Tangguh LNG operation activities. The contractor is likely to hire workers from outside region that will be settled in the villages located in Bintuni and Fakfak or surroundings. Interaction with the local workers will potentially increase either existing types of diseases or new diseases. This may be expected to the changes in disease patterns between the infection and non-infectious diseases patterns. Recalling also the operation period will last for ± 25 years since the operation begun, the impact significance is significant and classified as 'major', also need to be managed.

Operation Phase – Impact Evaluation

To determine or assess whether the operation activities impact on the disease patterns in the project area and its surrounding can be seen in the following Impact Evaluation Table:

Table III-159 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Disease Patterns

Impact	*Changes in disease patterns during operation phase are caused by the presence of supporting contractor of Tangguh LNG operation activities.*				
Nature of Impact	**Negative**	**Positive**			
	The impact is classified as 'negative' because it wil change the pattern of diseases in the villages surrounding Tangguh LNG operation site in the long term period of time.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The derivatie impact is a result of migration impact, and social interaction between supporting contractor of Tangguh LNG operation activities who enter the project area and local community.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact of changes in disease patterns will occur ± 25 years since the operation phase begun. Since the changes in disease patterns to local community will last less than 5 year, the impact is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact is 'regional' because the presence of contractor does not only cover in the villages but also regency.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, diseases that affect many people in the Bintuni Bay and Fakfak region are dominated by infectious diseases or communicable diseases such as Acute Respiratory Infection, diarrhea and malaria. *The operation of LNG Plant activities will last for ± 25 year since the operation activities begun. It creates long term interaction between supporting contractor of Tangguh LNG and local community. This results the impact magnitude classified as 'large' for the changes in disease patterns.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The receptor is quite sensitive to the changes in disease pattern and prevalence of disease because the level of healthcare and public health standard are not yet well supported. Thus, the impact receptor sensitivity is categorized as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**

	The level of vulnerability is 'high' caused by the interaction between supporting contractor of Tangguh LNG with community frequently occur, causing disease patterns coupled with healthcare is still insufficient so it cause the impact severity to changes in disease pattern is 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The possibility of community exposure to new diseases or diseases brought by migrants occurs when crewchange activities (twice a week) takes place although the changes in new emerging disease patterns can assessed in certain times. The impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact is classified as 'major' because need to be managed by considering the following terms: *1. The impact occurs in the long term period of time which is moreless 25 years but can be recovered.* *2. Although the changes in disease pattern centred in the area surrounding Tangguh LNG operation site, the changes still possibly spread out to regency level.* *3. The healthcare facilities are still lack in the villages surrounding Tangguh LNG operation site.*				

Post-operation phase – Impact Prediction

In the Post-Operation phase, supporting contractor of Tangguh LNG operation will demobilize workers. Although the contractors and migrant workforce are not associated with Tangguh LNG, they will not necessarily return to their place of origin but settle in the villages located at Bintuni and Fakfak region or surroundings. Then it will remain an interaction of workers with local people who will potentially increase the existing or new types of diseases. This may be expected to the changes in disease patterns belonging to infectious and non-infectious diseases. The settlement of contractors and workers will create endemic disease in the region of their settlement. However, at that time, the capacity of public health facilities and services is forecasted to have a much better to be able to cope with potential changes in disease patterns. Thus, the impact significance of changes in diseases patterns is classified as 'minor'.

Post Operation Phase – Impact Evaluation

To determine or assess whether the Post-Operation activities impact on the disease patterns in the project area and its surrounding can be seen in the following Impact Evaluation Table:

Table III-160 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Disease Pattern

Impact	*The changes in disease pattern during the post operation phase occur as a result of workforce demobilization of Tangguh LNG after the operation phase. The in-migration is indicated to cause changes in disease patterns to local community, Moreover, the contractor of Tangguh LNG will not entirely exit from surrounding Tangguh LNG operation site, village, district and regency. This will cause additional population number in local community region.*			
Nature of	**Negative**	**Positive**		

Impact	*The 'negative' impact will occur in the changes in disease patterns in the villages visited by migrants or workers/contractors of Tangguh LNG who will not return to their place of origin.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The changes in disease patterns are 'derivate impact' as a result of workforce demobilization by Tangguh LNG during the post operation phase.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact of changes in disease patterns will occur after the post operation phase in the 'long term' period of time. It is because the contractor who had worked for Tangguh LNG will not necessarily return although the workers has been returned to their point of hire. The contractor is possibly to settle within more than 5 years, so it can cause changes in disease patterns to local community due to presence of migrants.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact is classified as 'regional' because the presence of contractor is not only in the villages but also regency.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, diseases that affect many people in the Bintuni Bay and Fakfak region are dominated by infectious diseases or communicable diseases such as Acute Respiratory Infection, diarrhea and malaria. *Although the operation phase of Tangguh LNG has ended, the contractors who had worked for Tangguh LNG do not necessarily bring their workers back to point of hire. It will cause migrants settle in the villages surrounding Tangguh LNG operation site. The impact magnitude is classified as 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact sensitivity is classified as 'low' because the public health implemented by Tangguh LNG during construction and operation phases expected to improve healthcare service capacity to be more proper although the changes in disease patterns up to regional level.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' because the healthcare service is sufficiently provided to address the changes in disease patterns in local community. Through public health supported by Tangguh LNG during the construction and operation phases, it is expected that the public health service capacity in the affected area is improved.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The possibility of community is exposed to new diseases or diseases brought by migrants because of direct interaction with local community. However, the changes in disease patterns can be seen in certain times. The impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The changes in disease patterns in the post operation phase are classified as 'minor' impact. In addition to derivative impact of workforce demobilization, the changes in disease patterns are expected to be coped through public service facilities in surrounding Tangguh LNG operation site. At present, the facilities are much better to address various health problems. Thus, the impact is not significant ('minor') but still need to be managed.				

3.3.4.2 Changes in Disease Prevalence

a. Environmental Baseline

Construction Phase

Looking at disease prevalence, ARI has the highest rate of patients. Other infectious or communicable diseases are generally included in ten common diseases in Teluk Bintuni Regency. In addition, accident and trauma as part of non-communicable disease also included in ten common diseases in this region.

The prevalence of ten common diseases in Fakfak Regency is mostly the same as Teluk Bintuni Regency.

The prevalence of ARI is also the most disease in Fakfak Regency. This condition is similar to Teluk Bintuni Regency or even generally to other areas in the West Papua Province or even relatively similar to other regions in Indonesia.

Meanwhile, the ten common diseases based on the inpatients data of RSUD Fakfak in 2010-2011 showed that communicable disease such as malaria is a disease frequently occurred in Fakfak Regency.

In addition to communicable and non-communicable diseases, HIV/AIDS patients also exist in Fakfak Regency. The prevalence tends to increase year to year. The highest peak is reached in 2010, and decreased in 2011.

Pulmonary TB disease is also a disease that occurs in many districts in Fakfak Regency as 313 patients recorded in 2007. Then, it decreased to 164 in 2011. The distribution of disease is in each district in which 80 patients of pulmonary TB were observed in Fakfak District. While in Karasas District, people with pulmonary TB have never found since 2007. In East Fakfak District and Bomberay District in 2011 also have no cases of pulmonary TB.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Total number of people living in the project area and social contact between migrants and local community increase (sometimes followed by deteriorated environmental health condition due to overpopulation) the possibility of disease prevalence in study area changed through existing or new emerging diseases increase.

Total number of people living in the project area and social contact between migrants and local community increase (sometimes followed by deteriorated environmental health condition due to overpopulation) the possibility of disease prevalence in project area changed. Therefore, it is predicted to change certain disease prevalence such as disease classified as new emerging disease and othe non-communicable diseases. It has occured in Fakfak Regency, in which non-communicable disease has been included in ten common diseases in 2011.

Construction Phase – Impact Evaluation

To determine or assess whether the construction activities have impact on the changes in disease prevalence in project area and surrounding can be seen in the following table of Impact Evaluation below:

Table III-161 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Disease Prevalence

Impact	*Change in disease prevalenc as a result of interaction between local workers and migrants, as well as interaction between migrants in the villages during construction phase.*				
Nature of Impact	**Negative**	**Positive**			
	The impact is classified as 'negative' because it predicted an increase in the prevalence of certain diseases during the construction phase due to the interaction between local workers with migrants, the interaction between the community and migrants, and as a result of environmental degradation.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	A 'derivative impact', due to the in-migration impact, and as a result of interaction between local community and migrants workers who enter the project area.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Construction activities will take place over 5 years. Due to the impact of changes in disease prevalence is experienced more than one year by the local community, it is classified as 'short term' impact.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent is classified as 'regional' because an interaction between local workers from villages surrounding project area, regency and district.				
Impact Magnitude	**Neligigble**	**Small**	**Medium**	**Large**	
	Looking at disease prevalence, ARI reaches the highest rate of disease in Teluk Bintuni and Fakfak Regencies. Meanwhile, the malaria prevalence in Teluk Bintuni Regency has declined to 0%. *The project activities will last for ± 5 years (short term), and the impact extent will cover district to regency levels. Interactions between local workforce and migrant workforce in camp potentially transmit diseases among them. Then, the transmission of disease to community possibly occur when crewhange process (local workforce who are back to their place potentially transmit the disease to their family or surroundings). The prevention of disease transmission in camp can be managed through healthcare facilities provided by project. Thus, the impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Receptor is sensitive to the changes in disease patterns and prevalence of disease because of the level of healthcare and level of public health are existed, but not well supported. Thus, the impact receptor sensitivity is categorized as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' because the healthcare service is sufficiently provided to address the changes in disease patterns in local community. It will create difficulties to address the changes in disease prevalence.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The possibility of community exposed to new diseases or diseases brought by migrants occurs when crewchange activity (twice a week). Local workers who work at Tangguh LNG return to their villages which are not supported with good quality of public health service and facilities to address disease prevention and treatment.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*By considering the following conditions:* 1. *The healthcare facilities and environmental health of community are in poor condition;* 2. *There are 10,500 workers working in the LNG Plant construction who mostly consist of migrants and are potentially to transmit diseases to local community; and* 3. *Crewchange activities during twice a week in which interaction between workers and local community is possibly to occur.* *Thus, the impact is significant ('major') and need to be managed.*

Operation Phase – Impact Prediction

A large population of people who are in the project area as well as contacts between migrants and local people increased (sometimes followed by environmental health conditions deteriorated due to overpopulation) the possibility of disease prevalence in the study area is also changed, as well as an increased incidence of existing and new diseases.

A large population of people who are in the project area as well as social contact increase between migrants and local people (sometimes followed by deteriorated environmental health conditions due to overpopulation) can possibly change disease prevalence in the project area.

This is predicted to result in changes in disease patterns and prevalence of certain diseases such as diseases that are categorized as new emerging disease and other infectious diseases. This has been seen in Fakfak District, where in 2011, the non-communicable diseases have been included in the ten common diseases in Fakfak Regency.

Operation Phase – Impact Evaluation

To determine or assess whether the construction activities have an impact on the disease patterns in the project site and its surrounding can be seen in the following Impact Evaluation Table:

Table III-162 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Disease Prevalence

Impact	*Changes in disease prevalence caused by the interaction between local workers with migrants, as well as interaction with the migrants in the villages during the operation phase.*				
Nature of Impact	**Negative**	**Positive**			
	The impact is classified as 'negative' because it predicted an increase in the prevalence of certain diseases during the operation phase due to the interaction between local workers with migrants, the interaction between the community and migrants, and as a result of environmental degradation.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	A 'derivative impact', due to the in-migration impact, and as a result of interaction between local community and migrants workers who enter the project area.				
Impact	**Temporary**	**Short Term**	**Long Term**	**Permanent**	

Duration	*The operation of LNG Plant activities will last for ± 25 year since the operation activities begun. It is because the changes in disease prevalence will be experienced by local community more than 5 years, so the impact is classified as 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent is classified as 'regional' because there is interaction between local community derived from villages surrounding project area, regency and district levels.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Looking at disease prevalence, ARI reaches the highest rate of disease in Teluk Bintuni and Fakfak Regencies. Meanwhile, the malaria prevalence in Teluk Bintuni Regency has declined to 0%. *The project activities will last for ± 25 years (short term) since the operation phase begun, and the impact extent will cover district to regency levels. Interactions between local workforce and migrant workforce in camp potentially transmit diseases among them. Then, the transmission of disease to community possibly occur when crewhange process (local workforce who are back to their place potentially transmit the disease to their family or surroundings). The prevention of disease transmission in camp can be managed through healthcare facilities provided by project. Thus, the impact magnitude is classified as 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Receptor is sensitive to the changes in disease patterns and prevalence of disease because of the level of healthcare and level of public health are existed, but not well supported. Since the impact is local and the community skill to mitigate the impact is still low (healthcare service), the impact receptor sensitivity is categorized as 'low'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'high' due to long term impact, and healthcare service is not sufficiently provided to address the changes in disease patterns in local community. It will create difficulties to address the changes in disease prevalence.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The possibility of community exposed to new diseases or diseases brought by migrants occurs when crewchange activity (twice a week). Local workers who work at Tangguh LNG return to their villages which are not supported with good quality of public health service and facilities to address disease prevention and treatment. The impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	By considering these conditions: 1. *The health and environmental health facilities for community are not supported well.* 2. *The crew change occurred everyday, except Sunday, is possibly to create interaction between workers and local community.* *Thus, the impact is 'major' (significant) and need to be managed.*				

<u>Post Operation Phase – Impact Prediction</u>

In the post operation phase, the contractor will demobilize workforce because the contractor is no longer operate the LNG Plant. The, Although contractors and workers do not tied to the LNG Plant operation, they are unlikely back to their home. It is possible to occur because they have lived and settled in villages surrounding Tangguh LNG operation site in the long term, which is less than 25 years.

By a large number of employees and contractors who are located in the villages in the region of Teluk Bintuni and Fakfak regencies, it will remain in contact with the local community. This is expected to lead to the possibility of the changes in disease prevalence in the project area.

Changes in disease prevalence occur in certain diseases such as diseases that are categorized as new emerging disease and other infectious diseases. This has been seen in Fakfak Regency, where in 2011 the non-communicable diseases have included in ten common diseases. However, in the post-operation phase of Tangguh LNG, predicted public health care facilities have been able to address a variety of existing health problems. On the other hand, the local government is predicted to increase its public health programs from year to year, so that the impact significance is 'minor'.

Post Operation Phase – Impact Evaluation

To determine whether the LNG Plant activities in post-operation phase are predicted to impact on changes in disease prevalence in project area and surrounding can be observed on Impact Evaluation below:

Table III-163 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Disease Prevalence

Impact	*Changes in disease prevalence at the time of workforce demobilization caused by the interaction between the workforce and contractor who settled in Tangguh LNG operation area (outside the fence of Tangguh LNG area) with the local community led to changes in prevalence of certain diseases, such as malaria, tuberculosis, and other infectious diseases.*				
Nature of Impact	**Negative**	**Positive**			
	The impact is classified as 'negative' because of changes in prevalence of certain diseases				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	'Derivative' impact of job opportunities, especially in the operation phase, which result settlement of migrants in the region, long term interaction between migrants and community, even possibility of migrants live in local community area despite Tangguh LNG operating life has ended.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact of changes in disease prevalence will occur in the 'long time', as predicted impact of changes in disease prevalence of the local community after a period of Tangguh LNG operation ends and inherents over a period of 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent is classified as 'regional' because there is interaction between workforce of supporting contractor of Tangguh LNG operation occur not only in villages surrounding Tangguh LNG operation site, but also regency and district levels.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Looking at disease prevalence, ARI reaches the highest rate of disease in Teluk Bintuni and Fakfak Regencies. Meanwhile, the malaria prevalence in Teluk Bintuni Regency has declined to 0%. *Despite of recent changes in disease prevalence can be predicted within a certain period, but the impact due to the workforce demobilization in the post-operation phase of Tangguh LNG resulting in permanent (irreversible). Therefore, the existing impact magnitude is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact sensitivity is classified as 'low'. Although the disease prevalence increases, the healthcare facilities in every level (village, district and regency) expected to be sufficiently provided once community has supported by social programs of Tangguh LNG during construction and operation.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity on changes in disease prevalence is 'medium'. This is due to the existence of equilibrium with quite inadequate health facilities in villages surrounding Tangguh LNG operation site.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is 'medium' because there is a possibility of changes in disease prevalence due to interaction between contractor workers (possibly migrants), with local community that can be only indicated in certain times.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact significance of changes in disease prevalence is 'minor'. Although it has a permanent effect, it is expected that the capacity of the public health services are adequate to cope with changes in disease prevalence in the post operation phase of Tangguh LNG. Thus, the impact is not significant ('minor').				

3.3.4.3 Changes in Access to Healthcare

a. Environmental Baseline

<u>Construction Phase</u>

The development of health care facilities in Teluk Bintuni Regency continued to show improvement from year to year since 2008. Even in 2011 has established a hospital in the region. Considering from the minimum service standards, the number of health care facilities in the area has provide good service because of the small number of population compared to the health care facilities available. Human resources in the health sector have also been quite good. However, there is no specialist until 2011.

On the other hand, the development of health care facilities based on the ratio of health care facilities to the people in Fakfak Regency has been very good, because all districts have Puskesmas (community health center). Even the average of all districts in the Fakfak Regency already have more than one puskesmas, except for the Central of Fakfak District has only one Puskesmas and one Pustu (supporting community health center). In addition, Fakfak Regency also has one hospital established since 2004.

Human resources in the health sector in Fakfak Regency have been proper if it complies with the ratio of total population. The data of health workers in Fakfak Regency since 2005-2010 shows that number of medical personnels nurse specialist have completed including specialists and nurses. Likewise, non-medical personnel are also already available. Moreover, medical personnels are already spread across the districts.

Based on the Minimum Service Standard of Health by the Ministry of Health, Ratio Standard between medical personnel and population in 2008 is supposed to nine specialists, 30 doctors, 11 dentists, 158 nurses and 75 midwives for every 100.000 people. While for Puskesmas, the ratio is every five Puskesmas per 100.000 people. By considering this, the access to health care facilities in this region is in good condition.

b. Impact Prediction

Construction Phase – Impact Prediction

The rapid population number due to construction activities will cause pressure on health services in the villages surrounding Tangguh LNG operation site, where migrants settle. There is also an increase need of modern medicine rather than traditional medicine by local community because of the complexity of the disease.

Construction Phase – Impact Evaluation

To determine whether the LNG Plant activities in construction phase are predicted to impact on changes in access to health facilities can be seen in Table of Impact Evaluation:

Table III-164 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Health Facilities Access

Impact	*Changes in Health Facilities Access, because of population growth caused by migrant workers settled in the area. These changes include the pressure on public health services.*				
Nature of Impact	**Negative**	**Positive**			
	The 'negative' impact as the declining quality of health service because of the additional number of migrants that will give service burden.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	'Derivative' impact is an impact of population growth.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact duration is classified as 'Short Term' during construction phase about 5 years. Due to changes in to health facilities access is predicted to last for more than 1 year, the impact duration is included in the 'short term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Changes in health facilities access occur in the surrounding project area, so the impact is classified as 'local'.				
Impact	**Negligible**	**Small**	**Medium**	**Large**	

Magnitude	*IPM data of Teluk Bintuni Regency in 2011 shows there are one unit of hospital, 20 Puskesmas, and one unit clinic that accommodate 54,194 residents of Teluk Bintuni Regency. While based on the Fakfak in Figures 2010 shows that there are one hospital units, 9 units of Puskesmas, 38 Pustu, two clinics that accommodate 66,098 people will need health care service. The impact magnitude will occur in the southern region because close to LNG Plant location.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At the time of the health facilities are available but still do not meet the service quality standards due to population ratio and the lack of human resource capacity in the health sector. Coupled with the incoming migrants and their families.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	At the time of health facilities well provided but are still not functioning properly, which is caused by the ratio of the population and the lack of human resource capacity in the health sector. Coupled with incoming migrants and their families in the southern region because close to LNG Plant location.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	It is classified as 'medium' because depend on many migrants who will give burden on service.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact is classified as 'major' because healthcare facilities in the villages will get high exposure from migrants especially in Babo, Tanah Merah, Saengga and Tofoi villages in which Puskesmas exists in the villages and also become migrants' destination. Thus, the impact is significant ('major') and need to be managed.				

Operation Phase – Impact Prediction

LNG Plant activities in operation phase will involve the contractors and workers who are mostly migrants come from outside project area. The rapid population number because of operation activities will also lead to pressure on health care facilities in the villages surrounding Tangguh LNG operation site where the contractors and migrant workers settled. On the other hand, there is also an increase need of modern medicine rather than traditional medicine by local community because of the complexity of the disease. By considering this, the impact is classified as 'major' and means it needs to be managed.

Operation Phase – Impact Evaluation

To determine whether the LNG Plant activities in operation phase are predicted to impact on changes in access to health facilities can be seen in Table of Impact Evaluation:

Table III-165 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Health Facilities Access

Impact	*Changes in Health Facilities Access, because of population growth caused by migrants/contractors settled in the villages surrounding Tangguh LNG operation site. The changes include capability of public health services.*			
Nature of Impact	**Negative**	**Positive**		
	The 'negative' impact as the declining quality of health service because of the additional number of migrants that will give service burden.			

Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	'Derivative impact' is a impact of population growth which is caused by the presence of supporting contractors of Tangguh LNG operation activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact duration lasts for ± 25 years since the operation phase begun. Since the impact of changes in health facilities access of local community is predicted to occur during more than 5 years, the impact is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact magnitude is identified as 'regional' impact because the contractors of Tangguh LNG will be spread to district and regency levels.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	IPM data of Teluk Bintuni Regency in 2011 shows there are one unit of hospital, 20 Puskesmas, and one unit clinic that accommodate 54,194 residents of Teluk Bintuni Regency. While based on the Fakfak in Figures 2010 shows that there are one hospital units, 9 units of Puskesmas, 38 Pustu, two clinics that accommodate 66,098 people will need health care service. The impact magnitude is classified as 'large' because of imbalance between population growth and increased number of healthcare facilties				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At this time, the health facilities have been provided but are still not functioning well because the limited capacity and behaviors of human resource capacity. Thus, the impact receptor sensitivitiy is classified as 'medium'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Although the existing health facilities are available in the villages, the human resources are not sufficient. This has caused a strain on the health services and level of impact severity higher due to imbalance of population growth and healthcare service quality.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact is classified as 'medium' because the presence of supporting contractor of Tangguh LNG operation activities will create impact to the healthcare facilities access.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Impact classified as 'major' because of existing health facilities in the villages surrounding Tangguh LNG operation site is not prepared to accommodate the needs of health service for contractors. Thus, the impact is critical ('major') and must be managed.				

Post Operation Phase – Impact Prediction

After the accoplishment of LNG Plant operation activities, the contractors and workers who are mostly derived from outside the project area will be demoblized. The workers who had lived about 25 years in operation period will not necessarily return to their home. They will continue to settle in the villages of Bintuni and Fakfak. However, most of them will not have any further income or unemployed. Access to healthcare of Tangguh LNG has not existed yet, so it will increase the burden on health services around their living. The number of migrants increases the population in which there was also an increase in the needs of local communities of traditional medicine into modern medicine. The complexity of the disease that occurs will also change access to healthcare. Therefore, the impact of changes in access to healthcare is moderate.

Post Operation Phase – Impact Evaluation

To determine whether the LNG Plant activities in post-operation phase are predicted to impact on changes in access to health facilities can be seen in Table of Impact Evaluation:

Table III-166 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Changes in Health Facilities Access

Impact	*Changes in Health Facilities Access because of population growth is caused by Tangguh LNG closing. Local community who previously work in Tangguh LNG will find difficulties to access to health facilities because they are lack of income previously earned from working in Tangguh LNG.*				
Nature of Impact	**Negative**	**Positive**			
	The 'negative' impact resulted from workforce demoblization activities cause unemployment. Therefore, residents will be more difficult to access the healthcare facilities.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The type of impact is 'derivative impact' which is resulted from incoming migrants consisted of contractor workers supported Tangguh LNG operation.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	After the post-operation phase of Tangguh LNG ended, local community who work in Tangguh LNG or its contractor will lose access provided by company, Nevetheless, they will be charged for their own medical cost. This condition is predicted to last for more than 5 years, so the impact will occur in the 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact magnitude is identified as 'regional' because the contractors of Tangguh LNG will be spread to district and regency levels.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	IPM data of Teluk Bintuni Regency in 2011 shows there are one unit of hospital, 20 Puskesmas, and one unit clinic that accommodate 54,194 residents of Teluk Bintuni Regency. While based on the Fakfak in Figures 2010 shows that there are one hospital units, 9 units of Puskesmas, 38 Pustu, two clinics that accommodate 66,098 people will need health care service. *The impact magnitude is classified as 'large' because the workforce demoblization and completion of Tangguh LNG operation, workers and contractor of Tangguh LNG will lose their work. This will give big impact to income and access to healthcare facilities of community.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact sensitivity is classified as 'low'. Although the Tangguh LNG is no longer operated, intervention of Tangguh LNG through public health and economic programs in construction and operation phases is expected to give benefit and resilience to community in improving their economic condition in order to be able to access the existing healthcare facilities.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact likelihood is classified as 'medium'. Although Tangguh LNG is not longer operated, it still gives contribution through healthcare facilities in this region.				
Impact	**Very Small**	**Small**	**Medium**	**High**	

Likelihood	*The impact likelihood is classified as 'medium' because Local Government will continue to improve public health program supported by Tangguh LNG.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact significance is classified as 'moderate' because workforce of Tangguh LNG will lose their work andincome. Therefore, on the one hand, they tend to have difficulty in getting access to healthcare. However, a variety of economic development programs provided by Tangguh LNG and Local Government is expected to make a good society has the capacity to be able to work at another company, and is able to build a business in a larger scale so that it will still be able to reach out to existing health services. Therefore, the significance impact is significant, and classified as 'moderate'.				

3.3.4.4 Changes in Environmental Health

a. Environmental Baseline

<u>*Construction Phase*</u>

The data showed that the main source of drinking water in the Teluk Bintuni Regency is from rain water (32.8%), protected well (16.4%), and unprotected well (8.50%). The number of residents who use rainwater, unprotected wells and unprotected springs are possible to allow high spread of of gastrointestinal illness cases such as GE and diarrhea, and possibility of iodine deficiency.

More than half of population of Teluk Bintuni Regency have latrine facilities as is recorded 60.49% of self latrine ownership. The construction is good since more than half (55.38%) were using the *leher angsa* / gooseneck latrine.

The environmental health data taken from Fakfak Regency in Figure of 2011 is only main source of drinking water and household latrine.

Clean water source in Fakfak Regency is good enough because most or nearly half of the households already using tap water (44.21%). However, there are still many people use rain water (38.2%).

The latrine ownership or facilities in Teluk Bintuni Regency is good because more than half of people already have their own latrines (64.74%).

The latrine construction by type of latrine use is very good, because more than three-quarters of the population (85.07%) have *leher angsa* / gooseneck latrines (one type of latrine that meets the standards of environmental health). However, there are still quite a lot of people using the *pelengsengan* latrine and a unstandardized latrine to environmental health.

b. Impact Prediction

<u>*Construction Phase – Impact Prediction*</u>

The workforce recruitment and demobilization will encourage workers and job seekers towards the villages surrounding Tangguh LNG operation site. Incoming migrants is predicted to lead to pressure on environmental health conditions in the villages surrounding Tangguh LNG operation site.

<u>*Construction Phase – Impact Evaluation*</u>

To determine or assess whether the construction activities have an impact on the environmental health in the project site and its surrounding can be seen in the following Impact Evaluation Table:

Table III-167 Impact Evaluation – LNG Plant Activities in Construction Phase against Changes in Environmental Health

Impact	*The changes in environmental health occur due to the influence of migrant workers to the villages surrounding Tangguh LNG operation site.*				
Nature of Impact	**Negative**	**Positive**			
	It is classified as 'negative' due to decline in changes of environmental health conditions as a result of population increase caused by migration. The population increase is because of the presence of Tangguh LNG. This leads to increasing sources of domestic waste.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	It is a 'derivative' impact of in-migration who settled in villages surroundign Tangguh LNG operation area. The impact of the presence of migrants provide social and economic pressures, including environmental health caused by daily activities of migrants which produce domestic waste.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will occur in the short term during the construction period of 5 years. Since the impact of changes in environmental health perceived by local communities more than 1 year, socially, impact duration is classified as 'short term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact is 'local' because the impact occurred in the villages of migration destination surrounding operation area including, Irarutu III, Tofoi, Tanah Merah, and Saengga.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The data showed that the main source of drinking water in the Teluk Bintuni Regency is from rain water (32.8%), protected well (16.4%), and unprotected well (8.50%). The latrine ownership in Teluk Bintuni Regency is more than half of the population already has its own (60.49%). Clean water sources in the district of the consortium showed 44.21% of households are already using tap water, and as much as 38.2% use rainwater. More than half of population of Teluk Bintuni Regency have latrine facilities as is recorded 60.49% of self latrine ownership. Clean water source in Fakfak Regency is good enough because most or nearly half of the households already using tap water (44.21%). However, there are still many people use rain water (38.2%). The latrine ownership or facilities in Teluk Bintuni Regency is good because more than half of people already have their own latrines (64.74%). *The impact magnitude is classified as 'medium' because the magnitude is local and occurs in the short term during construction phase.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At present, the environmental health facilities such as trash, sewage, household toilets and clean water sources are already available, but not yet functioning properly.				
Impact	**Very Low**	**Low**	**Medium**	**High**	**Very High**

Severity	*The impact severity is 'high' because:* *1. A large number of workers coming to the villages* *2. A lack of functioning environmental health facilities in villages*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood depends on the behavior of people in the villages and the ability of natural resources to perform recovery. Thus, it reduces environment capacity to life.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact is 'major' because it reduces environment capacity to life. Thus, the impact is significan ('major') and need to be managed.				

<u>Operation Phase – Impact Prediction</u>

The workforce recruitment and demobilization will encourage workers and job seekers towards the villages surrounding Tangguh LNG operation site. Incoming migrants is predicted to lead to pressure on environmental health conditions in the villages surrounding Tangguh LNG operation site.

<u>Operation Phase – Impact Evaluation</u>

To determine or assess whether the operation activities have an impact on the environmental health in the project site and its surrounding can be seen in the following Impact Evaluation Table:

Table III-168 Impact Evaluation – LNG Plant Activities in Operation Phase against Changes in Environmental Health

Impact	*The changes in environmental health occur due to the influence of migrant workers to the villages surrounding Tangguh LNG operation site.*				
Nature of Impact	**Negative**	**Positive**			
	It is classified as 'negative' due to decline in changes of environmental health conditions as a result of population increase caused by migration. The population increase is because of the presence of Tangguh LNG. This leads to increasing sources of domestic waste.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	It is a 'derivative' impact of in-migration who settled in villages surroundign Tangguh LNG operation area. The impact of the presence of migrants provide social and economic pressures, including environmental health caused by daily activities of migrants which produce domestic waste.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will occur during ± 25 years since the operation phase begun. Since the impact of changes in environmental health perceived by local communities more than 5 year, socially, impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		

	The impact is 'local' because the impact occurred in the villages of migration destination surrounding operation area including, Irarutu III, Tofoi, Tanah Merah, and Saengga.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The data showed that the main source of drinking water in the Teluk Bintuni Regency is from rain water (32.8%), protected well (16.4%), and unprotected well (8.50%). The latrine ownership in Teluk Bintuni Regency is more than half of the population already has its own (60.49%). Clean water sources in the district of the consortium showed 44.21% of households are already using tap water, and as much as 38.2% use rainwater. More than half of population of Teluk Bintuni Regency have latrine facilities as is recorded 60.49% of self latrine ownership. Clean water source in Fakfak Regency is good enough because most or nearly half of the households already using tap water (44.21%). However, there are still many people use rain water (38.2%). The latrine ownership or facilities in Teluk Bintuni Regency is good because more than half of people already have their own latrines (64.74%). *The impact magnitude is classified as 'medium' because the impact extent is local and occurs in the long term during operation phase.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact is 'local' because the impact occurred in the villages of migration destination surrounding operation area including, Irarutu III, Tofoi, Tanah Merah, and Saengga.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is 'high' because: 1. *A large number of workers coming to the villages* 2. *A lack of functioning environmental health facilities in villages*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood depends on the behavior of people in the villages and the ability of natural resources to perform recovery. Thus, it reduces environment capacity to life.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact is 'major' because it reduces environment capacity to life. Thus, the impact is significan ('major') and need to be managed.				

<u>Post Operation Phase – Impact Prediction</u>

After the completion of the operation of LNG plant will go into the post-operation phase. Post-operation activities will release the contractors and workers. Since the duration of LNG Plant expansion project lasted about 25 years since the operation phase begun, it cause contractors and workers posibbly to settle and adapt to local community. Therefore, their daily activities will change the environmental health conditions in the villages where they settled. The impact extent of changes in environmental health conditions in the post-operation is in regional scale and long-term period. However, it is predicted that after the completion of Tangguh LNG of operation phase, public awareness of the importance of hygiene and environmental sanitation will be much better. In addition to that, prediction, at the time, health facilities can provide better service, so that the impact can be classified as insignificant impact, or 'minor'.

<u>Post Operation Phase – Impact Evaluation</u>

To determine whether the activities in post operation phase are predicted to impact on changes in environmental health can be seen in Table of Impact Evaluation:

Table III-169 Impact Evaluation – LNG Plant Activities in Post Operation Phase against Environmental Health

Impact	*Changes in Environmental Health occur at the workforce demobilization in the post-operation phase. Although the workers of Tangguh LNG has returned to each point of hire, the contractors who had worked for the Tangguh LNG will not fully return the workers to their original place.*				
Nature of Impact	**Negative**	**Positive**			
	Changes in environmental health impacts are 'negative' for local people in the villages. The impact of 'negative' comes from the presence of migrants who had settled though Tangguh LNG operation has ended. The presence of migrant will increase solid and liquid waste from daily activities while basic sanitation facilities has not been optimum utilized.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	It is a 'derivative impact' becausethe workforce demobilization does not necessarily cause workers return to their home. Thus, the impact occurs because of increasing number of population living in the villages.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	After a period of post operation Tangguh LNG ends, the workers or contractors Tangguh most likely will remain settled in villages surrounding Tangguh LNG operation site, over a period of 5 years, so the impact will be 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent is 'regional' because migrants derived from contractor and workers of Tangguh LNG will remain settled in Bintuni and Fakfak.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	The data showed that the main source of drinking water in the Teluk Bintuni Regency is from rain water (32.8%), protected well (16.4%), and unprotected well (8.50%). The latrine ownership in Teluk Bintuni Regency is more than half of the population already has its own (60.49%). Clean water sources in the district of the consortium showed 44.21% of households are already using tap water, and as much as 38.2% use rainwater. More than half of population of Teluk Bintuni Regency have latrine facilities as is recorded 60.49% of self latrine ownership. Clean water source in Fakfak Regency is good enough because most or nearly half of the households already using tap water (44.21%). However, there are still many people use rain water (38.2%). The latrine ownership or facilities in Teluk Bintuni Regency is good because more than half of people already have their own latrines (64.74%). *Since the impact extent is classified as 'regional', the impact magnitude is classified as 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The impact severity is classified as 'low' because: 1. *The public awareness of the importance of hygiene and environmental sanitation are predicted to be much better.* 2. *Basic sanitation facilities in the communities are quite good although not optimally used, and predicted to be improved in the long term period of time.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' because the basic sanitation to support environmental health is quite good.				
Impact	**Very Small**	**Small**	**Medium**	**High**	

Likelihood	*The impact likelihood is 'medium' because there are supports on the environmental health improvement programmed by local government and supported by Tangguh LNG.*				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	Entering the post-operation phase, Tangguh LNG will release all workers that will indirectly pull out some migrant groups, and the various businesses that they develop. However, the majority of migrants is expected to settle in the local area, so that changes in environmental health have potentially to occur. Predicted after the completion of Tangguh LNG operation, public awareness of the importance of hygiene and environmental sanitation will be much better. In addition to that prediction, at the time, health facilities can provide better service. Therefore, the impacts are not significant ('minor').				

3.4 MARINE FACILITIES ACTIVITIES

3.4.1 Geophysical - Chemical

3.4.1.1 Oceanography

a. Changes in Flow Patterns

- **Environmental Baseline**

Flow patterns during the northeast and southeast seasons in the Bintuni Bay are more dominated by tidal currents that have similar patterns. The flow moves into the Bintuni Bay when the water level is at MSL heading to the highest tide, however this is not the case with the current conditions at the bay head with its many estuaries. At the time the surface water is at MSL, the current is still observed to be moving in the opposite, i.e. heading in the direction of the bay mouth. Flow velocity varies between 5 cm/second up till approaching 100 cm/second near the mouth, in particular at the deep part of the bay.

At the time the water surface is at its highest tide, the flow pattern changes significantly in the surroundings of the bay head. The flow pattern is observed to be moving into the river mouths as during the highest tide, the push of water masses from the sea direction is maximum. Flow velocity during the highest tide in the deep part of the bay can be still observed to be faster at approximately 50 cm/second, while around the bay mouth flow velocity can reach 100 cm/second.

After the surface water position is at the highest tide, the water surface will be at MSL heading to the lowest ebb. In this condition, almost the entire water mass moves to the outside through the bay mouth, except that at a number of locations surrounding the river estuaries it is observed that the water mass is moving in the direction of the rivers. Flow velocity at the time the surface water position is at the MSL point heading to ebb ranges between

5 cm/second to almost reaching 100 cm/second. Similarly to the previous sea surface position, faster flow velocity is observed at the deeper parts of the bay.

Considering that the tidal type occurring in the Bintuni Bay is mixed tide prevailing semi-diurnal, accordingly after 6 hours since the tide, ebb will occur. At the time the water surface is at the lowest ebb point, at the entire bay and river estuaries water masses will move outside heading to the bay mouth. In the inner part, the flow velocity is stronger > 100 cm/second, while near the shoreline it is observed to be much slower (< 10 cm/second).

- **Impact Prediction**

Tangguh LNG plans to expand marine facilities consisting of BOF facilities (Bulk Offloading Facility), LNG 2 Jetty (Combined LNG – Condensate Jetty) and the Combo Dock enhancement. The existence of such marine facilities may lead to changes in flow patterns.

The design of the combined LNG – Condensate Jetty, the BOF facility and the new Combo Dock enhancement will use the piling system. Design descriptions can be observed in Chapter I, Sub-Chapter 1.2.4 Part B7 regarding the Combined LNG – Condensate Jetty and B8 regarding the Combo Dock Enhancement).

In relation to the flow patterns, the piling system may change the flow patterns (ebb and tides) from laminar to turbulence locally in the surroundings of the pilings. Observing the slow flow velocity near the shoreline (<10 cm/second) and the piling diameter of approximately 90 cm, accordingly the distance of turbulence/vortex of the piling is maximally 90 cm conform the piling diameter in the direction of the bay mouth during ebb and the bay head during tide.

The flow pattern changes will occur repetitively according to tidal patterns occurring in the Bintuni Bay. The mixed tide prevailing semi-diurnal type causes that every 6 hours, the flow pattern will change from tide flows to ebb flows and vice versa. The changes will continually occur during the existence of the marine facilities that are used during the operations phase.

- **Impact Evaluation**

With a flow velocity that is much slower near the shoreline (reaching < 10 cm/second) and with no significant affects to the sea current patterns as impact receptor, the impact significance of the marine facilities existence against the flow changes is ‘negligible’.

Apart from that, observed from the existence of the LNG 1 Jetty and Combo Dock that are located near the proposed marine facilities location to be constructed/expanded, no significant impacts are indicated on the changes in flow patterns.

Table III-170 Impact Evaluation – The Presence of the Marine Facilities on the Changes in Flow Pattern

Impact Description	*Changes in flow patterns due to the existence of the specific terminal facilities occur due to the presence of pilings with a diameter of 90 cm. Flows at the activity locations are affected by ebbs and flows. Ebbs and flows in the Bintuni Bay are of the mixed tide prevailing semi-diurnal type causing that every 6 hours the flow patterns will change from tide flows to ebb flows and vice versa.*				
Impact Nature	**Negative**	**Positive**			
	The presence of the specific terminal facility can lead to potential changes in flow patterns that have negative impacts.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The presence of BOF, new Combined LNG - Condensate Docks and LNG 1 and Combo Dock facilities previously existing, will cause changes to the flow pattern, so that the type of impact is a 'direct impact'.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will last as long as the presence of the specific terminal facility. The Tangguh LNG operations activity plan is approximately 25 years since the operations phase starts. Therefore, the duration of impact is categorized as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The length of the LNG – Condensate combined dock is approximately 1,5 km with pilings at every 18 m. The BOF with a length of approximately 175 m from the coast will also use the piling system. By using the piling system for the Combined LNG- Condensate Dock, the flow pattern of ebb and flow will change from laminar to turbulence, however the changes will only occur locally around the pilings.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The ebb and tide types occurring in the Bintuni Bay are mixed tide prevailing semi-diurnal, accordingly after 6 hours from tide, ebb will occur. At the time the water surface is at the lowest ebb, at all parts of the bay and river estuaries water masses will move outwards through the bay mouth. In the central part the flow velocity is strong >100 cm/second, while near the coastline it is much slower (<10 cm/second).				
	The distance of turbulence/vortex of the respective piling is 90 cm conform the diameter of the pilings, in the direction of the bay mouth during ebb and to the bay head during tide. *Therefore, the impact is local with a small flow velocity i.e. less than 10 cm/second, although the duration of impact is long term, the impact magnitude is categorized as 'loe'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The changes occurring do not cause significant direct impacts to the sea flow patterns as receptor of impact. Therefore, the receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	As the impact magnitude is categorized as 'slight' and the receptor sensitivity is classified as 'low', accordingly the impact severity is categorized as 'slight'.				
Impact Likelihood	**Very Low**	**Low**	**Moderate**	**High**	
	The changes of the flow pattern occur every 6 hours and will certainly occur during the presence of the specific terminal facility in the operations phase. Therefore the impact likelihood is categorized as 'high'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*As the impact severity is 'slight with a 'high' impact likelihood, accordingly the impact significance is categorized as 'negligible' and classified as an unsignificant impact.*

b. Abrasion of Shorelines

- **Environmental Baseline**

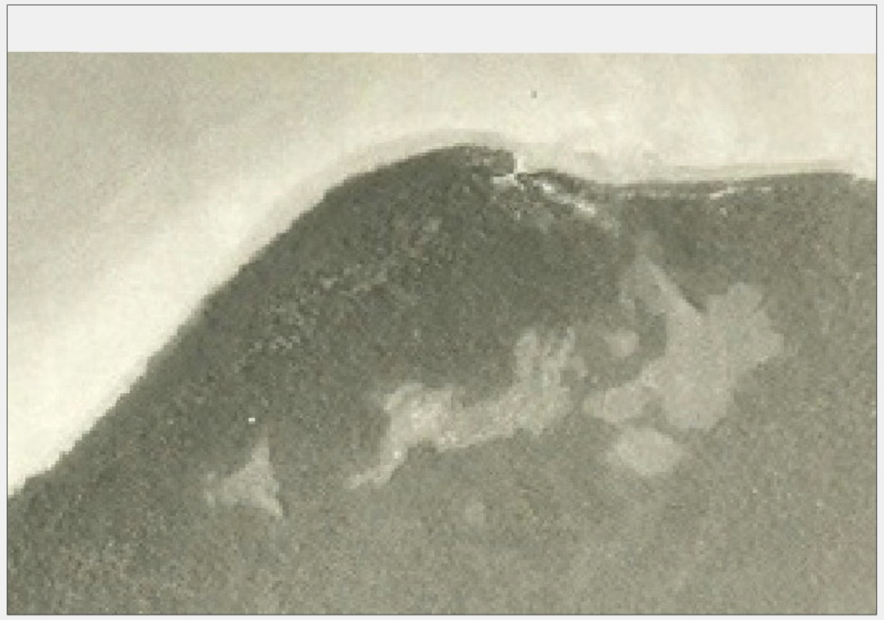
The frequency of occurrence of waves with a height of >1 m is only 1,2%. This condition can be understood as the activity site is in the Bintuni Bay waters and far from the bay mouth that leads to the open sea.

The phenomenon of abrasion and accretion in the Bintuni Bay areas occur naturally that is observed since before the construction of Tangguh LNG.

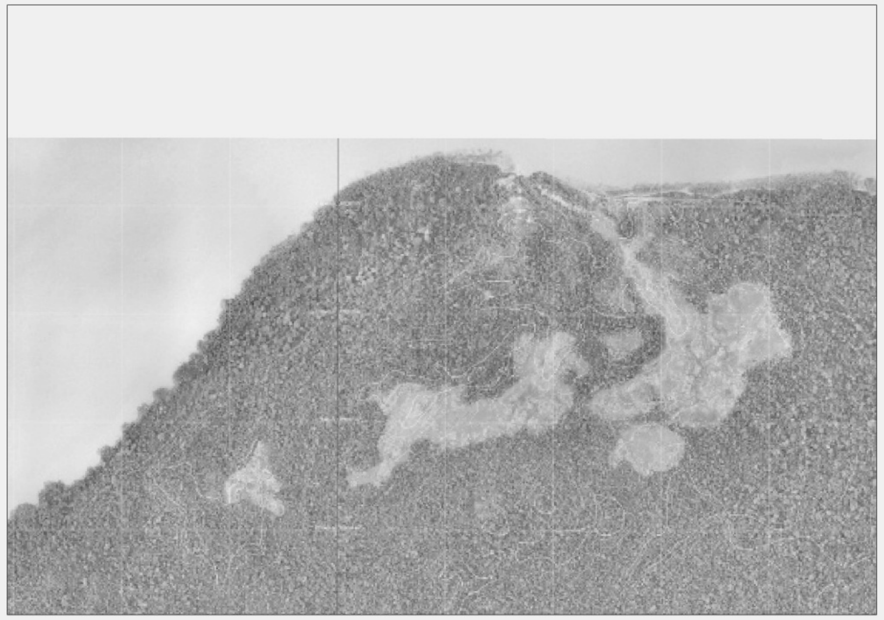
Based on satellite images in 1978 to 2009 (**Figure III-60**), there are no real visible abrasions in the surroundings of LNG 1 and Combo Dock locations. In fact, after the construction in 2009 to 2013, at t

he east side of the LNG 1 dock mangrove growth were observed.

During ebb, areas in the surroundings of the jetty are mudflat that can be reached up till approximately 600 – 1000 m of the coastline with mangrove formations. The mudflat indicates that sedimentation has a greater role compared to abrasion.



1978



1998

2009

2010

2011

2013

Figure III-60 Satellite Images in the Surroundings of the LNG 1 Dock Site in 1978, 1998, 2009, 2010, 2011, 2013

- Prediction of Impact

Tangguh LNG plans to develop specific terminal facilities consisting of BOF (Bulk Offloading Facility) facilities, LNG 2 dock (Combined LNG – Condensate Dock) and the Combo Dock development. The presence of the specific terminal facilities may cause changes to the flow patterns that result in potential abrasion and accretion of the coastline.

Coastal abrasion occurs when a coast experience losses/reductions of sediments; meaning that the carried sediment is greater than settled. One of the important factors causing abrasion is the type of waves and the distance of wave formation until heading for the coast. The farther the distance, the waves formed will be greater. At the time the waves break, sediment on the sea floor will be lifted (abraded), which will further be carried by two types of forces, i.e. the wave energy component along the coast and flows along the coast generated by breaking waves.

The rate of transport along the coast depends on the wave angle of incidence, duration and wave energy. Accordingly, large waves will carry more material per time unit than when driven by small waves that carry more sand compared to large waves.

The frequency of wave occurrences with wave heights of >1 m in the Bintuni Bay is less than 1,2%. This condition illustrates that wave heights in the Bintuni Bay is relatively small so that the energy that may cause abrasion is also small.

Apart from the wave factor, abrasion is also caused by the type of sediment substrate on the sea floor. The sediment type in the surroundings of the specific terminal facilities consists of 50% loam, 30% sand and 20% clay is indeed quite sensitive to movements of water, however the presence of mangrove will reduce the carrying away of sediment due to its root system.

The dock design of pilings also cause that the sediment transport rate is not disturbed, unlike massive type docks that may cause abrasions.

- Evaluation of Impact

Based on analogy of the existence of the LNG 1 Dock and Combo Dock at present and by observing photos of the site conditions, there are no indications of coastal abrasions at the activity locations due to the construction of the LNG 1 Dock and the Combo Dock.

Tangguh LNG also observe through satellite images (**Figure III-61**) indicating that there are no coastal abrasions at the west side of the Combo Dock. In fact, at the east side of the LNG 1 Dock mangrove natural growth process occurs in new sedimentation areas (**Figure III-61**).

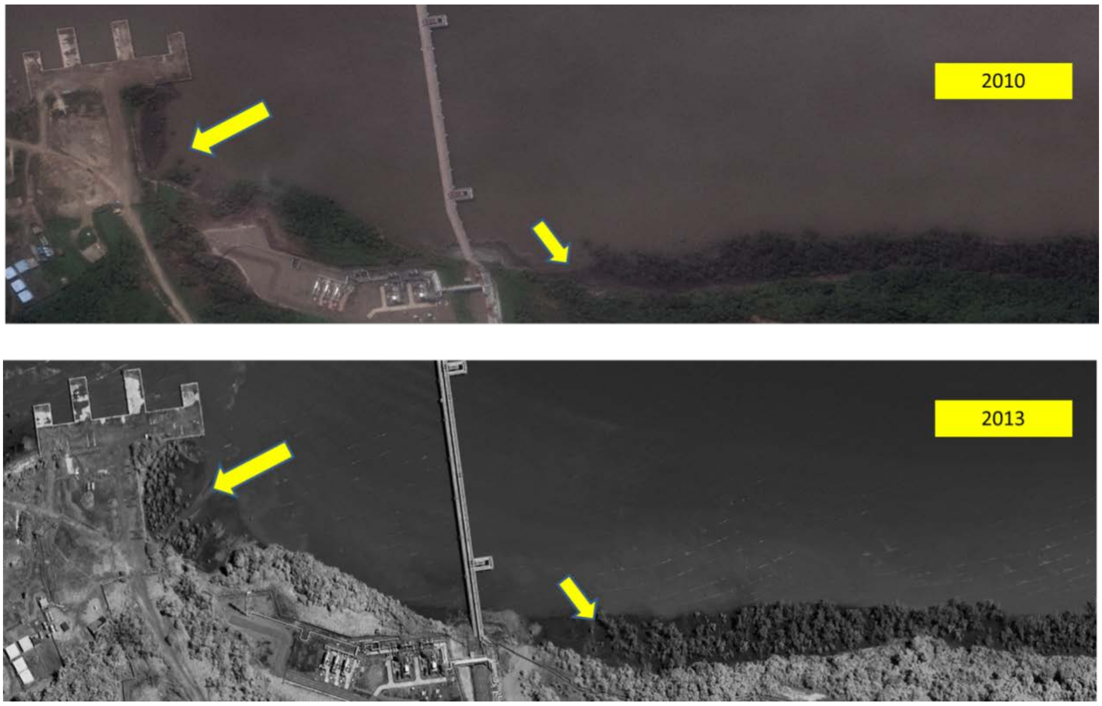


Figure III-61 Satellite Images in the Surroundings of the LNG 1 Dock Site in 2010 and 2013

Based on the approach method and years of field experience (analogy) it can be concluded that the plan to construct the LNG 2 Dock (Combined Dock of LNG 2 – Condensate), the BOF facility and new Combo Dock development in the location near the specific terminal facilities that is presently operating as well as considering the oceanographic condition at the site, the significant characteristics of impact of the specific terminal facilities presence against coastline abrasions is classified as 'minor'.

Table III-171 Evaluation of Impact – The Presence of Specific Terminal Facilities on Coastline Abrasions

Impact Description	*The presence of specific terminal facilities may lead to changes in bathymetry, flow and wave patterns that simultaneously will result in changes in sedimentation patterns that can cause abrasions and accretions.* *Sediment types surrounding the specific terminal consist of 50% loam, 30% sand and 20% clay is indeed quite sensitive to water movements, however the presence of mangrove will reduce the carrying away of sediment due to its rooting system.*				
Impact Nature	**Negative**	**Positive**			
	Changes in the flow patterns will change the coastline due to abrasions so that the characteristics of impact is categorized as 'negative'.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Coastline abrasions are secondary impacts of changes in the flow patterns.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact will last as long as the presence of the specific terminal facilities. The Tangguh LNG operations activity plan is approximately 25 years since the start of operations, so that the impact duration is categorized as 'long term'.				

Impact Extent	**Local**	**Regional**	**Global**		
	The impact will only occur along coastlines in the surroundings of the specific terminal facilities areas, accordingly the spread of impact is categorized as 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The environmental baseline condition indicates that the flow velocity near the coastline is slow (<10 cm/second), and the frequency of high wave occurrences of >1 m is only 1,2%, accordingly the possibility of abrasions in the surroundings of Tangguh LNG project is small. In general, the abrasion and accretion phenomenon is continuous in the Bintuni Bay areas that were observed long before the Tangguh LNG project activities. *The length of the LNG – Condensate Combined Dock is approximately 1,5 km with pilings at every 18 m. The BOF with a length of approximately 175 m of the coast will also use the piling system.* *As the impact that might occur is local and only along the coastline surrounding the specific terminal facilities, with very small velocity namely less than 10 cm/second, although the duration of impact is long term, the impact magnitude is categorized as 'low'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Loam, sand and clay are quite sensitive against water movements, accordingly the receptor sensitivity is categorized as 'medium'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	As the impact magnitude is categorized as 'low' and the receptor sensitivity impact is categorized as 'medium', accordingly the impact severity is 'medium'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Observed from the coastline natural conditions that are still dominated by mangrove, the flow effect will be reduced by the rooting system. Based on analysis results of wave heights in the last 10 years, wave heights of > 1 meter are less than 1,5%. Due to the presence of mangrove and the small waves the impact likelihood is categorized as 'very low'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	As the impact severity is categorized as 'medium' and the impact likelihood are categorized as 'very low', accordingly the impact significance are categorized as 'minor' and is classified as unsignificant.				

3.4.1.2 Quality of Sea Water

a. Increase in Content of Total Suspended Solids (TSS)

- **Environmental Baseline**

  The Bintuni Bay is an estuary waters area that receive quite high sediment intake from the surrounding lands, accordingly causing that the TSS concentrations are naturally high, and frequently exceed the TSS quality standards of (80 mg/l) for mangrove areas based on the Minister of the Environment Decree No. 51 year 2004. Based on information in the initial Tangguh 2002 Integrated AMDAL, the TSS value in estuaries vary between a minimum concentration of 32 mg/L (S-230 in wet seasons) and maximum concentration of 173 mg/L (S-130L in dry seasons), with an average concentration of 71 mg/L.

From the environmental baseline survey results in 2012-2013, TSS concentration exceeding quality standards are observed at the NS-02 location (near the Saengga River estuary) and NS-05 (near the Senindara River estuary) in dry seasons with concentrations of respectively 193 mg/L and 86 mg/L. The high TSS concentrations at the NS-02 and NS-05 locations are because the locations near the coasts are dominated by mangrove and near estuaries carry sediments to the Bintuni Bay.

Tangguh LNG monitors TSS concentrations in intake water for desalination water at the LNG 1 dock site. Monitor results during 2011 (47 monitoring data) are indicated in **Table II-35** and **Figure II-52** Sub-Chapter 2.1.8.3 on Sea Water Quality in Chapter II of Environmental Baseline. Based on monitoring results, in the dry season TSS concentration ranges between 32 mg/L up till 267 mg/L with an average value of 102 mg/L, while in the wet seasons it ranges between 23 mg/L to 369 mg/L with an average value of 139 mg/L. Of the 47 TSS monitoring data, 27 data or 57% of the TSS monitoring exceed the mangrove quality standard, namely ≤ 80 mg/L. This indicates that naturally the TSS concentration at the activity location (near shore) is quite high.

TSS concentrations offshore surrounding the dredge material disposal activities are 7 mg/L during dry seasons and 9 mg/L in wet seasons.

- Prediction of Impact

  Seabed dredging will be conducted during the construction phase, consisting of:

  - BOF : channel for the maneuver area and BOF maintenance dredging. Volume = 750,000 m^3
  - LNG – Condensate Combined Dock and maintenance dredging. Volume = 130,000 m^3.
  - Development of the Combo Dock : Volume 180,000 m^3

  During the operations phase, maintenance dredging will be conducted routinely with an estimated volume of dredge material at every activity of approximately 400.000 m^3.

  Modeling input is performed with the assumption that dredging is conducted for eight hours per day with a total dredge material of 2,000 m^3 (the dredging rate is 250 m^3/hour). The estimated release of material is assumed as 1% during the dredging operations.

  The particle size distribution for dredge material is presented in **Table III-159** based on data provided by Tangguh LNG. Specific data on dredge material at the location is inadequate, so that the assumption is based on previous work experiences, i.e. 2,650 kg/m^3.

Table III-159 Particle Size Distribution of Dredge material

Size of Particles (μm)	Volume Fraction (%)
4	23
30	44
125	30
2000	3

Total dredge material released during dredging is 2,5 m^3/day (8 hours of dredging). Dredging activities spread sediments into the water column, during the dredging and during the sediment flows from the hoppers and barges. Increased TSS at the disposal sites of the dredging activities can be observed from the turbidity "plumes" visible behind the dredger.

Modeling results during the dry season indicate that the maximum TSS value increase is 4,8 mg/L. TSS spread illustrations during dredging can be observed in **Figure III-62**. Spreads only occur at the Bulk Offloading Facility (BOF) site. The TSS value immediately drops below 5 mg/L at a distance of more than 200 m of the dredging site.

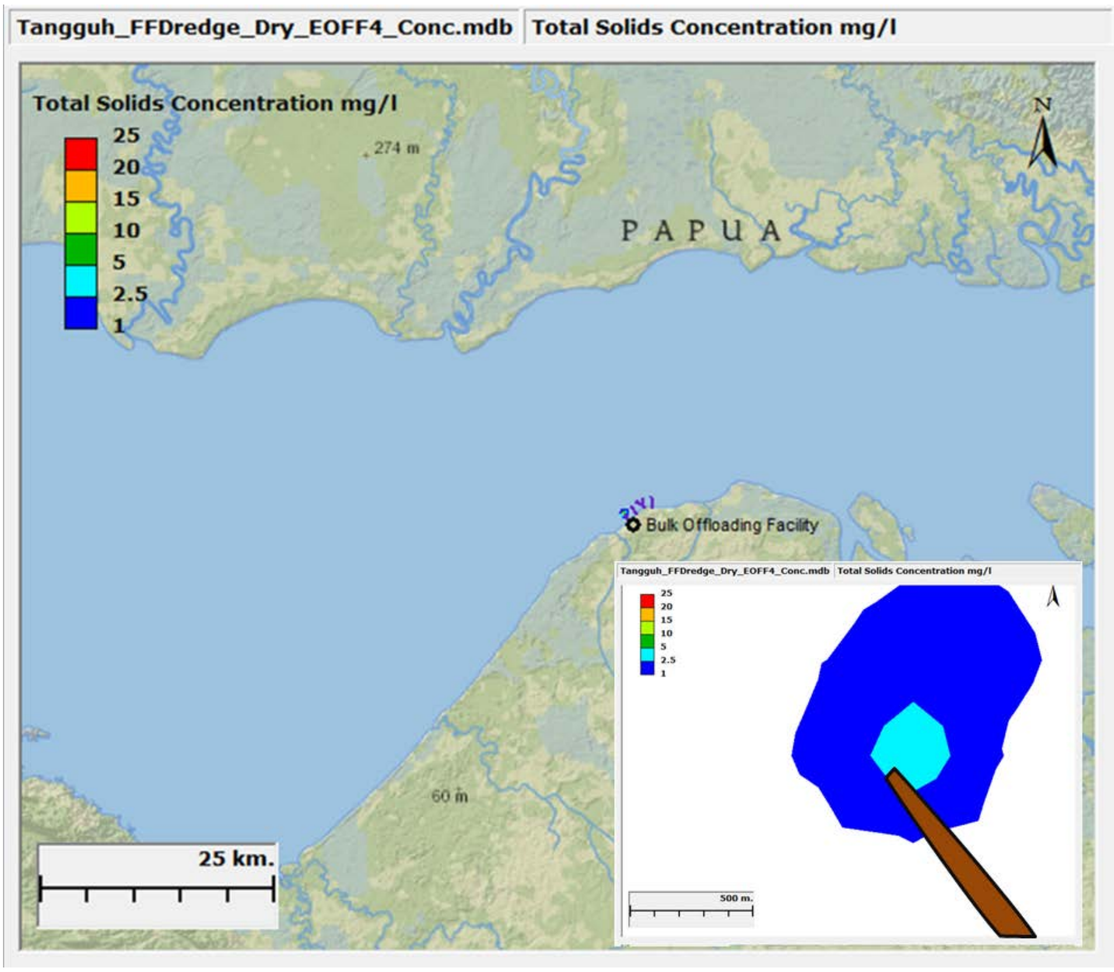


Figure III-62 Maximum Increased TSS Concentration during Dredging at BOF in Dry Seasons

During wet season modeling, the maximum TSS increase reaches 11.8 mg/L. **Figure III-63** indicates the maximum increase of TSS spread.

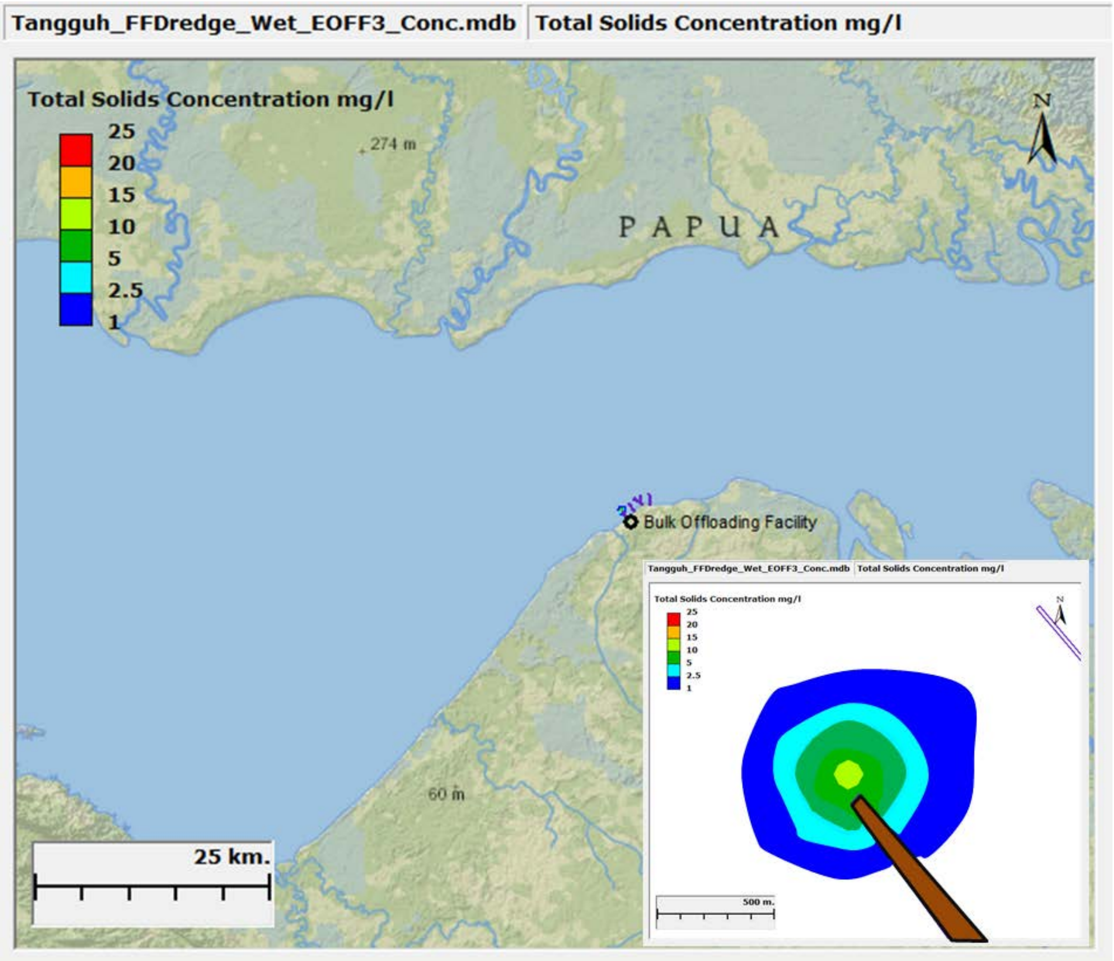


Figure III-63 **Maximum Spread of TSS Concentration during Dredging at BOF in Wet seasons**

Disposal of dredge material is conducted with a total estimation of 1.000 m^3 per disposal and is performed 2 times a day with a disposal range of approximately 4 hours. The duration of every disposal is estimated at 10 minutes.

During the dry season scenario, the maximum increase of the TSS value is 3.9 mg/L. Illustrations on the TSS spread during the dredge material disposal is indicated in **Figure III-64**. Limited spread can be observed in the surroundings of the east disposal sites in which the TSS value quickly drops to below 2.5 mg/L at a distance of more than 1.0 km.

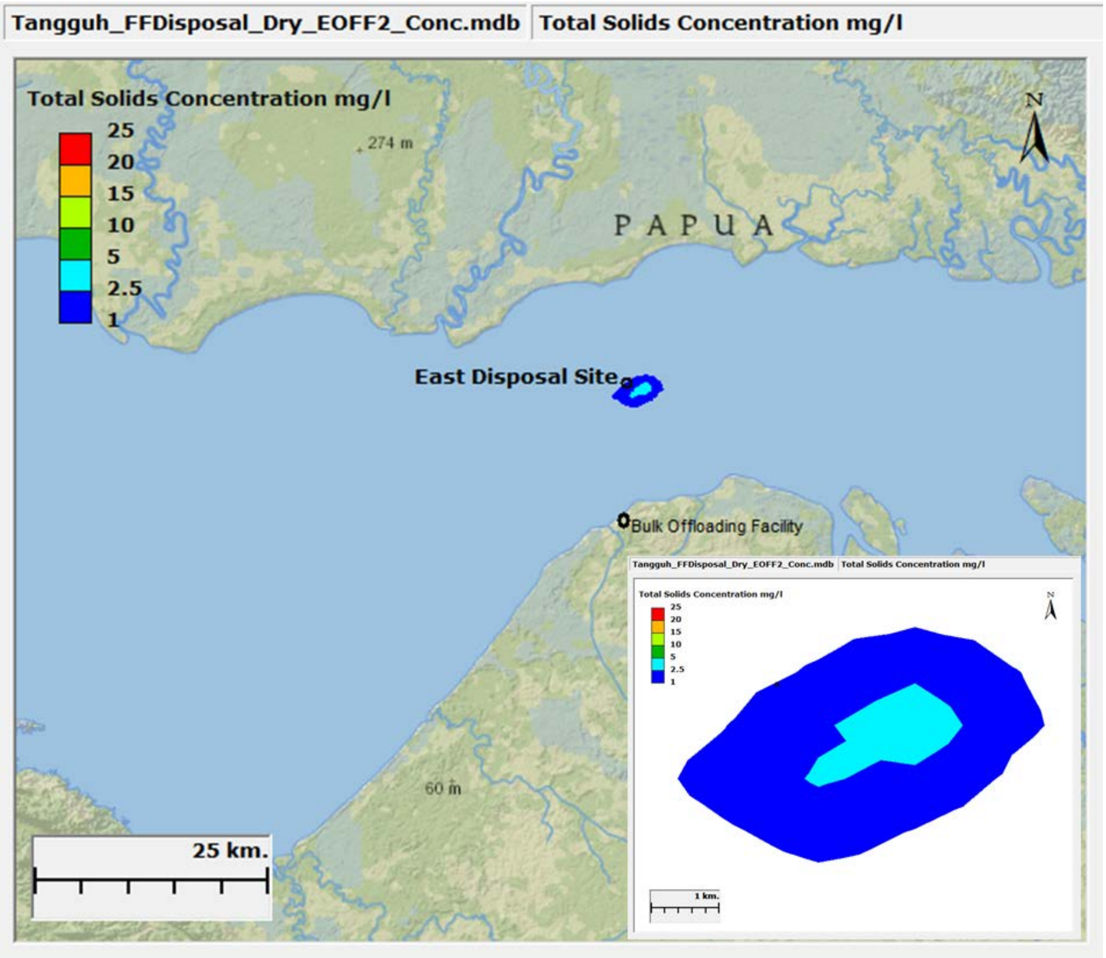


Figure III-64 Maximum TSS Increase during Dredge material Disposal at the East Disposal in Dry Seasons

In the wet season scenario, maximum TSS increase is 5.5 mg/L. **Figure III-65** indicates the spread of maximum increased TSS in wet seasons.

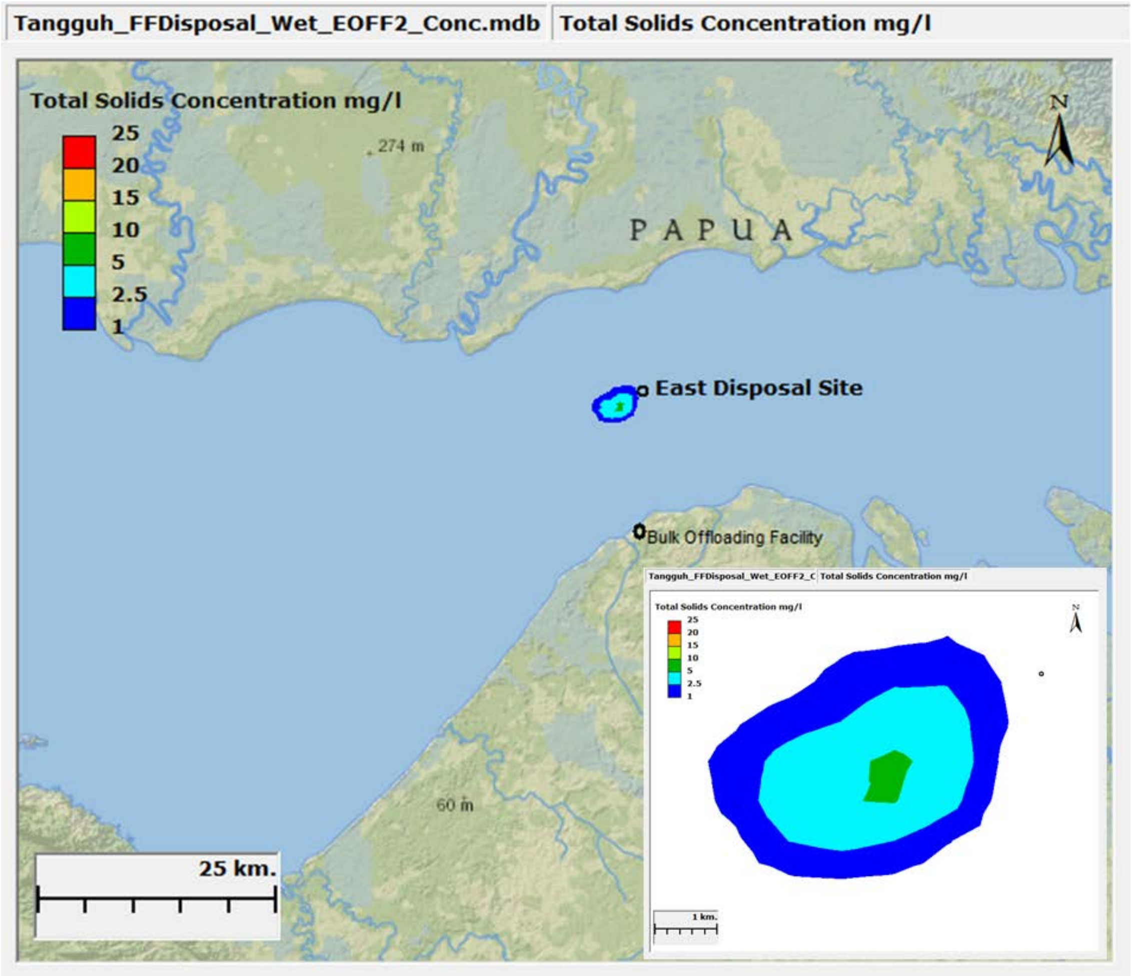


Figure III-65 Spread of Maximum Increased TSS during the Disposal of Dredge material in the East Disposal during Wet seasons

- **Evaluation of Impact**

  Based on the modeling of near shore dredging activities, it was found that the maximal value of TSS concentration increase is 4.8 mg/L during dry seasons and 11.8 mg/L during wet seasons.

  If the maximum TSS increase figure due to dredging in dry seasons is added to the value of the TSS ambient concentration during the dry season, the TSS value will range between 37 up till 279 mg/L, while if the maximum TSS increased figure due to dredging in wet seasons is added to the TSS ambient concentration value in wet seasons, the TSS value will range between 35 up till 381 mg/L.

  Considering that the Bintuni Bay in near shore areas naturally have quite high TSS contents, accordingly the sensitivity is low. The impact of dredging activities is 'minor', and is not categorized as a significant impact.

Table III-172 **Evaluation of Impact – TSS Increase from Dredging during Construction and Maintenance Dredging**

<table>
<tr><td rowspan="1">Impact Description</td><td colspan="5">Dredging of the sea floor conducted during the construction phase consist of :
– BOF : channel for the maneuver area and maintenance dredging of the Bulk Offloading Facility. Volume = 750.000 m³
– LNG – Condensate Combined Dock and maintenance dredging. Volume = 130.000 m³.
– Development of the Combo Dock: Volume 180.000 m³

During the operations phase, maintenance dredging will be performed routinely with an estimated dredge material volume during each activity of approximately 400.000 m³.

Dredging activities spread sediments into the water column, during the excavation and during the flow of sediments from hoppers and barges. The increase in TSS at the disposal sites of the dredging activities can be observed from the turbidity “plume” visible behind the dredger.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Dredging during construction and maintenance dredging will increase TSS concentrations in the water column. The TSS concentration increase may reduce the sea water quality.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Dredging activities will directly increase TSS concentrations.</td></tr>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">Dredging during BOF construction will last for approximately 8 to 12 months and is continued with dredging for the Combo Dock construction for approximately 6 to 8 months. Accordingly, the activity of dredge material disposal will take place during this time period.

Referring to the note on Tangguh operations activities, maintenance dredging will be conducted once in every 5 years. However, it is predicted that for the Tangguh LNG Expansion Project maintenance dredging will last for 3 to 6 months a year (or more, depending on the conditions in the field). Therefore, the disposal of dredge material will also last for 3 to 6 months.

As the impact is intermittent or repetitive and occur for a long term that lasts during the operations phase (±25 years since the operations phase starts), the Duration of Impact is categorized as ‘long term’.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Based on modeling results of TSS spread in the surroundings of the dredging areas, in the spread range increased TSS concentrations are found within a maximum distance of 500 meter from the dredging site. Therefore, the impact extent is ‘local’.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">Modeling results indicate that sediment dispositions of the dredging activities will only occur in the surroundings of the dredging sites with a distance of 500 m. The TSS maximum value is predicted to be 4,8 mg/L in dry seasons and 11,8 mg/L in wet seasons. This maximum value will only occur in short terms as the ambient conditions are only temporary and the plume will quickly spread and settle into the sea floor. The spread of the TSS plume is limited as the sea is not deep causing that sedimentation already occur in areas surrounding the plume.

Based on information of the AMDAL 2002 environmental baseline, the TSS value at estuaries vary between the minimum concentration of 32 mg/L (S-230 in wet seasons) and maximum concentration of 173 mg/L (S-130L in dry seasons), with an average concentration of 71 mg/L. The TSS concentration that naturally is already high, indicates that a large amount of sediment is carried in the ecosystem that may be caused by high rainfall, runoff water and tidal water.</td></tr>
</table>

	Monitoring of TSS concentrations are conducted regularly every week at the Dock-1 sea water intake. This monitoring location is near the dredging site. Monitoring results during 2011 indicates that TSS concentrations in dry seasons range between 32 to 267 mg/L with an average value of 102 mg/L, while in wet seasons, the TSS concentrations range between 23 to 369 mg/L with an average value of 139 mg/L. Of 47 dredging results data during 2011, 27 data (57%) are larger than 80 mg/L that already exceeds the TSS quality standard of mangroves based on the Regulation of the Minister of the Environment No. 51 year 2004. *If the maximum TSS increased number due to dredging in the dry seasons is added to the TSS ambient concentration value in dry seasons, the TSS value is 37 – 279 mg/L, while if the TSS maximum increased number due to dredging in wet seasons is added to the TSS ambient concentration value in the wet seasons, the TSS value is 35 – 381 mg/L.* *In general dredging activities do not cause significant impacts, however as the impact is repetitive for a long time (from the construction phase continued to the operations phase), accordingly the impact magnitude is categorized as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	The Bintuni Bay is estuary waters receives quite high sediment intake from the surrounding land causing that the TSS concentration is naturally high and frequently exceed the TSS quality standard (80 mg/l) for mangrove areas based on the Regulation of the Minister of the Environment No. 51 year 2004. Accordingly, the increase of TSS concentration is not sensitive for the environmental condition at the Bintuni Bay waters, in particular near the coastlines. Accordingly, the receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	With a impact magnitude categorized as 'medium' and receptor sensitivity categorized as 'low', the impact severity is categorized as 'low'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Increase in TSS will certainly occur during every dredging activity. Therefore, the impact likelihood is categorized as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	With the combination of the 'low' impact severity and 'high' impact likelihood, the impact significance is categorized as 'minor' and classified as insignificant impacts.				

TSS spreads in the dredge material disposal sites (offshore locations) in dry seasons is 3.9 mg/L and 5.5 mg/L in wet seasons. The maximum values (3.9 mg/L and 5.5 mg/L) only occur during short periods because the ambient condition is temporary and the plume quickly spreads out or settle to the bottom. Initial TSS baseline values during the dry seasons and wet seasons at the disposal site (OS-08) is 7 mg/L and 9 mg/L which when added with the maximum TSS increase due to the disposal produces a TSS value of 10.9 mg/L in the dry seasons and 14.5 mg/L in the wet seasons. The value is still below the sea water ambient quality standard of mangrove waters, namely 80 mg/L based on the Regulation of the Minister of the Environment No. 51 year 2004. The result estimates indicate that dredge material disposal have a minor impact, therefore the characteristics of impact are classified as 'insignificant impacts'.

Table III-173 Evaluation of Impact – The Increase of Suspended Solid Contents (TSS) due to Dredge material Disposal

Impact Description	*The disposal of dredge material will be conducted during the BOF construction phase, the LNG – Condensate Combined Dock, the Combo Dock Extension and maintenance dredging during the operations phase. Disposal activities release suspended sediments to the water column during the dredge material disposal. Increased TSS due to the disposal activities is very obvious.* *Dredge material will be disposed in two disposal sites at the Bintuni Bay, namely the West Disposal Site with a depth of approximately 50 meters and the East Disposal Site with a depth of approximately 60 meters.* *A disposal barge with a capacity of 1.000 m^3 will be used for dredge material disposal two times a day (total = 2.000 m^3/day). It is attempted to dispose all dredge material within 10 minutes for each barge.*				
Impact Nature	**Negative**	**Positive**			
	Dredging disposal material of the construction phase and maintenance dredging activities during the operations phase will increase the TSS in the water column.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Dredge material disposal will directly increase the TSS concentration.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Dredging during the BOF construction phase will last for approximately 8 to 12 months and will be continued with dredging for the construction of the Combo Dock expansion for approximately 6 to 8 months. Accordingly, the dredging disposal material for these activities will be conducted during the same period. *It is estimated that for the Tangguh Expansion Project maintenance dredging will last for 3 to 6 months every year (or more, depending on the conditions in the field). Therefore, dredging disposal material activities will also last for 3 to 6 months.* *As the impact is intermittent or repetitive and occur for a long term during the operations phase (±25 years since the operations phase starts), accordingly the impact duration is classified as 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Based on the modeling of TSS spread in the surrounding areas of the dredging disposal, an increase in the spread of TSS concentration of 2,5 mg/L is obtained, at a distance of maximum 1 km of the disposal site in less than 4 hours. Therefore, the impact extent is 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Modeling results indicate that dredge material disposal lead to increased TSS at the disposal site. The direct maximum value of TSS concentration increase in the dry seasons are 3,9 mg/L. The spread (plume) of TSS increase is limited to the east disposal site. The TSS value drops below 2,5 mg/L at a distance of more than 1 km of the disposal site. In wet seasons, the TSS increase is proportional with the values in the dry seasons. The maximum increase is estimated at 5,5 mg/L. *The maximum values (3,9 mg/L and 5,5 mg/L) only occur for short terms as the ambient condition is temporary and the plume quickly spreads or settles below. The initial TSS baseline during the dry seasons and wet seasons at the disposal sites (OS-08) are 7 mg/L and 9 mg/L which when added to the TSS maximum increase due to disposal results is a TSS value of 10,9 mg/L during the dry seasons and 14,5 mg/L during the wet seasons. The value is still below the sea water ambient quality standard for mangrove waters, namely 80 mg/L based on the Regulation of the Minister of the Environment No. 51 year 2004. This estimated result indicates that the dredge material disposal will not produce a value that exceeds the quality standard or results in significant impacts, therefore the impact magnitude is categorized as 'low'.*				

Receptor Sensitivity	**Low**	**Medium**	**High**		
	The Bintuni Bay is estuary waters with a quite high intake of sediments from the surrounding lands causing that the TSS concentration is naturally high and frequently exceed the TSS quality standard (80 mg/l) for mangrove areas. The farther from the coast (off shore) the lower the TSS concentration will be, however it is still relatively higher compared to TSS in the open sea. Therefore, the increased TSS concentration is quite sensitive to environmental conditions in the Bintuni Bay offshore waters. Accordingly, the receptor sensitivity is categorized as 'medium'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	With a impact magnitude categorized as 'low' and receptor sensitivity is categorized as 'medium', the impact severity is categorized as 'low'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	Increased TSS will certainly occur at all dredge material disposal activities. Therefore, the impact likelihood is categorized as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	With the combination between the 'low' impactseverity and 'high' impact likelihood, the impact significance is categorized as 'minor' and isclassified as an insignificant impact.				

3.4.2 Biology

3.4.2.1 Marine Biota

a. Changes in Diversity of Nekton (including Marine Mammals)

- **Environmental Baseline**

  The prediction of impact for all types of nekton is focused on marine mammals because this type of marine biota is sensitive to disturbances by human activities.

  A number of studies and monitoring activities of marine mammals in the Bintuni Bay conducted by Tangguh LNG since 2005 to 2013 at least recorded the emergence of five marine mammals species that are all members of the Cetacea ordo consisting of four dolphin and one whale species, namely;

  a. Indo-Pacific humpback dolphins (*Sousa chinensis*);

  b. Spinner dolphins (*Stenella longirostris*);

  c. Indo-Pacific bottlenose dolphins (*Tursiops aduncus*);

  d. Bottlenose dolphins (*Tursiops truncatus*); and

  e. Bryde Whale (*Balaenoptera Brydei*).

  Marine mammals are divided into three ordo, namely *Cetacea*, *Sirenia* dan *Carnivora*. In particular in the Bintuni Bay waters, so far only the *Cetacea* ordo is found, that is divided into two groups i.e. *Odontocetes* and *Mysticete.* In the overall, dolphin species found in the Bintuni Bay waters are members of the *Odontocetes* group, while the *Bryde* whale found is a member of the *Mysticete* group.

Based on the frequency of encounters and species found, the *Sousa chinensis* is the species most frequently found, while the most rarely is the *Bryde* whale. Other dolphin species are the *Stenella longirostris*, *Tursiops aduncus* and *Tursiops truncatus* which encounter percentage are almost similar.

- **Impact Prediction**

Source of Impact

The impact against changes in nekton diversity (including marine mammals) is sourced from sea transportation activities for workforce, equipment and material during the construction phase and LNG and condensate loading and transporting operations, as well as logistics during the operations phase.

In supporting transportation activities for workforce, equipment and material during the construction phase (1-4 years), a number of vessels will be used, among others support vessels, tug boats, material barges, crane barges, dredging vessels, dredging barges and LCTs.

Transportation activities during the operations phase include:

- LNG and condensate transport activities;
- Maintenance activities of gas wells and platforms;
- Inspection and maintenance of pipelines; and
- Transportation of workforce, equipment and supporting materials of the LNG Train operations.

The number and frequency of vessel movements during the operations phase can be observed in the following **Table III-133** :

Table III-174 Sea Transportation during the Operations Phase

No.	Operations	Number of Boats	Frequency of Boat Movements
1	*Crew boat support ship (SPTB) – Small personnel transfer boat*	*6 boats*	*12 hours/day*
2	*Crew Boat*	*2 boats*	*12 hours/day*
3	*Multipurpose Support Boat – Offshore Support Vessel (OSV)*	*2 boats*	*12 hours/day*
4	*Security Boat*	*4 boats*	*24 hours/day*
5	*Pilot Boat*	*1 boat*	*6 hours/day*
6	*Tug Boat*	*6 tugs*	*6 hours/day*
7	LCT	*3 LCTs*	*3 x /week*
8	*Cargo Boat (big cargo)*	*2 boats*	*4 x/month*
9	*Fuel Tanker*	*1 boat*	*4x/month*
10	LNG *Tanker*	*15 boats*	*15x/month*
11	*Condensate Tanker*	*3 boats*	*3x/month*
12	*Mooring Boat*	*2 boats*	*6 hours/day*

Potential Impact

In seawaters, in particular when vision is one of the limiting factors, sounds and sense of hearing are absolute factors and are very important for the life of marine mammals. Sounds and hearings can be beneficial to maintain group unities in social life, for Echolocation to identify and obtain food, to detect sounds of approaching predators and also to avoid dangerous situations such as the potential of being hit by objects in the sea (J. Gordon *et al.*, 2004).

A large part of marine mammal groups produce and receive sounds. Underwater vocalizations generated can be in the form of clicking, trills, warbles, whistles, and vocalizations that resemble the sounds of bells (J. Gordon *et al.*, 2004). The *Odontocetes* group is known to produce sounds in diverse variations, while details of vocalization sounds produced by the *Mysticetes* group is not sufficiently understood. The *Odontocetes* group is known to communicate at a moderate frequency (from 1 kHz to more than 20 kHz) and a number of species echolocate at a high frequency (from 20 – 150 kHz). This is a reversed contrast with the *Mysticetes* group that has an echolocation system at a low frequency (<10 Hz - <10 kHz) (**Figure III-66**).

Shipping activities are one of the contributors to underwater noise in the sea, in particular low-frequency noise, however higher noise frequencies can also be generated depending on the vessel size and propulsion systems used. It is estimated that approximately 85% of vessel activity noises are generated from the vessel propulsion system due to rotation of propellers (Barlow & Gentry 2004 in Genesis 2011). The noise generated has the potential of closing/masking of sounds of marine mammal activities.

As can be observed in **Figure III-66** a large part of sound energy radiated from vessels (commercial) is below 1 kHz **Figure III-66**, however it is also known that noise from smaller vessels with a more powerful propulsion system is capable to generate ambient noise at a frequency of more than 1 kHz (Kipple 2002 in Genesis 2011). This condition is potential to disturb marine mammals that emit and receive sounds in low frequencies.

The potential closure of noises at higher frequencies (1-25 khz) occur when vessels are near herds of marine mammals. In this condition, the *Odontocetes* group that also operates at the same frequency may also experience sound closure due to vessel noise.

Apart from sound closure due to vessel noise, potential vessel sounds can also affect the behavior of marine mammals. Ranging from as small as direction disorientation towards sound sources, to large potentials such as long-term behavior changes in foraging, navigation and reproduction activities.

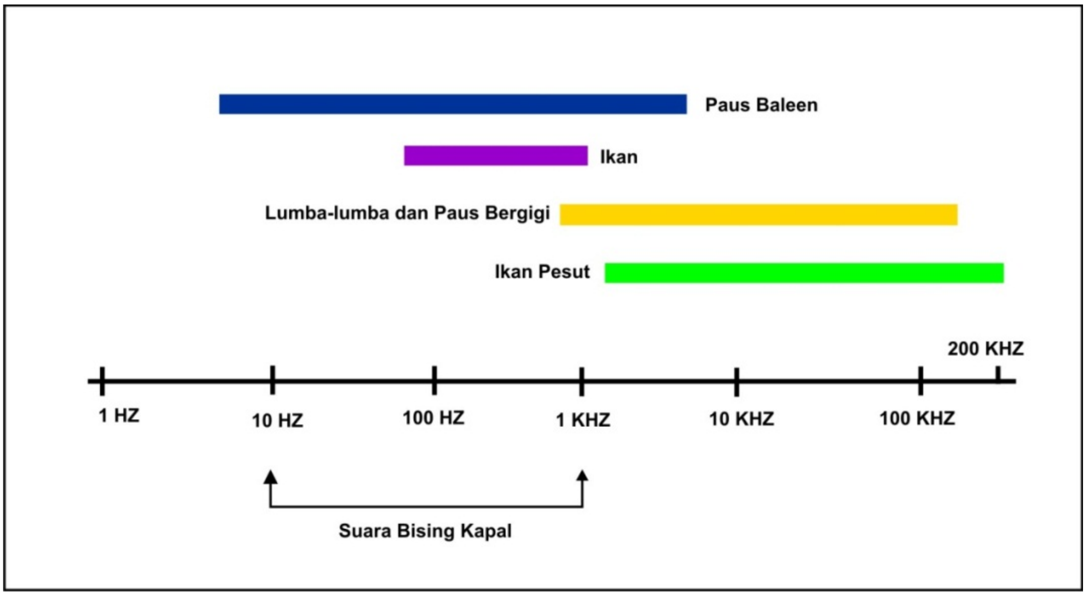


Figure III-66 Frequency Relationship between Marine Mammals Sounds and Vessel Sounds (source: B. Southall, NMFS/NOAA)

When a vessel approaches, marine mammals can change or discontinue sound productions they use to communicate, forage, avoid predators and other environmental vigilances (Au & Green 2000, Van Parijs & Corkeron 2001). For example, the change in behavior of the bottle nose dolphins (*Tursiops truncatus*) that change their sound level when there are vessel noises.

Studies on the hearing of Indo-Pacific bottle nose dolphins by Houser *et al.*, 2008 explains the hearing ability of these animals ranging from 150 Hz to 160 kHz.

- **Impact Evaluation**

  As described above, sounds produced by humans (*Anthropogenic*), including the sea transportation activities have the potential to disturb a number of marine mammals physiological functions including short-term changes of behavior and assuming the worst possible long-term changes may occur (Payne & Webb 1971, NRC 2003, 2005). The type and impact magnitude depends on the characteristics of the source of sounds, the environment and marine mammals as impact receptors. The many small vessels used that in general use powerful propulsion systems generating noise at low to moderate frequencies are estimated to affect the sound closure of the *Odontocetes* group (including dolphins) that are frequently found in the Bintuni Bay waters. Apart from that, sounds at low frequencies generated by large ships such as tankers may affect the sound closure of the *Mysticetes* group, namely the *Bryde whale* that was also found in the Bintuni Bay waters.

The possibility of marine mammals being hit by vessel movements may occur, although to date since the presence of Tangguh LNG there are no records of such accidents due to Tangguh LNG activities. A number of marine mammal species will immediately avoid areas with disturbances of vessel movements, however on the contrary a number of marine mammal species in particular dolphins of the *Sousa chinensis* species in herds will approach vessel movements (Erftemeijer, *et. al*. 1989). For the present operations activities, Tangguh LNG already implemented marine mammal protection procedures, among others regulations regarding vessel routes and vessel speeds. This procedure will continually be applied for the Tangguh LNG Expansion Project activities.

Based on above descriptions, the impact of sea transportation activities for workforce, equipment and material during the construction phase, LNG and condensate loading and transporting during the operations phase against the changes of nekton diversity (including marine mammals) is classified as 'moderate'.

Table III-175 Impact Evaluation – Sea Transportation Activities for Workforce, Equipment and Material, Loading of LNG and Condensate towards the Changes in Nekton Diversity (including Marine Mammals)

Impact Description	*Sea transportation for workforce, equipment and material during the operations phase.* *A potential source of impact from sea transportation activities during the operations phase originates from vessel movements and vessel noises. Details on the number of vessels and frequency of vessel movements can be observed in* ***Table III-133*** *on the Sea Transportation Activities during the Operations Phase.*				
Impact Nature	**Negative**	**Positive**			
	Marine mammals (dolphins and whales) are sensitive towards direct disturbances of vessel movements in the form of waves and the possibility of the marine mammals being hit. In addition, the acoustic energy arising from transportation activities may disturb marine mammals communication and navigation systems causing that the marine mammals avoid the areas.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Disturbances due to noises, generation of waves and the possibility of hitting marine mammals are direct impacts of vessel movements.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The impact of vessel movements of sea transportation for workforce, equipment and materials as well as the loading and transporting condensates will last during the Tangguh LNG project operations period namely approximately 25years since the operations phase starts. Therefore, the impact duration is categorized as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	Sea transportation activities for workforce from Babo and Kokas to the Combo Dock (round trip), equipment and material can originate from outside the Bintuni Bay towards BOF as well as to the Combo Dock and vice versa. *While LNG and condensate tankers may originate from outside the Bintuni Bay towards the LNG and condensate dock and vice versa. The entire vessel movements will pass though the determined shipping channel (access channel) presently available and being in the study area limits so that the impact extent is categorized as 'local'.*				

Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	The Bintuni Bay is a habitat of several dolphin and whale species such as Sousa chinensis and Stenella longirostris, that are sensitive to acoustic energy. The onset of acoustic energy from vessel movements may disturb communications, navigations and the orientation of marine mammals. *As can be observed in* ***Figure III-66*** *a large part of sound energy radiated from (commercial) vessels are below 1 kHz, however, it is also known that the noise of smaller vessels with more powerful propulsion systems are capable to generate ambient noises at frequencies of more than 1 kHz (Kipple 2002 in Genesis 2011). This condition has the potential to disturb marine mammals that emit and receive sounds in low frequencies.* *Potential closure at higher frequencies (1-25 kHz) occurs when the vessels are near herds of marine mammals. In this condition, the Odontocetes group that also operates at the same frequency will possibly experience closure of sounds due to vessel noises.* *Apart from closure of sounds due to vessel noises, potential vessel noises may impact the behavior of marine mammals. Ranging from as small as direction disorientation against sound sources to large potentials such as long-term behavioral changes in foraging, navigation and reproductive activities.* *The possibility of marine mammals being hit by vessel movements may occur, although to date since the presence of the Tangguh LNG no such incidents are recorded due to Tangguh LNG activities. A number of marine mammal species will immediately avoid areas disturbed by vessel movements, however, on the contrary a number of mammal species in particular dolphins of the Sousa chinensis species in herds will approach vessel movements (Erftemeijer, et. al. 1989). However, as the impact may occur in a long term, the impact magnitude is categorized as 'mesium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	Impact receptors are nekton (including marine mammals) that is very sensitive towards acoustic energy. Apart from sound closure due to vessel noises, the potential vessel noises may affect marine mammal behaviors. Ranging from as small as disorientation of directions towards sound sources to large potentials such as long-term behavior changes in foraging, navigation and reproduction activities. However, nektons have high swimming capabilities and are able to avoid so that the receptor sensitivity is categorized as 'moderate'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	As the impact magnitude and receptor sensitivity impact are categorized as 'moderate', accordingly the impact severity is included in the 'high' category.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	The likelihood of disturbances against marine mammals caused by this transportation activity is classified as 'low' based on the present experiences whereas dolphins frequently swim following vessels.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	As the impact severity is classified as 'high' and the impact likelihood is classified as 'low', accordingly the impact significance is categorized as 'moderate' and is classified as a significant impact.				

b. Decrease in Plankton Abundance due to Dredging and Dredge Material Disposal as well as Maintenance Dredging

- **Environmental Baseline**

  Based on identification results of phytoplankton up till the genus level, phytoplankton identified in the Bintuni Bay waters is grouped into four classes, namely *Cyanophyceae*, *Bacillariophyceae*, *Chrysophyceae* and *Dinophyceae*. The first two classes are more dominant in abundance compared to the last two classes. Either at near-shore as well as offshore locations abundance of all classes fluctuate spatially and temporally.

During dry seasons, the abundance of *Cyanophyceae* dominates, except at the OS-03 and OS-13 (*offshore*) points. The *Cyanophyceae* class is only represented by one genus, namely the *Trichodesmium*. This genus is a member of the filamentous *Cyanobacteria class. Therefore,* according to Rubin *et al*. (2011), its presence is very important in nitrogen fixation to increase water productivity, flow of nutrients as well as organic and inorganic material cycles. In this case, they provide pseudo basic substrates (*pseudobenthic substrates*) for many microscopic organisms in the sea, including bacteria, diatom, *dinoflagellata*, *protozoa* and *copepod*.

The *zooplankton* community composition based on identification is grouped into eight classes, namely *Protozoa*, *Crustacea*, *Urochordata*, *Chaetognatha*, *Nemertina*, *Polychaeta*, *Pelecypoda* and *Gastropoda*. In the overall, only *Crustacea* and *Protozoa* are dominant classes. The percentage of the two classes consists of 30 – 90 % of *zooplankton* filtered in the planktonet is *Crustacea* and 5 – 55% *Protozoa*.

Near-shore, the abundance of *zooplankton* is more fluctuating compared to offshore locations. In all locations, the abundance of *zooplankton* is not directly proportional to the number of taxa. The observation point with the highest *zooplankton* abundance is OS-14 (offshore in dry seasons), due to the domination of *Stadia Nauplia* abundance which is the initial stadia of *copepod/crustacean*. In general, the abundance of *zooplankton* is < 100.000 cell/m^3, then between 100,000 – 200,000 cell/m^3 (NS02, NS05, NS06, NS08, OS08, and OS11) and > 200,000 cell/m^3 (OS14).

The abundance of benthos between the dry seasons and wet seasons is not directly proportional with the number of taxa. Stations with a less number of taxa, have a higher abundance. The difference in the presence of taxa and its abundance depends on the substrate condition. In general, benthos is plentiful found in soft substrates i.e. muddy substrates. If oxygen waters still meet the minimum physiological benthos needs and the organic matter content is available, then benthos in particular the sea worms group will be plentiful found.

- **Impact Prediction**

The impact on plankton is a secondary impact from increase in TSS concentration due to the dredging activities and dredge material. Dredging and disposal activities spread suspended sediments into the water column. The two activities will increase TSS concentrations. TSS can reduce sunshine penetrations into the water column that will disturb the phytoplankton photosynthesis process. Decrease in abundance of phytoplankton can linearly decrease the abundance of *zooplankton*.

Dredging during BOF construction will last for approximately 8 to 12 months followed by dredging for the Combo Dock construction for approximately 6 to 8 months. Dredge material disposal at the dredge material disposal site will also be conducted during the same period.

During the operations phase of the Tangguh LNG expansion activities it is predicted that maintenance dredging will be conducted once a year for approximately 3 months (or more, depending on conditions in the field). If dredging is performed, disposal of dredge material activities will also be conducted for approximately 3 months.

Disturbances against benthos will take place during the dredging activities and ongoing dredge material disposal, which is repetitive and occur for a long term during the operations phase (± 25 since the operations phase starts).

TSS modeling results are described in Sub-Chapter 3.4.1.2 at the TSS Parameter. The conclusion against the maximal TSS concentration can be observed in **Table III-135**.

Table III-176 Modeling Results against Maximum Increase in TSS Concentration of Dredging and Dredge Material Disposal Activities

Season	Increase in Maximum TSS Concentration at the Dredging Site (mg/L)	Increase in Maximum TSS Concentration at the Disposal Site (mg/L)
Dry Season	4.8	3.9
Wet season	11.8	5.5

- **Impact Evaluation**

Phytoplanktons are animals sensitive to environmental changes. The rate of growth and phytoplankton photosynthesis are highly dependent on the presence of sunshine and nutrients (Dugdale 1975; Ryther 1956; Yentsch 1974). Increase in TSS in the waters will prevent sunshine penetration into the waters. Masc Isaaac and Dugdale (1976) state that decreased light levels will cause a decrease in the absorption of ammoniac and nitrate by phytoplankton.

Table III-177 Impact Evaluation – Impact on Dredging and Dredge Material Disposal and Maintenance Dredging towards Plankton Abundance

Impact Description	*The impact on plankton originates from increase in TSS generated from dredging and dredge material disposal activities. Dredging and disposal activities spread suspended sediments into the water column. The two activities will increase the TSS concentration. TSS can reduce sunshine penetration into the water column that disturbs the photosynthesis process of phytoplankton. Decrease in abundance of phytoplankton will directly decrease the abundance of zooplankton.*

Impact Nature	**Negative**	**Positive**			
	In certain conditions the increase in concentration of TSS due to dredging and disposals may have adverse effects on phytoplankton. This can decrease the abundance of phytoplankton and zooplankton.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	Disturbances on phytoplankton are secondary impacts of increase in TSS concentrations due to dredging and dredge material disposal activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Dredging during the construction of BOF will occur for approximately 8 to 12 months and will be continued by dredging for the Combo Dock development construction for approximately 6 to 8 months. Dredge material disposal at the dredge material disposal site will also be implemented during the same period. *For the Tangguh LNG Expansion Project it is estimated that maintenance dredging will be implemented once every year for approximately 3 months (or more, depending on the conditions in the field) during the operations phase. When dredging is conducted, the dredge material disposal activities will be conducted for approximately 3 months every year.* *Disturbances on plankton will occur during the implementation of dredging and dredge material disposal. Therefore, the impact is intermittent and repetitive and will last for a long term during the operations phase (± 25 years since the operations phase started), accordingly the impact duration is categorized as 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Impacts on decrease in plankton abundance occur in the surroundings of the dredging and dredge material disposal activities. Based on modeling results on TSS impact of the dredging activities, the impact maximum distance is estimated to reach 500 meter from the dredging site. While based on modeling of TSS activities impact of dredge material disposal, the impact maximum distance is estimated to reach 1 kilometer of the disposal site. *As the spread of impact is still in the Tangguh LNG ANDAL study area, the impact extent against plankton is categorized as 'local'.*				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Based on identification results of phytoplankton up till the genus level, the identified phytoplankton in the Bintuni Bay waters are grouped into 4 classes, namely Cyanophyceae, Bacillariophyceae, Chrysophyceae and Dinophyceae. *The environmental baseline for water biology indicates that the abundance of phytoplankton is dominated by the genus Cyanophyceae and Bacillariopycheae with an abundance in the dry seasons ranging between 4x106 cells/m^3 up till approaching 16x10^7 cells/m^3 and during the wet seasons < 2x10^7 cells/m^3.* *In general, plankton is located in the water surface layer. Increased TSS can lead to reduced light penetration, however in this case disturbances against plankton is relatively small in the surface due to turbidity caused by dredging that is sourced in the depths (seabed).* *Modeling results or particle spreads in the dredge material disposal site indicates that TSS concentration (silt and clay) occur at the disposal point, in which increased concentration of 20 mg/L occurs within 1 hour after disposal is spread in a radius of 150 meter. In a period of 4 hours after disposal, the increased concentration is 1 mg/L spread in a radius of 400 meter.* *The increase in TSS concentration based on modeling results indicate that the maximum value will occur in a short period as the TSS plume will immediately spread and settle.* *Based on weekly monitoring results in 2011, TSS concentration in the dredging area can reach 267 mg/L in dry seasons and 369 mg/L in wet seasons, far above the maximum threshold (80 mg/L mangrove areas) during active dredging. Dredging activities can lead to temporary increase in TSS concentrations of 4.8 mg/L during the dry season and 11,8 mg/L during the wet season. Compared to the present condition, the increase in TSS concentration of the dredging activity plan does not cause significant impacts.*				

	Environmental baseline studies indicate that the TSS concentration in the dredge material disposal areas are still low with a concentration of 7 mg/L during the dry season and 9 mg/L during the wet season. Increase in TSS concentrations of 3.9 mg/L during the dry season and 5.5 mg/L during the wet season cause a significant increase compared to its initial concentration, however are still far below the applicable quality standard for mangrove areas (80 mg/L). This increase is also insignificant against the TSS concentration in water as disturbances on the sunshine penetrations. *The impact is local and can immediately return to initial conditions. However as the impact occurs repetitively for ±25 years since the operations phase starts, accordingly the impact magnitude is categorized as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	In addition to sunshine, the growth of phytoplankton is determined by a number of other factors, among others: the elements of nutrients, temperature, etc. Naturally, TSS concentrations at the dredging site is already adequately high, accordingly phytoplankton at the dredging site is not sensitive to TSS changes. Based on this matter, the receptor sensitivity is categorized as 'low'.				
Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	As the impact magnitude is categorized as 'moderate' and the receptor sensitivity is categorized as 'low', the impact severity is included in the 'low' category.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Disturbances on the plankton growth cannot be avoided in during dredging and disposal activities.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The combination of the 'low' *impact severity and the 'high' impact likelihood lead to impact significance with a 'minor' category and is classified as insignificant impacts.*				

c. Decrease in Benthos Abundance due to Dredging and Dredge Material Disposal

- **Environmental Baseline**

  Abundance of benthos in the Bintuni Bay waters during the dry season do not exceed 1,608 ind/m^2, while in the wet season, the abundance of benthos is maximally only approximately 675 ind/m^2. In the overall, at almost every station, the abundance of benthos in the dry seasons are higher than in the wet seasons except at Station NS-05 and NS-07.

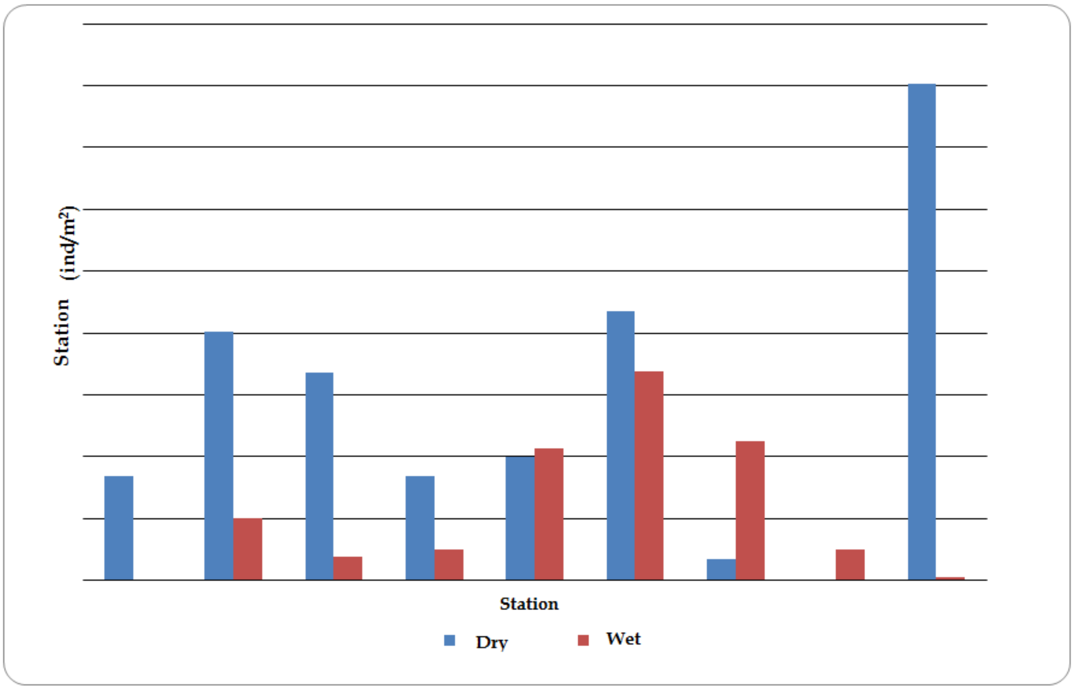


Figure III-67 Abundance of Benthos at Each Nearshore Observation Station in the Dry Seasons and Wet seasons

In general, dominating species originate from the *Polychaeta* class except at a number of stations, such as NS 01 (dry seasons), NS 06 and NS 09 (wet seasons). At NS 01 (dry seasons), the dominating benthos is the *Crustacea* class, almost similar to the benthos condition at the NS 09 (wet season) that has a similar proportion, namely 50%. *Polychaeta* is one of the sea worm groups measuring 5-10 cm with a diameter of 2-10 mm. A number of *Polychaeta* species live permanently on the water bottom. They drill and make holes as living spots.

Crustacea are benthos animals that are incapable or have limited moving abilities and can tolerate salinity changes. *Crustacea* occupy various coastal waters such as sandy, rocky and muddy coasts. Species found in the three types of coasts are different according to the capability of the respective species that adjust to the physical-chemical conditions of the waters (Nybakken, 1992).

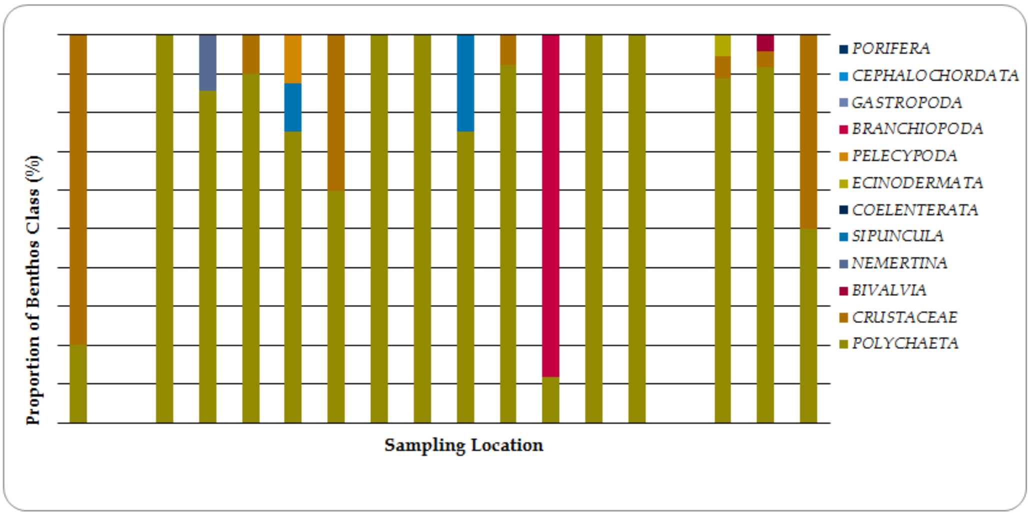


Figure III-68 Proportion of Class Abundance (%) in Benthos at Each Nearshore Observation Station during Dry Seasons and Wet seasons

- **Impact Prediction**

The impact on the benthos diversity is sourced from dredging activities during the construction and maintenance dredging activities in the operations phase. Dredging of the seabed will be implemented during the construction phase and the operations activities of the LNG and condensate Combined Dock, BOF and the enhancement of the Combo Dock. Dredging activities can cause two impacts, namely:

- The loss of benthos and its habitat as benthos live in dredged sea sediments. During dredging, benthos will be carried away with dredge material by barges and may possibly die before the disposing of dredge material is conducted; and
- Increase in TSS concentrations will produce sediments near the dredging site. Released sediments will spread in the surroundings of the dredging areas. Sediments will immediately settle and cover the seabed that is the habitat of benthos.

Dredging during the construction of BOF will be conducted for approximately 8 to 12 months and is continued with dredging for the construction of the Combo Dock enhancement for approximately 6 to 8 months. Overboard disposal of dredge material at the dredge material disposal sites will also be conducted during this period.

It is estimated that during the operations phase activities of the Tangguh LNG expansion maintenance dredging will be implemented every year for approximately 3 months (or more, depending on the conditions in the field).

Disturbances against benthos will occur during the dredging activities. As the impact is intermittent, repetitive and will occur for a long term during the operations phase (± 25 years since the operations phase starts).

The Impact magnitude on the loss of benthos covers the entire dredging area for the construction of the marine facilities with an area of approximately:

Rough estimation of the dredging area:

BOF

Extent of the channel = 72,000 m^2

Extent of the maneuvering area = 135,000 m^2

Extent of the total dredging area = 207,000 m^2

Combined LNG – Condensate Dock

Extent of the dredging area = 130,000 m^3 : 4 m (depth) = 32,500 m^2

Enhancement of the Combo Dock

Extent of the dredging area = 180,000 m^3 : (11 – 8) m (depth) = 60,000 m^2

Dominant benthos species in the dredging location is the *Polychaeta*, with an average abundance ranging between 125 up till 600 ind/m^2.

- **Impact Evaluation**

Table III-178 Impact Evaluation – Impact on Dredging during the Construction Phase and Maintenance Dredging towards Benthos Abundance

<table>
<tr><td rowspan="1">Impact Description</td><td colspan="5">Seabed dredging will be implemented during the construction and operations periods of the LNG – condensate combined dock, Bulk Offloading Facilities (BOF), the development and maintenance of the Combo Dock. Dredging activities may cause two impacts, namely:
– Loss of the benthos and its habitat as benthos live in the dredged sea sediment. During dredging, the benthos will be carried away with the dredge material by barges and might be damaged prior to the disposal of dredge material is implemented; and
– Increase in TSS concentrations will produce sediments near the dredging sites. Released sediments will be spread in the surroundings of the dredging areas. Sediments will immediately settle and cover the seabed which is the habitat of benthos.</td></tr>
<tr><td rowspan="2">Impact Nature</td><td>Negative</td><td>Positive</td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Dredging activities will result in the reduction of benthos at the dredged seabed parts and carried out together with dredge materials. While benthos in the surroundings of the dredging areas will be disturbed due to the sedimentation of turbidity. Both are negative impacts of the dredging.</td></tr>
<tr><td rowspan="2">Impact Type</td><td>Direct</td><td>Secondary</td><td>Indirect</td><td>Cumulative</td><td>Residual</td></tr>
<tr><td colspan="5">Benthos carried together with dredge material and the closure of benthos habitats due to turbidity sedimentations are directly caused by dredging activities.</td></tr>
</table>

<table>
<tr><td rowspan="2">Impact Duration</td><td>Temporary</td><td>Short Term</td><td>Long Term</td><td>Permanent</td><td></td></tr>
<tr><td colspan="5">Dredging during the BOF construction will last for approximately 8 to 12 months and will be continued with dredging for the construction of the Combo Dock development for approximately 6 to 8 months.

It is predicted that for the Tangguh LNG Expansion Project maintenance dredging will be implemented once a year for approximately 3 months (or more, depending on the conditions in the field). Therefore, the disposal of dredge material will also last for approximately 3 months.

Disturbances on the benthos will occur when the dredging activities are implemented. Therefore, the impact is intermittent or repetitive and occur for a long term during the operations phase (±25 years since the operations phase starts), accordingly the impact duration is categorized as ‘long term’.</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Disturbances to the benthos communities will occur at the combined LNG – condensate jetty, combo dock and channel to facilities located in the boundary areas of the Tangguh LNG Expansion Project.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Low</td><td>Medium</td><td>High</td><td></td></tr>
<tr><td colspan="5">In general, dominating species originate from the Polychaeta and Crustacea classes. Polychaeta is one of the sea worm groups measuring 5-10 cm with a diameter of 2-10 mm. A number of Polychaeta species permanently live in bottom waters. Crustacea occupy various types of coastal waters, such as sandy, rocky and muddy coasts.

Abundance of benthos in the Bintuni Bay waters during the dry seasons do not exceed 1,608 ind/m2, while in the wet seasons, the abundance of benthos is maximally only approximately 675 ind/m2. In the overall, at almost every station, the abundance of benthos during the dry seasons is higher than during the wet seasons.

The impact magnitude of the lost benthos covers the entire dredging areas implemented to construct the special terminal facilities with a rough estimate of the dredging area as follows:

BOF
– Extent of channel = 72,000 m^2
– Extent of the maneuver area = 135,000 m^2
– Extent of the total dredging area = 207,000 m^2

The Combined LNG – Condensate Jetty
Extent of the dredging area = 130,000 m^3 : 4 m (depth) = 32,500 m^2

Combo dock Enhancement
– Extent of the dredging area = 180,000 m^3 : (11 – 8) m (depth) = 60,000 m^2

Dominant benthos species in the dredging site is Polichaeta, with an abundance of 150 ind/m^2.

The area extent of sedimentation with a thickness of more than 5 cm is 590 m^2 during dry seasons and 80 m^2 during wet seasons.

The extent of the dredging area if compared to the extent of the Bintuni Bay area is very small. Accordingly the number of benthos disturbed is relatively small.

With a local impact spread, the benthos species resistant to sedimentation, but lasting for a long term, the impact magnitude is categorized as ‘medium’.</td></tr>
<tr><td rowspan="2">Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">The sensitivity of benthos in the dredging site is relatively small against the changes of TSS concentrations due to the conditions of the Bintuny Bay that naturally have high TSS concentration fluctuations. However, its sensitivity against the dredging activities is categorized as ‘medium’ because there is the potential of death when dredged and lifted to the disposal sites.</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Slight</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">With a ‘medium’ impact magnitude and a ‘medium’ receptor sensitivity, the impact severity is categorized as ‘high’.</td></tr>
</table>

Impact Likelihood	Very Low	Low	Medium	High	
	The possibility of impact on the benthos due to dredging will certainly occur. Therefore, the impact likelihood are categorized as 'high'				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	With a 'high' impact severity and 'high' impact likelihood, the impact significance is categorized as 'major' and is classified as a significant impact.				

d. Decrease in Benthos Abundance due to Dredge Material Disposal

- **Environmental Baseline**

Based on benthos environmental baseline data during dry seasons (2012), the abundance of benthos found in every observation station in the Bintuni Bay are highly varied, ranging from 0 to 735 ind/m². At a number of locations such as OS-02, OS-05, OS-13 and OS-14 benthos are not found. During wet seasons the abundance of benthos ranges between 8 to 260 ind/m².

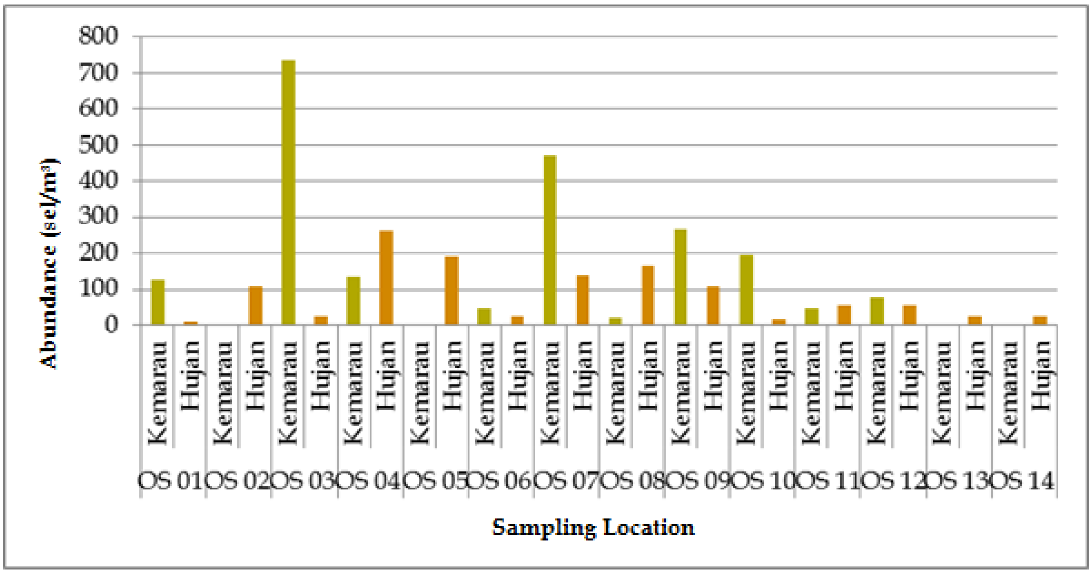
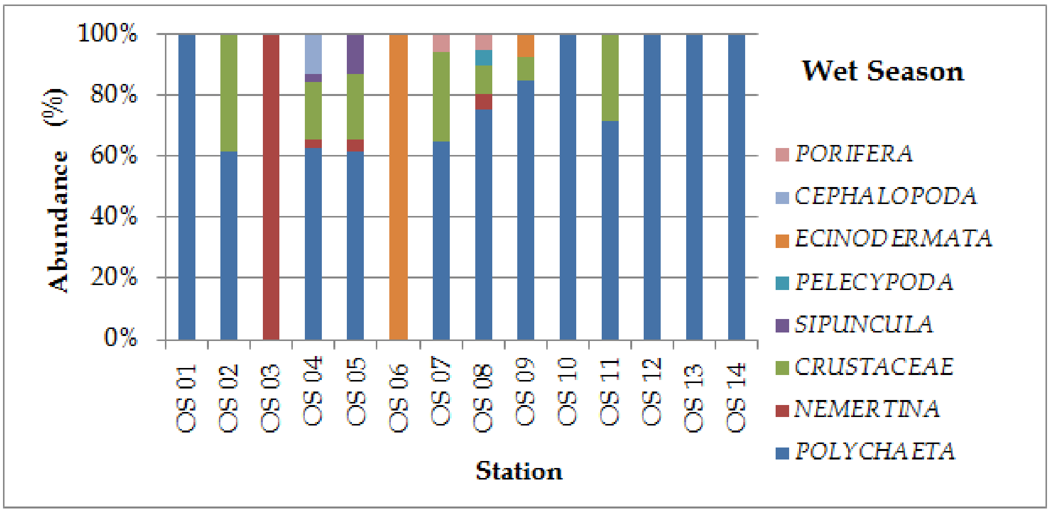


Figure III-69 Abundance of Benthos at Each Offshore Observation Station during the Dry Seasons and Wet seasons

In general, dominating species originate from the Polychaeta and Crustacea classes. However, during the dry seasons at OS-03 dominating species originate from the Nemertina class and at OS-06 of the Echinodermata class. Polychaeta is a group of sea worms measuring 5-10 cm with a diameter of 2-10 mm. A number of Polychaeta species live permanently in the bottom waters. The species dig holes as spots to live.

The *Crustacea* group that occupy seawaters habitats are benthos animals, that are incapable or have limited movement abilities and tolerate changes in salinity. *Crustacea* inhabit waters of various coastal types, such as sandy, rocky and muddy coasts. Species found at the three coast types are different according to the ability of the respective species to adapt to the physical-chemical conditions of the waters (Nybakken, 1992).



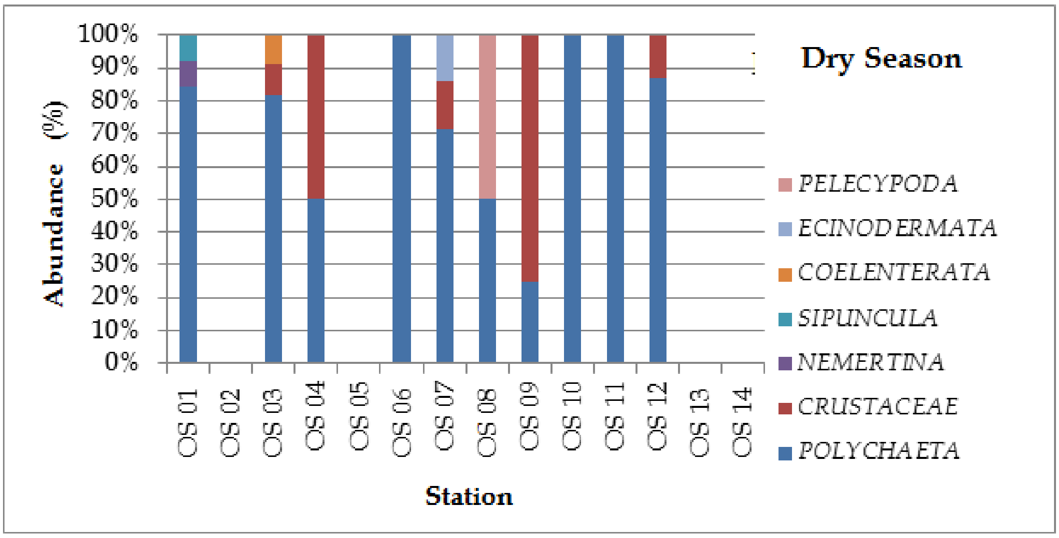


Figure III-70 Proportion of Class Abundance (%) of Benthos in Each Offshore Observation Station during Dry Seasons and Wet seasons

- **Impact Prediction**

The impact of benthos diversity is sourced from dredge material disposal activities during the construction phase, during maintenance and during disposal of dredge material. Disposal activities can lead to an accumulation of sediments in the surroundings of disposal sites and cover the seabed which is the benthos habitat with a specific thickness.

Disposals are implemented at two sites, namely the West Disposal Site with a depth of 50 meters and East Disposal Site with a depth of 60 meters. The disposal sites can be observed in **Figure I-49** (Potential Area of Dredge material Disposal) in Chapter I, Sub-Chapter 1.2.4 Marine Facilities.

Dredging plans during the BOF construction will be implemented for approximately 8 to 12 months which is then continued with dredging for the construction of the combo deck development for approximately 6 to 8 months. Dredge material disposal at the dredge material disposal sites will also be conducted during this period.

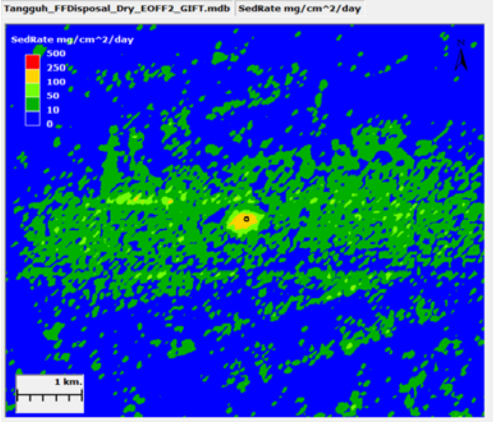
It is predicted that during the operations phase of the Tangguh LNG Expansion Project activities maintenance dredging will be implemented once a year for approximately 3 months (or more, depending on the conditions in the field). When dredging is performed, dredge material disposal will also be conducted for approximately 3 months.

Disturbances on benthos will occur during the implementation of activities, is of repetitive nature and occurs for a long term during the operations phase (±25 years since the operations phase starts).

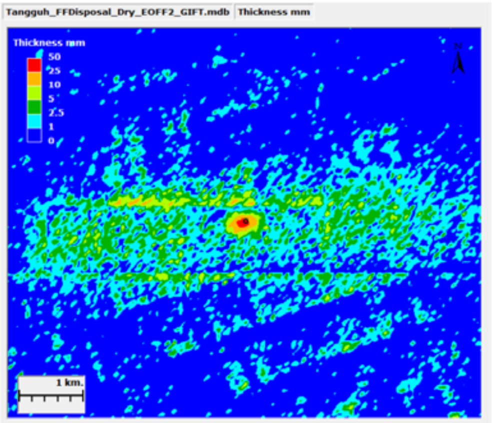
The amount of dredge material disposal is estimated to be 2,000 m^3 in 1 day. The amount is divided into 2 disposals because the maximal barge capacity is 1,000 m^3. The dredge material disposal process is implemented within 10 minutes.

Based on the modeling of dredge material disposal at the East Disposal Site during the dry seasons, the maximum sedimentation rate is 218 $mg/cm^3/day$ and the maximum estimation of thickness is 36.2 mm in the surroundings of the disposal sites. Similar modeling results during the wet seasons, at which the maximum sedimentation rate is 277 $mg/cm^3/day$ and the maximum estimated sediment thickness is 28.7 mm in the surroundings of the disposal sites.

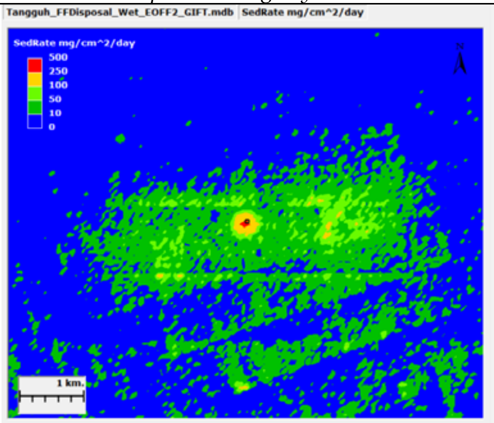
Thickness limits highly vary for every benthos and the impermeable nature of sediments. Ellis and Heim (1985) state that the recommended thickness for the benthos community does not exceed 5 cm during 1 month. Based on the modeling, there are no areas with a thickness exceeding 5 cm that are formed due to dredge material disposal activities, either during dry seasons as well as wet seasons.



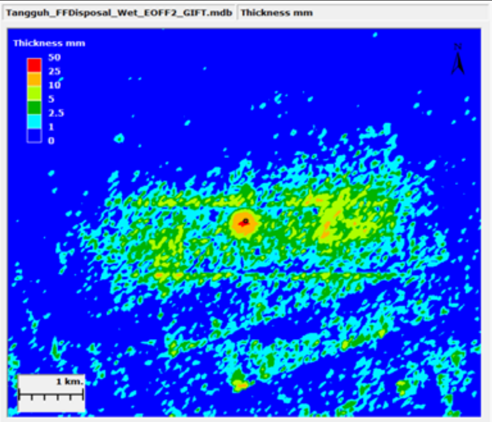
Maximum sedimentation rates of dredge material disposal during dry seasons



Maximum sediment thickness of dredge material disposal during dry seasons



Maximum sedimentation rates of dredge material disposal during wet seasons



Maximum sedimentation of dredge material disposal during wet seasons

Figure III-71 Modeling Results of Maximum Sedimentation Rates and Maximum Sedimentation Thickness during Dry Seasons and Wet seasons

- **Impact Evaluation**

  Dredging impacts on the community including the level of sensitivity and the likelihood of occurrences can be observed in **Table III-138**.

Table III-179 Impact Evaluation – Impact of Dredge Material Disposal on the Abundance of Benthos

Impact Description	*Dredging of sea sediments will be implemented during the construction of the Combined LNG – Condensate Jetty. Bulk Offloading Facilities (BOF), development of the combo dock and during the operations phase by performing dredging activities to maintain the required depths. Dredging activities may lead to increase in TSS concentrations that will produce sediment accumulation in the surroundings of the disposal sites. Dredge material disposal will release sediments and spread it in the surroundings of the disposal sites. The sediment will immediately settle and cover the seabed which is the benthos habitat with a specific thickness.* *Disposals are implemented at 2 locations, namely the West Disposal Site with a depth of 50 meters and the East Disposal Site with a depth of 60 meters.*			
Impact Nature	**Negative**	**Positive**		

	Dredge material disposal activities will lead to disturbances of the benthos existence due to the formation of sediments at the disposal areas that cover the living/ habitat of benthos on the seabed. The disturbances are negative impacts on benthos.				
Impact Type	**Direct**	**Secondary**	**Indirect**	**Cumulative**	**Residual**
	The formation of sediment layers on the seabed is a direct impact of dredge material disposal activities. The disposed material will immediately spread and settle in the seabed that will disturb the existence of benthos.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Dredging during the construction of BOF will last for approximately 8 to 12 months and will be continued with dredging for the construction of the combo dock development for approximately 6 to 8 months. Dredge material disposals at the dredge material disposal sites will also be implemented during this period.				
	It is estimated that during the operations period of the Tangguh LNG Expansion activities maintenance dredging will be performed once in one year for approximately 3 months (or more, depending on the conditions in the field). During the dredging activities, dredge material will also be implemented for approximately 3 months. *Disturbances on benthos in the dredge material disposal areas will take place during the dredging activities. During the dredging activities, dredge material disposals will also be implemented.* *As the impact is of an intermittent and repetitive nature and occurs for a long term during the operations phase (±25 years since the operations phase starts) at the same location , the impact duration is categorized as 'long term'.*				
Impact Extent	**Local**	**Regional**	**Global**		
	Based on modeling results of TSS spread in the surroundings of the dredge material disposal areas, there will be spreads of increased TSS concentrations in a distance of maximum 1.0 km from the disposal sites which will then settle to become sediments. Therefore, the impact extent is 'local'.				
Impact Magnitude	**Negligible**	**Low**	**Medium**	**High**	
	Abundance of benthos found in every observation station in the Bintuni Bay is highly variable ranging from 0 to 735 ind/m2. At a number of sites, no benthos is found during the dry seasons. This condition differs with the wet seasons in which there is a lower abundance with a smaller value range, namely 8 to 260 ind/m2. *In general, dominating species originate from the Polychaeta dan Crustacea classes. Polychaeta is a group of sea worms measuring 5-10 cm with a diameter of 2-10 mm. A number of Polychaeta species settle in the bottom waters. Crustacea occupy waters with various types of coasts, such as sandy, rocky and muddy coasts.* *The amount of disposed dredge material is estimated at 2,000 m^3 in 1 day. The amount is divided into 2 disposal activities by barges with the capacity of 1,000 m^3. Release of dredge material is disposed in 10 minutes at disposal sites with a depth of 3 meters.* *Based on modeling results in the impact spread areas the followings are estimated:* – *During dry seasons the maximum sedimentation rate is 218 mg/cm^2-day with a maximum sediment layer thickness of 36.2 mm.* – *During wet seasons the maximum sedimentation rate is 277 mg/cm^2-day with a maximum sediment layer thickness of 28.2 mm.* *During the actual disposals, it is very likely that the disposal points will slightly differ and are not exactly the same. Accordingly, the sediment formation process is relatively small due to spreads.* *Dominant benthos species in dredging sites is the Polichaeta with an abundance of 20 ind/m^2. With a locally spread of impact this benthos species is a species that are resistant to sedimentation and with a relatively small sediment thickness, however as it occurs for a long term, the impact magnitude is categorized as 'medium'.*				
Receptor Sensitivity	**Low**	**Medium**	**High**		
	As the affected benthos species are species resistant to the formation of sediments, the receptor sensitivity is categorized as 'low'.				

Impact Severity	**Slight**	**Low**	**Medium**	**High**	**Very High**
	With a 'medium' impact magnitude and 'low' receptor sensitivity, the impact severity is categorized as 'low'.				
Impact Likelihood	**Very Low**	**Low**	**Medium**	**High**	
	Generation of sediment will certainly occur during every disposal activity. Accordingly the impact likelihood is categorized as 'high'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	With a 'low' impact severity and 'high' impact likelihood, the impact significance is categorized as 'minor' and is classified as an insignificant impact.				

3.4.3 Social – Economic – Cultural

3.4.3.1 Fishery Activities Disturbance

a. Environmental Baseline

Construction Phase

Villages adjacent to the construction of a marine facilities are Saengga and Tanah Merah. Prior to Tangguh LNG acitivities in Tanah Merah, livelihood pattern of community is as fishermen and farmers. However, since the Tangguh LNG activities in Tanah Merah to the present time, many people work in Tangguh LNG and its contractors, as well as in the service sector supporting food needs of Tangguh LNG. Nevertheless, there are still 40% people work as fishermen. A part of them is a shrimp fishermen using a trammel net. Fishermen in Tanah Merah and Saengga Villages using fishing gear and shrimp nets. Fishing gear is used to catch snapper. Snapper fishing carried out in northern part of (*buoy*) of LNG, while the fishing ground of fishermen is around the coast to a depth of 10 meters.

Shrimp fishing activities in Bintuni Bay (including Saengga and Tanah Merah waters) is only done during the day and pay attention to the tide of time. The optimal time to operate the fishing net is when the "neap tides" (lowest ebb lasts for quite long time). Shrimp fishermen are generally fishing in 10 to 15 days within a month. The average production of a fisherman is about 5-10 kg / day (IPB Team, 2013). Shrimp peak season in south of Bintuni Bay (including Saengga and Tanah Merah) occurred in January-April.

In addition, people have high dependency on sea area such as for fishing activities. Sea transportation accessibility of Saengga and Tanah Merah Community consisting of:

(a) Mobility of fishermen who departed from housing to the lodges (base camp) which is a temporary shelter (overnight) close to the fishing grounds until a few days such as in Tanjung Asap. It is considered that the fishermen will take more time and spent if they depart from Tanah Merah or Saengga through the river / Saengga estuary.

(b) The mobility of people is going to another area (such as Babo and Kokas) to purchase various types of needs. A trip to Babo District takes 2.5 - 3 hours by 15 HP engine Johnson longboat, while Kokas requires 5-6 hours by longboat 15 HP engine Johnson longboat

(c) Commercial vessel (small capacity) carrying food and building material that enter into Tanah Merah and Saengga area through the estuary / river of Saengga is known as optional vessel (*kapal opsi*).

b. Impacts Prediction and Evaluation

<u>*Construction Phase – Impact Prediction*</u>

Construction activities will include marine facilities of *Combo Dock* enchancement and the construction of LNG Plant Condensate located within safety exclusion zone and Bulk Offloading Facilities (BOF), which currently lies outside the safety exclusion zone. There are major activities such as dredging in the area of construction, jetty construction activities and sea transportation for moving materials. These activities will be in direct contact with Tanah Merah and Saengga fishermen. Saengga estuary is one of the fishing grounds.

The development of marine facilities in sea (inshore) for 1-4 years will also include the implementation of safety exclusion zone. The existence of safety exclusion zone caused fishermen to lose their fishing ground. Morover, community boat / ship will gradually move to the center in order to avoid the restricted zone. Furthermore, these conditions are predicted impact on the decline in fishing income. In addition, there is a possibility of mobility of workers and equipment through vessel traffic, which potentially crash into fishing nets installed in the waters. As it is known that the operation of shrimp net is static (not drawn), but the net movement will follow the pattern of sea flow. Therefore, it is potentially being hit by vessel that is used for mobilizing workers, equipments and materials. By considering these, the impact is significant and classified as as 'major'.

<u>*Construction Phase – Impact Evaluation*</u>

To determine or asses whether the construction of marine facilities is predicted to impact on fishery activity disturbance can be seen in **Table III-168** of Impact Evaluation:

Table III-180 Impact Evaluation – Construction Activities against Fishery Activity Disturbance

Impact	*Construction activities of Marine facilities are predicted to have an impact in the form of disturbance on fishing ground of local fishermen as a result of BOF construction activities and channel dredging*				
Nature of Impact	**Negative**	**Positive**			
	The construction activities of marine facilities of Tangguh LNG are predicted to result impact on fishing activities derived from Tanah Merah and Saengga. For security purpose, a safety exclusion zone will be apllied in surrounding construction area of BOF, Combo Dock, and LNG 2 jetty as well as along the supporting vessel movement for construction activities of marine facilities of Tangguh LNG. By the presence of safety exclusion zone, the fishing ground of local fishermen in Tanah Merah and Saengga will be limited.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	A safety exclusion zone for local community as the result of construction activities of marine facilities is a 'direct impact; for fishermen derived from Tanah Merah and Saengga villages.				
Impact	**Temporary**	**Short Term**	**Long Term**	**Permanent**	

<table>
<tr><td>Duration</td><td colspan="5">Sea transportation activities to support the construction activities of marine facilities of Tangguh LNG is predicted to run for 1-4 years. Therefore, the impact is categorized as 'short term' impact because the disturbance experienced by local community only last less than a year (not more than 5 years).</td></tr>
<tr><td rowspan="2">Impact Extent</td><td>Local</td><td>Regional</td><td>Global</td><td colspan="2"></td></tr>
<tr><td colspan="5">Scope of the impact extent of sea transportation to support the construction activities of marine facilities of Tangguh LNG is categorized as 'local' impact. This is due to the construction activities of marine facilities is predicted to take place in the safety exclusion zone and surrounding Saengga estuary. Sea transportation activities to support mobilization of workforce, equipment, and material required during the construction phase of marine facilities of Tangguh LNG specifically, is predicted to pass through the waters. Thus, it will not disturb fishing ground of traditional fishermen within a maximum of three miles of shoreline.</td></tr>
<tr><td rowspan="2">Impact Magnitude</td><td>Negligible</td><td>Small</td><td>Medium</td><td>Large</td><td></td></tr>
<tr><td colspan="5">Teluk Bintuni in Figure 2012, indicated that 34,51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors.

The impact magnitude from sea transportation activities to support mobilization of workforce, equipments and material is classfieid as 'medium' by the presence of 'local' impact extent in Saengga estuary. Moreover, the activities will only last for short term (1-4 years).</td></tr>
<tr><td rowspan="2">Impact Receptor Sensitivity</td><td>Low</td><td>Medium</td><td>High</td><td></td><td></td></tr>
<tr><td colspan="5">The construction and sea transportation activities during the construction phase of marine facilities activities of Tangguh LNG will have an impact on the local fishing community, especially from Tanah Merah and Saengga villages. This activity will cause the sea water turbidity and possibility of reducing fishing ground of fishermen that can lead to reduce their income. On the other hand, based on the population census and surveys conducted by PSKK UGM in 2011 showed that even though the community has been able to meet their dalily needs, people cannot leave their daily income to save. In addition, there are still many local people from Saengga Village have livelihood as fishermen, so the disturbance on local fishing ground predicted to have an impact on the loss of their primary daily income. Therefore, the sensitivity of impact is identified as 'high' for the receptor (fishing community).</td></tr>
<tr><td rowspan="2">Impact Severity</td><td>Very Low</td><td>Low</td><td>Medium</td><td>High</td><td>Very High</td></tr>
<tr><td colspan="5">Sea transportation during construction phase of marine facilities activities of Tangguh LNG will give impact on local fishermen, particularly in Tanah Merah and Saengga villages who strongly depend on fisheries sector surrounding Saengga estuary. Thus, this activity has 'high' severity.</td></tr>
<tr><td>Impact Likelihood</td><td>Very Small</td><td>Small</td><td>Medium</td><td>High</td><td></td></tr>
</table>

	The impact likelihood of fishery activity disturbance is likely to occur because of safety exclusive zone, which covers fishing ground of fishermen as well as the impact of dredging activities in the construction of BOF, Combo Dock and jetty of LNG 2 (combined LNG jetty - Condensate).				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact of a 'major', as is predicted fishery activity disturbance around the Saengga estuary, which will have an impact on household income of fishermen from Tanah Merah and Saengga and takes place in the short term. Thus, the impact is critical ('major') and must be managed.				

Operation Phase – Impact Prediction

Marine facilities activities in operation phase is a sea transportation activities for Tangguh LNG operation purposes as well as the application of safety exclusion zone will directly in contact with fishermen in Tanah Merah and Saengga who carried out fishing activities, particularly in the waters around the estuary of Saengga. This condition is expected to create fishery activity disturbance. As a result, fishermen should depart from housings to the lodges (base camp) as well as community travel to Babo by longboat.

In a period of ± 25 years is predicted to be an increase in the ownership of sea transportation along with the development of governance, infrastructure, and socio-economic in Saengga and Tanah Merah. This is expected to increase the mobility of public transport by sea. Marine facilities activities in operation phase, particularly the presence of safety exclusion zone and sea transportation activities for LNG transport (with an adequate high intensity) are predicted to affect the mobility of community fishing activities. Vessel traffic for marine facilities purposes in order to support Tangguh LNG operation will occur with high intensity, depending on the vessel traffic activities required. For LNG transport, vessel traffic will be carried out for 4 times a week; condensate transport is predicted twice in a month, while for transporting material for the purposes of operation facilities maintenance, and workforce carried out by a lower intensity in accordance with the needs of the Tangguh LNG.

It is predicted that fishing community who has fishing ground in the area of marine facilities operation of Tangguh LNG will be disrupted within ± 25 years. The impact of fishery activity disturbance of local community because of operation activity will affect the socio-economic communities. By these considerations, the impact is classified as significant or 'major' and needs to be managed.

Operation Phase – Impact Evaluation

To determine or asses whether the construction of marine facilities is predicted to impact on on fishery activity disturbance can be seen in the following table:

Table III-181 Impact Evaluation – Operation Activities against Fishery Activity Disturbance

Impact	*The marine facilities activities in operation phase of Tangguh LNG is predicted to cause disturbance on fishing ground as a result of sea transportation activities for purpose of Tangguh LNG operation.*			
Nature of	**Negative**	**Positive**		

Impact	*The impact is classified as 'negative because there is vessels movement to support mobilization of workforce, equipments and materials as well as sea transportation used for LNG and codensate transport. This activity is predicted to restrict the community fishing ground. The impact results the decline in community income either in the context of subsistence economic or commercial.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The vessel movement to support mobilization of workforce, equipments and materials as well as sea transportation used for LNG and codensate transport directly results a restriction zone for community's fishing ground.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The vessel movement for marine facilties purpose will occur simultaneously moreless 25 years since the operation phase begun. Since the impact of fishery activity disturbance occurs more than 5 years period, the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	LNG and codensate transport activities through sea passing by the bay in certain of depth and far away from fishing ground of traditional fishermen in the villages. Howeverm the operation activity of BOF will permanently take control the fishing ground of Tanah Merah and Saengga villages.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Teluk Bintuni in Figure 2012, indicated that 34,51% of Teluk Bintuni Regency worked in the agriculture, fisheries and hunting sectors. *Although the shipping line that has been set is located in the middle of the sea and far away from fishing ground of traditional fishermen maximum of 3 miles of shoreline, the activity quite intensively occurs. Vessel movement for the purposes of marine facilities in order to support the Tangguh LNG operation activities will occur with high intensity, depending on the required vessel movement activities. For LNG transport, vessel movement will be carried out for 4 times a week; condensate transport is predicted to be over 2 times in a month, while for mobilizing materials is for the purposes of operation facilities maintenance, and workforce mobilization at a lower intensity in accordance with Tangguh LNG requirement. Thus, the impact magnitude caused restriction zone of fishing ground and sea transportation accessiblity is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Most of the population depend on traditional fishing sector to meet theiir daily needs.				
	Fishing ground of local fishermen within a maximum of 3 miles of shoreline and area in the east of Saengga estuary as fishing ground of community in the past will be converted into the BOF operation area. The fishing ground is in adjacent and coincided with safety exclusion zone. *According to these conditions, the impact of fishery activity disturbance is classified as 'high'.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The lack of community capacity in getting alternative livelihood makes vulnerability to condition if there is a pressure to vessel movement of Tangguh LNG. This impact is predicted to occur in the long term, (± 25 years since the operation phase begun). Therefore, this impact has severity which is 'very high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of fishery activities disturbance is possibly to occur because the instensity of the activity is quite high. Thus, the impact likelihood is classified as 'high'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*The community has high dependency to sea territory to meet daily needs. On the other hand, vessel movement to support Tangguh LNG operation directly is predicted to fishery activity disturbance in the long term period of time (± 25 years). This impact has high impact likelihood. Thus, the impact is significant ('major') and needs to be managed.*

3.4.3.2 Decline in Fishermen's Income

a. Environmental Baseline

Villages adjacent to the construction of a marine facilities are Saengga and Tanah Merah. Prior to Tangguh LNG acitivities in Tanah Merah, livelihood pattern of community is as fishermen and farmers. However, since the Tangguh LNG activities in Tanah Merah to the present time, many people work in Tangguh LNG and its contractors, as well as in the trade sectors. Nevertheless, there are still 5% people work as fishermen. A part of them is a shrimp fishermen using a trammel net.

Shrimp fishing activities in Bintuni Bay (including Saengga and Tanah Merah waters) is only done during the day and pay attention to the tide of time. The optimal time to operate the net is when the "neap tides" (lowest ebb lasts for quite long time). Shrimp fishermen are generally fishing in 10 to 15 days within a month. The average production of a fisherman is about 5-10 kg / day (IPB Team, 2013). Shrimp peak season in south of Bintuni Bay (including Saengga and Tanah Merah) occurred in January-April.

Based on the study of PSKK UGM team (2009), in 2009, the population of Tanah Merah who has main livelihood in fishery is around 13.8%, while as a side job is amounted to 34.0%. The population of Saengga who has main livelihood in fisheries around 22,2% and work as a side job in the fishery of 37.5%. From this, it can be explained that the fishery is a source of community income, although there is a tendency to decrease and shift to other sectors. Based on the study of PSKK UGM team (2009), people's income from fisheries sector in Saengga Village is at Rp1.812.333,00 while in Tanah Merah Village is at Rp 1,004,417.00.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Construction activities of marine facilities will include Combo Dock enhancement and the construction of LNG Plant Condensate located within safety exclusion zone and Bulk Offloading Facilities (BOF), which currently lies outside the safety exclusion zone. There are major activities such as dredging in the area of construction, jetty construction activities and sea transportation for moving materials. These activities will be in direct contact with Tanah Merah and Saengga fishermen. Saengga estuary is one of the fishing grounds.

The decline in fishermen's income impact of gas transmission activities in construction phase is a derivate impact of fishery activity disturbance. The average fishermen production of each fisherman is around 5-10 kg/day (IPB team, 2013). Based on the data, income of shrimp nets' fishermen is predicted to Rp 45.000,00/kg. Moreover, income of shrimp nets' fishermen (before deducting operating costs) is between Rp 225,000.00 to Rp 450.000,00 per trip. Assuming that despite the fishermen affected, and then it has important implications because it will eliminate the rights to earn revenue. In the stage of construction activities for 1-4 years there is a potential loss of income of fishermen who catch shrimp and fish. Therefore, its impact is significant or classified as 'major'.

Construction Phase – Impact Evaluation

To determine or assess whether construction activities of marine facilities influence fishermen income can be seen in the Impact Evaluation **Table III-139** below:

Table III-182 Impact Evaluation – Construction Activities against Decline in Income of Fishermen

Impact	*The existence of safety exclusion zone and high frequency of vessel movement in construction phase of marine facilities is predicted to have an impact in the form of a decline in income of fishermen. It is a derivative of impact on fishery activity disturbance surrounding fishing ground of fishermen from Tanah Merah and Saengga.*				
Nature of Impact	**Negative**	**Positive**			
	The marine facilitities of Tangguh LNG in construction phase is predicted to result impact on decline in income of fishermen. It is a derivative impact from fishery activity disturbance on local fishermen derived from Tanah Merah and Saengga. For security purpose, a safety exclusion zone will be apllied in surrounding construction area of BOF, Combo Dock, and LNG 2 jetty as well as along the supporting vessel movement for construction activities of marine facilities of Tangguh LNG. By the presence of safety exclusion zone, the fishing ground of local fishermen in Tanah Merah and Saengga will be limited.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The safety exclusion zone for community as a result of marine facilitities of Tangguh LNG in construction phase that cause fishing activity disturbance for local community. Thus, the impact is 'derivative impact' for fishermen derived from Tanah Merah and Saengga.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The existence of safety exclusion zone and high frequency of vessel movement to support marine facilities in construction phase is predicted to occur during 1-4 years. Thus, the impact duration is categorized as short term because the derivative impact of decline in fishermen income derived from local community and lasted for a year; and not mre than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	Scope of the impact extent of sea transportation to support the construction activities of marine facilities of Tangguh LNG is categorized as 'local' impact. This is due to the construction activities of marine facilities is predicted to take place in the safety exclusion zone and surrounding Saengga estuary. Sea transportation activities to support mobilization of workforce, equipments, and materials required during the construction phase of marine facilities of Tangguh LNG specifically, is predicted to pass through the waters. Thus, it will not disturb fishing ground of traditional fishermen within a maximum of three miles of shoreline.				
Impact	**Negligible**	**Small**	**Medium**	**Large**	

Magnitude	*Bintuni in Figures in 2012 showed as much as 34.51% Bintuni Bay community working on agriculture, fishing, and hunting. Based on the survey results of PSKK UGM (2009), there was an increase in income of people in the fishing industry in 2009 to 2011. Community of North DAVs (Tomu, Ekam, Rejosari, Taroy, Weriagar, and Mogotira) gains income of Rp 1,716 .697, -00 and community revenue in South DAVs (Tanah Merah, Saengga, Onar Lama, Onar Baru, and Otoweri) gains income of Rp 1,521,930.00. While in 2011, community income in North DAVs is Rp 3.013.509,00 and in South DAVs by Rp2.450.002,00.* *The impact magnitude of sea transportation activity to support mobilization of workforce, equipments, and materials is classified as 'medium' by 'local' impact extent surrounding Saengga estuary everyday.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The construction and sea transportation activities during the construction phase of marine facilities activities of Tangguh LNG will have an impact on the local fishing community, especially from Tanah Merah and Saengga villages. This activity will cause the sea water turbidity and possibility of reducing fishing ground of fishermen that can lead to reduce their income. On the other hand, based on the population census and surveys conducted by PSKK UGM in 2011 showed that even though the community has been able to meet their dalily needs, people cannot leave their daily income to save. In addition, there are still many local people from Saengga Village have livelihood as fishermen, so the disturbance on local fishing ground predicted to have an impact on the loss of their primary daily income. Therefore, the sensitivity of impact is identified as 'high' for the receptor (fishing community).				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The safety exclusion zone for community as a result of marine facilitities of Tangguh LNG in construction phase will cause impact on local fishermen, particularly from Tanah Merah and Saengga community, who depend on Saengga estuary as their fishing ground. Thus, this activity is at 'high' impact severity.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of fishery activity disturbance is possibly to occur because of safety exclusion zone and sea transportation including fishin ground as well as impact of dredging on BOF development, Cmbo Dock and LNG 2 jetty.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact significance is classified as 'major' because there will be a fishery activity disturbance surrounding Saengga estuary that will impact on decline in level of income of fishermen household derived from Tanah Merah and Saengga. This will last for short term period of time. Thus, the impact is classified as ('major') and needs to be managed.				

Operation Phase – Impact Prediction

Construction activities of marine facilities including safety exclusion zone and Bulk Offloading Facilities (BOF) are currently outside the safety exclusion zone. These activities will be in direct contact with Tanah Merah and Saengga fishermen particularly in Saengga estuary. Saengga estuary is one of potential shrimp resources.

The decline in fishermen's income impact of gas transmission activities in construction phase is a derivate impact of fishery activity disturbance. The average fishermen production of each fisherman is around 5-10 kg/day (IPB team, 2013). Based on the data, income of shrimp nets' fishermen is predicted to Rp 45,000,00/kg. Moreover, income of shrimp nets' fishermen (before deducting operating costs) is between Rp 225,000,00 to

Rp 450,000,00 per trip. Since the presence of Tangguh LNG activities in Tanah Merah until present (about 10 years), many people shift their livelihood from fishery to be employee in Tangguh LNG and its contractors, or trade sectors supporting Tangguh LNG activities.

In a similar trend, it is predicted within ± 25 years many fishing families (especially children) will shift their work to the fisheries sector. However, there are still a small number of affected fishermen, especially fishermen who catch fish as a side job and obviously give a negative impact. Regarding some of these considerations can be said that the impact of the operation activities are significant or classified as 'major', so it needs to be managed.

Operation Phase – Impact Evaluation

To determine or assess whether the operation activities of marine facilities particularly affect to the decline in fishermen income, can be seen in the following **Table III-171** Impact Evaluation:

Table III-183 Impact Evaluation – Operation Activities against Fishermen's Income

Impact	*The existence of safety exclusion zone and high frequency of vessel movement in construction phase of marine facilities is predicted to have an impact in the form of a decline in income of fishermen. It is a derivative of impact on fishery activity disturbance surrounding fishing ground of fishermen from Tanah Merah and Saengga.*				
Nature of Impact	**Negative**	**Positive**			
	The safety exclusion zone and vessels movement to support mobilization of workforce, equipments, and materials as well as sea transportation used for LNG and codensate transport is predicted to restrict the community fishing ground. The impact results the decline in community income either in the context of subsistence economic or commercial.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The safety exclusion zone and vessels movement to support mobilization of workforce, equipments, and materials as well as sea transportation used for LNG and codensate transport is predicted to restrict the community fishing ground. Thus, it is predicted to decrease income of local fishermen.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Vessel movement for marine facilities purpose will simultaneously occur moreless 25 years since the operation phase begun. Since the decline in level of income experienced by fishermen derived from local community during more than 5 years, the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	LNG and codensate transport activities through sea passing by the bay in certain of depth and far away from fishing ground of traditional fishermen in the villages. However, the operation activity of BOF will permanently take control the fishing ground of Tanah Merah and Saengga villages. Thus, the impact extent is classified as 'local'.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Bintuni in Figure in 2012 showed as much as 34.51% Bintuni Bay community working on agriculture, fishing, and hunting. Based on the survey results of PSKK UGM (2009), there was an increase in income of people in the fishing industry in 2009 to 2011. Community of North DAVs (Tomu, Ekam, Rejosari, Taroy, Weriagar, and Mogotira) gains income of Rp 1,716 .697, -00 and community revenue in South DAVs (Tanah Merah, Saengga, Onar Lama, Onar Baru, and Otoweri) gains income of Rp 1,521,930.00. While in 2011, community income in North DAVs is Rp 3.013.509,00 and in South DAVs by Rp2.450.002,00. *Although the shipping line that has been set is located in the middle of the sea and far away from fishing ground of traditional fishermen maximum of 3 miles of shoreline, the activity quite intensively occurs. Vessel movement for the purposes of marine facilities in order to support the Tangguh LNG operation activities will occur with high intensity, depending on the required vessel movement activities. For LNG transport, vessel movement will be carried out for 4 times a week; condensate transport is predicted to be over 2 times in a month, while for the purpose of mobilizing material is for the purposes of operation facilities maintenance, and workforce mobilization at a lower intensity in accordance with Tangguh LNG requirement. Thus, the impact magnitude caused restriction zone of fishing ground and sea transportation accessiblity is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Fishing ground of local fishermen within a maximum of 3 miles of shoreline and area in the east of Saengga estuary as fishing ground of community in the past will be converted into the BOF operation area. The fishing ground is in adjacent and coincided with safety exclusion zone. By considering these situations, the impact of fishery activity disturbance is classified as 'high'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The lack of community capacity in getting alternative livelihood makes vulnerability to condition if there is a pressure to vessel movement of Tangguh LNG. This impact is predicted to occur in the long term, (± 25 years since the operation phase begun). Therefore, this impact has severity which is 'very high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of decline in fishermen income is a derivative impact of fishery activity disturbance which is possibly to occur. It is because the intensity of activity is quite high, so the impact likelihood of impact is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The community has high dependency to sea territory to meet daily needs. On the other hand, vessel movement to support Tangguh LNG operation directly is predicted to fishery activity disturbance in the long term period of time (± 25 years). This impact has high impact likelihood. Thus, the impact is significant ('major') and needs to be managed.				

3.4.3.3 Sea Transportation Accessibility Disturbance

a. Environmental Baseline

<u>*Construction Phase*</u>

In addition, Saengga and Tanah Merah villages are closely to marine facilities activities. The mobility of sea transportation accessibility of Saengga and Tanah Merah Community consisting of:

(a) Mobility of fishermen who departed from housing to the lodges (base camp) which is a temporary shelter (overnight) close to the fishing grounds until a few days such as in Tanjung Asap. It is considered that the fishermen will take more time and spent if they depart frpm Tanah Merah or Saengga through the river / estuary of Saengga.

(b) The mobility of people to go to another area (such as Babo and Kokas) to purchase various types of needs. A trip to Babo District takes 2.5 - 3 hours by 15 HP engine Johnson longboat, while Kokas requires 5-6 hours by longboat 15 HP engine Johnson longboat

(c) Commercial vessel (small capacity) carrying food and building material that enter into Tanah Merah and Saengga area through the estuary / river of Saengga is known as optional vessel (*kapal opsi*).

The sea transportation owned by household in Saengga and Tanah Merah consist of traditional boat/*sampan*, row boat/sail boat, *ketinting,* and longboat **(Table III-172).**

Table III-184 Number and Type of Sea Transportation owned by Household in Saengga and Tanah Merah

No	Means of Transportation	Tanah Merah	Saengga
1	Traditional boat/ *Sampan*	19	-
2	Row boat/Sail boat	25	28
3	*Ketinting*	53	80
4	*Motor tempel*/Longboat	3	-

Source : PSKK UGM 2009

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Sea transportation activity during marine facilities of Tangguh LNG in construction phase consists of mobilization of workforce, equipment and material. For the security purpose, a safety exclusion zone along will exist along the support vessel transport line for marine facitlities of Tangguh LNG in construction phase. The construction phase will occur during 1-4 years. The sea transportation is predicted to result impact on community transportation who use traditional transportation to go to economic center or other villages. The impact is predicted to occur due to the presence of safety exclusion zone. Thus, the community boat will avoid activity area and tend to move forward to avoid the zone. The impact is also predicted to raise impact on mobility traffic of people who use public transport to go to the economic centers or between villages. The impact is predicted because of the presence of safety exclusion zone, so that the boat / ship will evade their community activity area. The Impact has a high intensity due to occur on daily lives. In addition, the potential of community’s ship / boat crash will happen when there is no approriate management of sea transportation, such as a high speed of vessel passing the community’s ship / boat that likely to result inbalanced ('shaky') position of ship or drowning. Although based on quantity, there is no traffic frequency of community with ships and boats, the transport frequency is considerably high when the ocean conditions is 'calm' and in the religious day celebration (such as Idhul Fitri and Christmas).

With the establishment of a safety exclusion zone and the number of ships entering and leaving the construction location caused by sea transportation disturbance on the local communities if there is no sufficient transportation to support the local community activities other than sea transportation. Therefore, the nature of this impact is an important impact or classified as 'major' and needs to be managed.

Construction Phase – Impact Evaluation

To determine or assess whether the construction activities of marine facilities particularly affect to the sea transportation, can be seen in the following **Table III-173** Impact Evaluation:

Table III-185 Impact Evaluation – Construction Activities against Sea Transportation Accessibility Disturbance

Impact	*Sea transportation activity during marine facilities of Tangguh LNG in construction phase is predicted to result impact on local community activities. Sea transportation to support marine facilities activities in construction phase consists of mobilization of workforce, equipment and material. For the security purpose, a safety exclusion zone along will exist along the support vessel transport line for marine facitlities of Tangguh LNG in construction phase. By the application of safety exclusion zone, the sea traportation of local community and Indigenous People will be disrupted.*				
Nature of Impact	**Negative**	**Positive**			
	Sea transportation activity during marine facilities in construction phase is predicted to result impact for local community activities. For the security purpose, a safety exclusion zone along will exist along the support vessel transport line for marine facitlities of Tangguh LNG in construction phase. By the application of safety exclusion zone, the sea traportation of local community and Indigenous People will be disrupted. Thus, this situation will create 'negative' impacy for community.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Sea transportation activity to support marine facilities in construction phase is a 'direct impact' received by local community because of the restriction of sea transportation access for local community. This will disrupt the local community activities.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The existence of safety exclusion zone and high frequency of vessel movement to support marine facilities in construction phase is predicted to occur during 1-4 years. Thus, the impact duration is categorized as 'short term' because the impact of sea transportation accessibility wil be experienced by local community and lasted for a year; and not more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent of sea transportation to support marine facitlities in construction phase is categorized as 'local' impact because it still is involved in study area. It is caused by sea transportation will cause sea transportation accessibility for local community in Tanah Merah, Saengga Babo and Onar.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. While the visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and 'kapal opsi' (small tonnage merchant ship carried about 15 tons). *The impact magnitude of sea transportation to support marine facilities activities in construction phase consist of mobilization of workforce, equipment and material is 'medium'. The sea transportation of community is only local disturbance during short term period of time (about 1-4 years).*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Restriction of transportation for local community cause sea transportation become the only choice for community. Thus, this activity is identified to give 'high' sensitivity to impact receptor.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The absence of choice for local community to alternative access to sea transportation cause a 'high' severity of impact.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The sea transportation to support marine facilities activities in construction phase will occur during 1-4 years with high intensity. Thus, the impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The impact is classified as 'major' because it is predicted to cause fishery activity disturbance surrounding Saengga estuary. In addition, it is also predicted to disrupt sea transportation accessibility of community living in the north and south of Bintuni Bay. This can lead to the decline in fishermen income although only occurs in the short term period of time. Therefore, the impac is critical ('major') and needs to be managed.				

<u>*Operation Phase – Impact Prediction*</u>

Marine facilities activities in operation phase is a sea transportation activities for Tangguh LNG operation purposes as well as the application of safety exclusion zone will directly in contact with fishermen in Tanah Merah and Saengga who carried out fishing activities, particularly in the waters around the estuary of Saengga. This condition is expected to create fishery activity disturbance. As a result, fishermen should depart from housings to the lodges (base camp) as well as community travel to Babo by longboat.

In a period of ± 25 years is predicted to be an increase in the ownership of sea transportation along with the development of governance, infrastructure, and socio-economic in Saengga and Tanah Merah. This is expected to increase the mobility of public transport by sea. Marine facilities activities in operation phase, particularly the presence of safety exclusion zone and sea transportation activities for LNG transport (with an adequate high intensity) are predicted to affect the mobilization of fishing community. Vessel traffic for marine facilities purposes in order to support Tangguh LNG operation will occur with high intensity, depending on the vessel traffic activities required. For LNG transport, vessel traffic will be carried out for 4 times a week; condensate transport is predicted twice in a month, while for mobilizing material for the purposes of operation facilities maintenance and workforce carried out by a lower intensity in accordance with the needs of the Tangguh LNG.

It is predicted that fishing community activities whose fishing ground in the area of marine facilities operation of Tangguh LNG will be disrupted within ± 25 years. The impact of fishery activity disturbance of local community because of operation activity will affect the socio-economic communities. By these considerations, the impact is classified as significant or 'major' and needs to be managed.

Operation Phase – Impact Evaluation

To determine or assess whether the operation activities of marine facilities particularly affect to the sea transportation, can be seen in the following **Table III-174** Impact Evaluation:

Table III-186 Impact Evaluation – Operation Activity against Sea Transportation Accessiblity Disturbance

Impact	*The marine facilities in operation phase of Tangguh LNG are predicted to cause sea transportation accessibility disturbance as a result of sea transportation activities for the purpose of Tangguh LNG operation.*				
Nature of Impact	**Negative**	**Positive**			
	Vessel movement for the purposes of workforce, equipment and large material mobilization as well as sea transportation used for LNG and condensate transport are predicted to limit the sea transportation accessibility of communit. The impact can decrease fishermen income either in subsistence or commercial context. Thus, this impact is classified as 'negative'.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The vessel movement for purpose of workforce, equipment and material mobilization as well as sea transportation used for LNG and codensate transport directly results a restriction zone for community's fishing ground. It is predicted that local fishermen will be limited to reach their fishing ground due to the operation of marine facilities of Tangguh LNG and vessel movement.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Vessel movement for marine facilities purpose will simultaneously occur moreless 25 years since the operation phase begun. Since the fishery activity disturbance will be experienced by local community during more than 5 years, the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	LNG and codensate transport activities through sea passing by the bay in certain of depth and far away from fishing ground of traditional fishermen in the villages. However, the operation activity of BOF will permanently take control the fishing ground of Tanah Merah and Saengga villages. Thus, the impact extent is classified as 'local'.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	Based on the data from the Central Berau of Statistics of Teluk Bintuni Regency (2012), it showed that the total number of visits of various types of cruise ships in port of Bintuni Bay were repectively 564 and 787 ships in 2010 and 2011. While the visits of foreign ships were consecutively 73 and 106 ships in 2010 and 2011. There are four regular ships (pioneer) which serves from Sorong-Babo-Bintuni route or vice versa such as Getsmani, Fajar Mulia, Fajar Indah, and Kasuari II). In addition, there are commercial ships (goods) carried food supplies, building material, and vehicles. The ship has two types which are in large tonnage and 'kapal opsi' (small tonnage merchant ship carried about 15 tons). *Although the shipping line that has been set is located in the middle of the sea and far away from fishing ground of traditional fishermen maximum of 3 miles of shoreline, the activity quite intensively occurs. Vessel movement for the purposes of marine facilities in order to support the Tangguh LNG operation activities will occur with high intensity, depending on the required vessel movement activities. For LNG transport, vessel movement will be carried out for 4 times a week; condensate transport is predicted to be over 2 times in a month, while for the purpose of material mobilization is for the purposes of operation facilities maintenance, and workforce mobilization at a lower intensity in accordance with Tangguh LNG requirement. Thus, the impact magnitude caused restriction of fishing ground and sea transportation accessiblity is 'large'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	At present, most of community depend on sea transportation to mobilization. Community has not yet good quality of access and infrastructure of sea transportation. *By looking at this situation, the sensitivity on fishery activity and sea transportation accessibility disturbances is classified as 'high' for receptor.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	Minimum access to alternative sea transportation causes vulnerability to the situation if there is a pressure on vessel movement of Tangguh LNG. This impact is predicted to occur in the long term (± 25 years since the operation begun). Thus, the impact severity is classified as 'high'.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood of sea transportation accessibility of community is very possible to occur because the intensity of activity is quite high. Thus, the impact likelihood is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The community has high dependency to sea territory to meet daily needs and transportation. On the other hand, vessel movement to support Tangguh LNG operation directly is predicted to sea transportation accessibility disturbance in the long term period of time (± 25 years). This impact has high impact likelihood. Thus, the impact is significant ('major') and needs to be managed.				

3.4.3.4 Changes in Cultural Heritage

a. Environmental Baseline

<u>Construction Phase</u>

Villages adjacent to the construction of a marine facilities are Saengga and Tanah Merah villages. Around the Saengga estuary are 'Kumapa' sacred stone and ' Sacred House'. People living in Tanah Merah and Saengga villages still adhere to traditional practices and their belief in the sacred objects. There are properties associated with the sacred nature of life (including the unseen), but there are also associated with the sacred nature of the historical origins of the village.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

Impact on changes in cultural heritage is a derivative impact of changes in social norms and values of Indigenous People*. The construction of BOF, LNG 2 jetty and combo dock development is implemented next to the location of sacred stones of Kumapa, while the BOF construction is predicted to be implemented next to sacred house of Indigenous People*. Sacred stones of Kumapa and sacred house still have strong values in Indigenous People*, so the BOF construction is sensitive to Indigenous People* as well as having high severity of disturbance. Although the location is not exactly in Kumapa stone and sacred house, BOF construction and combo dock development activities are possibly to disturb presence of Kumapa stones and sacred house. Therefore, the impact likelihood of disturbance on cultural heritage is classified as 'medium'. By considering these matters, the construction of BOF, LNG 2 jetty and combo dock development is classified as significant impact in 'moderate' category and need to be managed.

Construction Phase – Impact Evaluation

To determine or assess whether the BOF construction, LNG 2 jetty , and combo dock development will affect to changes in cultural heritage, can be seen in the **Table III-175** Impact Evaluation as follows:

Table III-187 Impact Evaluation – BOF Construction, LNG 2 Jetty and Combo Jetty Development *(Combo Dock)* against Cultural Heritage

Impact	*The construction of BOF, LNG 2 jetty and combo dock development is predicted to cause changes in cultural heritage of community living surrounding the project area.*				
Nature of Impact	**Negative**	**Positive**			
	The construction of BOF, LNG 2 jetty and combo dock development will result negative impact on changes in cultural heritage. Sacred stone of Indigenous People called as Kumapa stone located at surrounding project area is possibly to be disrupted by combo jetty development; and a sacred house located in Tangguh LNG area is predicted to disrupt BOF construction activity.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	The construction of BOF, LNG 2 jetty and combo dock development will give 'direct impact' on the presence of Kumapa stone located at surrounding project area and a sacred house located in Tangguh LNG.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The construction of BOF, LNG 2 jetty and combo dock development is predicted to occur in around 1-4 years. In this period, disturbance of Kumapa stone and sacred house of Indigenous People also exist. Socially, the impact duration occur in 'short term' period of time.*				
Impact Extent	**Local**	**Regional**	**Global**		
	The construction of BOF, LNG 2 jetty and combo dock development is potentially to cause disturbance and damage on Kumapa stone located at surrounding project area and a sacred house located in Tangguh LNG.				

Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At present, Indigenous People still adhere traditional values strongly. The traditional values are applied in their behaviors, norms, values, various adat practices and sacred objects (such as Batu Kumapa and Sacred Houes inside LNG Plant area). Nevertheless, based on the elaboration of UGM data survey, there is an increase in total of population composition compare to Indigenous People*. In 2003, the Indigenous People* and migrants composition reach to 71% compared to 29%. The comparation increased significantly in 2012 at 59% Indigenous People*, compared to 41% migrants. It is predicted to potentially decrease the value of cultural heritage of Indigenous People*.* *The construction of BOF, LNG 2 jetty and combo dock development has 'medium' impact magnitude. These activities will be implemented everyday during construction (with high intensity). Nevertheless, the duration of construction of BOF, LNG 2 jetty and combo dock development only run for short term (moreless 1-4 years) in the coverage of impact extent is surrounding project area.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Community of Tanah Merah and Saengga still adhere traditional values and customs strongly on Kumapa stones in surrounding project area, and also sacred house inside Tangguh LNG area. Thus, the impact sensitivity is classified as 'high'.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	In construction phase, combo dock development is predicted to occur next to sacred stone of Indigenous People which is Kumapa stone; meanwhile, BOF construction is predicted to be implemented in the sacred house. Kumapa stone and sacred house still have critical value for Indigenous People*, s the BOF development is sensitive to Indigenous People*. Thus, this impact has 'high' impact severity.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	Although the location is not exactly in Kumapa stone and sacred house, BOF construction and combo dock development activities are possibly to disturb presence of Kumapa stones and sacred house. Therefore, the impact likelihood of disturbance on cultural heritage is classified as 'medium'.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The construction of BOF, LNG 2 jetty and combo dock development is predicted to disturb the presence of Kumapa stones and sacred house of Indigenous People who still have sacred values for Indigenous People*. On the other hand, the impact likelihood of disturbance of Kumapa stones and sacred house is classified as 'medium' because the combo dock development does not implemented exactly in Kumapa stones; and BOF construction does not implemented in sacred house location. Thus, the impact is classified as 'significant' or 'moderate', and needs to be managed.*				

3.4.3.5 Community Perception

a. Environmental Baseline

Construction Phase

Marine facilities development such as jetty development, which is functioned to facilitate additional needs of the Tangguh LNG Project Expansion, consists of: Combined LNG- Condensate Jetty (LNG Jetty 2), New BOF Facilities (Bulk Offloading Facility), and Dock Combo Development.

Meanwhile, for safety purposes, will be apply safety exclusion one of approximately 700 hectares around the port. Safety exclusion one is also be applied to the LNG ship with a distance of 500 m from all sides of the LNG ships and 150 m for the combo dock area designated as a safety exclusion one to other vessel movement by safety considerations.

Sea transportation during the construction phase will be needed to support mobilization of workforce, material, equipment, and working vessels. During the construction activities, the types of vessels used include supporting vessel, tug boat, material barge, piling hammer, crane barge, dreging vessel, dreging barge, and LCT. In the marine facilities in construction phase, community level will probably have the perception that the dredging and disposal of dredging material will cause disruption to their fishing activities.

Development BOF Facility (Bulk Offloading Facility) will come from the sheet piling, filled with granular material that can be sourced from land or from outside the location of the Tangguh LNG. The pile volume is not yet revealed at this stage because of the design of BOF facility is unfinished, but estimated that a minimum of 300,000 meters of material will be required for charging sheet. BOF facility construction will take up to about 12 months. This BOF facility will be required to begin LNG Plant construction and other supporting facilities: as a loading area for construction equipment such as bulldozers, excavators, loaders, backhoes and dump trucks; and for the loading and unloading area of construction materials and components of LNG Plant.

Development of combo dock in supporting the activities of marine facilities construction will utilize public land areas in which there is a sacred stone (stone Kumapa). In addition, BOF construction activities could harm and destroy the existence of sacred house of Indigenous People* located in the territory of the Tangguh LNG.

In addition, sea transportation and material loading activities as well as transportation of LNG and condensate during operation phase have the potential to have an impact in the form of sea transportation accessibility disturbance in the communities around the bay who use this bay as sea access for their transportation from one place to other places. Fishing communities, especially those in Tanah Merah and Saengga villages are reveived 'direct impact' of their economic activity as a fisherman.

b. Impacts Prediction and Evaluation

<u>Construction Phase – Impact Prediction</u>

Sea transportation activities to support mobilization of workforce, equipment, and materials; as well as dredging and disposal of dredging material has the potential to disrupt the fishing ground and close sea access to public transportation. This could potentially lead to a negative perception in the community.

To support the construction activity of Combo Dock development is expected to disrupt the sacred stones called as Kumapa stone located in west of Combo Dock. Another activity is the construction of BOF facilities (Bulk Offloading Facility) which is passing toward the sacred house and feared to disrupt the existence of sacred house of Indigenous People* located in the territory of the Tangguh LNG.

Construction Phase – Impact Evaluation

Table III-188 Impact Evaluation – Construction Activities of Marine Facilities against Community Perception

Impact	*Sea transportation and dredging activities are predicted to cause community perception related to fishery activity and sea transportation disturbances. Meanwhile, BOF and marine facilities cause community perception related to the existence of sacred stones and house of Indigenous People*.*				
Nature of Impact	**Negative**	**Positive**			
	Community has perception that the sea transportation to support mobilization of workforce, equipment and material; and dredging and disposal of dredging material will disrupt fishing ground and closing the sea transportation access. On the other side, community has perception about disturbance on sacred stones of Indigenous People which is Kumapa stones located at surrounding project area as a result from the marine facilities activities particularly to combo jetty development; and BOF construction which is predicted to disrupt and damage the existence of sacred house of Indigenous People located at Tangguh LNG area.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Community perception is resulted from 'derivative impact' on fishery activity and sea transportation accessibility disturbances as well as disturbance on Kumapa stones and sacred house.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	The marine facilities activities in construction phase is predicted to occur during 1-4 years. Since the impact of community perception will simultaneously occur in local community during more than 1 year, and not more than 5 years. Thus, the impact duration is classified as 'short term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The community perception related to fishery activity disturbance and sea transportation accessibility due to dredging activity; community perception related to disturbance on Kumapa stones surrounding Saengga estuary; and community perception related to disturbance on sacred house located inside Tangguh LNG in pilling activity is predicted to occur in the community living in the villaged surrounding Tangguh LNG operation area. Meanwhile, community perception related to sea transportation to support marine facilities is predicted to create sea transportation disturbance for community in Tanah Merah, Saengga, Onar and Babo. Thus, the impact extent is classified as 'local'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there are various perceptions growing in the community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Community perception related to fishery activity and sea transportation accessibility disturbances as well as disturbance on Kumapa stones and sacred house is arised accordance with phase of activity. Since the marine facilities activities in construction phase only occur in the shor term *around 1-4 years), the impact magnitude is classified as 'medium'.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	The community severity in marine facilities activities in construction phase is classified as 'high' because: *1. Community has high dependency on fishery activity to meet their household needs;* *2. Community has limited capacity to develop alternative economic such as agriculture and business;* *3. Community occupies sea as main means of transportation access to mobilization;* *4. Kumapa stones and sacred house of Indigenous People* still has sacred values in community.*				
Impact	**Very Low**	**Low**	**Medium**	**High**	**Very High**

Severity	*The impact severity is classified as 'high' because there is a dependency on fishing ground, alternative sea transportation accessibility, and high value of Kumapa stones and sacred house of Indigenous People*.*				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is classified as 'medium'. It is because fishery activity and sea transportation accessibility disturbances as well as disturbance on Kumapa stones and sacred house are possible to occur during construction phase.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The sea transportation to support mobilization of workforce, equipment and material, as well as dredging and disposal of dredging material is predicted to raise community perception related to water turbidity and sea transportation accessibility disturbance. Meanwhile, the construction of marine facilities (BOF, LNG 2 jetty and combo dock development) is predicted to cause community perception related disruption and destruction of Kumapa stones and sacred house located in the area of Tangguh LNG. Although the impact only occurs in the short term (1-4 years), these perceptions emerge in high intensity in community, so the impact is classified as significant ('major') and needs to be managed.				

Operation Phase – Impact Prediction

The dependence of local community of Bintuni Bay, especially Tanah Merah and Saengga villages, is still relatively high to the waters / sea as fish catchment area. In addition, the community also has dependency against water / sea as the main transportation access. The pressure of vessel movement by the Tangguh LNG actvities has an impact on the limited area of fishing ground and sea transportation for the community. This impact is predicted to occur in a relatively long period (± 25 years since the operation phase begun). Therefore, the presence of marine facilities causes a negative perception to community, namely fishery activity and sea transportation accessibility distrubances.

Operation Phase – Impact Evaluation

Fishermen from Tanah Merah and Saengga have a high dependence on waters for their fishery activity. On the other hand, vessel movement to support Tangguh LNG operation directly interferes with the fishing ground and sea transportation accessibility. These impacts could lead to the perception that people continue to appear, according to the duration of operation activities of Tangguh LNG. Therefore, the impact is 'significant' and 'need to be managed'.

Table III-189 Impact Evaluation – Operation Activities against the Emergence of Community Perception

Impact	*Marine facilities activities in operation phase will use sea transportation in a high intensity for the purposes of mobilization of workforce, equipment and materials, as well as for LNG and condensate transportation. Support vessel movement is expected to result fishery activity and sea transportation accessibility disturbance to the community. This triggers community perception of their fishery activitity and sea transportation accessibility.*			
Nature of	**Negative**	**Positive**		

Impact	*Community perception associated with fishery activitity and sea transportation accessibility caused by support vessel movement in the operation phase of Tangguh LNG activities result a 'negative' impact. It is because the community perception is based on their concerns to the limited fishery activity and sea transportation accessibility.*				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Community perception appears as 'derivative impact' of the impact of fishery activitity and sea transportation accessibility disturbances on the marine facilities of Tangguh LNG in operation phase.				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Support vessel movement will continue to occur for approximately 25 years since the operation phase begun. Over a period of more than 5 years (approximately 25 years), the community perception is expected to exist and continue to grow in the local community, so the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent of community perception is in local community living in villages surrounding area of Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Mediun**	**Large**	
	At this time, there are various perceptions growing in the community related to Tangguh LNG activities. In addition, the community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural continue to grow. *Community perception related to fishery activity and sea transportation accessibility disturbances will continue to appear during the operation phase of Tangguh LNG. The perception appears in the community surrounding area of Tangguh LNG operation site. The operation activities of Tangguh LNG will occur in long term priod of time. Thus, the impact is categorized at 'large' level.*				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Community perception related fishery activity and sea transportation accessibility disturbances has 'medium' sensitivity for impact recipientor, because most of population depend fulfillment of their daily needs in the traditional fishing sector. However, there will be an alternative economic development in the agricultural sector and local businesses for the community to reduce the dependency. At present, the area of fishing ground of communities in the south are at the coastal marine, adjacent to the safety exclusion zone.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The dependency of fishermen in Tanah Merah and Saengga villages on fishing ground and sea transportation accessibility is still high. In fact, they will get the pressure by support vessel movement in Tangguh LNG activities. As a result, this will result impact on fishery activity and sea transportation accessibility disturbances. This impact is predicted to occur in the long term period of time (± 25 years since the operation phase begun). Therefore, the impact of community perception related fishery activity and sea transportation accessibility disturbances has a relatively 'high' impact severity.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	Support vessel movement is a major supporter of the Tangguh LNG operations. As long as the vessel movement is needed to support the Tangguh LNG operations, the community perception related to the fishery activity and sea transportation accessibility disturbances would occur. Therefore, the impact likelihood of community perception is 'high'.				
Impact	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**

Significance	*Community has a high dependence on ocean terittory to meet their daily needs and to mobilize. On the other hand, support vessel movement for operations of Tangguh LNG directly interfere with fishing ground and sea transportation accessibility. The impact creates a community perception that will continue to occur in the long term (± 25 years since the operation phase begun), in accordance with the age of the Tangguh LNG operations phase. The community perception has a high impact likelihood. Thus, the impacts are signficant ('major') and should be managed.*

3.4.3.6 Social Tension

a. Environmental Baseline

Construction Phase

The existence of marine facilities, which include the construction phase, including the safety exclusion zone, will have an impact on the activities and accessibility of sea transportation of community. Accoding to safety consideration, the area around the port construction activities will be restricted from other sea transportation. This could limit the fishing area for local fishermen and affect their access to fishing grounds and to other villages. Fishing communities in the Bay generally is a traditional fisherman. The catch is comprised of fish, shrimp, and crabs, which are scattered along the coast of North and South of Bintuni Bay water. This shows that the dependence of local communities on water / sea is relatively high. In addition to the use of water / sea as the main source of livelihood, community also utilizes water / sea as the main transportation access.

During the operation phase of marine facilities, the frequency of sea transportation in the Bay will increase dramatically and will affect fisheries activitiy, sea transportation accessibility, mobilization of workforce, equipment and materials, as well as loading and transportation of LNG and condensate especially during operation phase. In addition, regarding community safety purpose, a safety exclusion zone will be applied on all sides of the LNG vessels and 150 m for the combo dock area. The safety exclusion zone is approximately 700 hectares around the port.

In relation to these facts, utilization of the sea / water from the other party will certainly have an impact on the activity of local communities in the utilization of waters / sea. In other words, the fishing area of the local community will be affected by the activities of other parties. Perceptions about the existence of marine facilities that if it is not managed properly can create a negative perception of the community and potentially lead to social tensions.

For the safety condition is thought to have the potential for causing fishery activity disturbance in the areas of traditional fishing grounds. This causes narrow / limited area of fishing ground of fishermen.

b. Impacts Prediction and Evaluation

Construction Phase – Impact Prediction

In the construction phase of marine facilities, sea transportation activities for mobilization of workforce, equipment, and materials as well as dredging and disposal of dredging material could potentially lead to social tensions as a result of negative perceptions derivative contained in the local community. Similarly, the construction of marine facilities (BOF, 2 LNG 2 jetty and combo dock development) could be expected to lead to social tensions associated with a negative perception of the community. Negative community perception is closely related to the presence of sacred stones (Kumapa) and sacred house of Indigenous People*.

Construction Phase – Impact Evaluation

The shaped perceptions do not necessarily turn into social tensions. The mechanism in community has existed, that when there is a complaint, they will deliver it in advance to community leaders who will then discuss it with Tangguh LNG.

Table III-190 Impact Evaluation – Construction Activities of Marine Facilities against Social Tension

Impact	*During the construction phase of marine facilities is predicted to result social tension impact which is a derivative impact of community perception.*				
Nature of Impact	**Negative**	**Positive**			
	*Social tension in community is resulted from community perception that the sea transportation activities for mobilization of workforce, equipment, and materials as well as dredging and disposal of dredging material could potentially disrupt the fishing area and sea transportation accessibility as well as disrupt the the presence of sacred stones (Kumapa) and sacred house of Indigenous People**				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tension in community is resulted from community perception related to fishery activity and sea transportation, sared stones (Kumapa) and sacred house of Indigenous People disturbances in all marine facilities activities in construction phase. Thus, this impact is classified as 'derivative impact'.*				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Marine facilities activities in construction phase is expected to run for about 1-4 years. Therefore, the impact duration is categorized as 'short-term' impact, because the impact of social tensions that exist in the local community will be experienced by local community for more than 1 year and not more than 5 years.				
Impact Extent	**Local**	**Regional**	**Global**		
	Social tension related to marine facilities activities in construction phase is predicted to occur in the villages close to the project area. Thus, the impact extent is classified as 'local'.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a variety of perception growing in the community related to Tangguh LNG activities. In addition, community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural *Despite the community perception about fishery activity and sea transportation, sared stones (Kumapa) and sacred house of Indigenous People* disturbances will appear every day but do not necessarily lead to social tensions. It is caused by grievance mechanism in the community who will deliver their complaints first to the community leaders or head of village then discuss with Tangguh LNG. Marine facilities activities in construction phase will take place in the short term (about 1-4 years). Therefore, the impact magnitude is 'moderate'.*				

Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Sensitivity to social tension occurred in marine facilities activities in construction phase is 'medium', because despite community perception appears every day, there is a grievance mechanism in the community who will deliver their complaints first to the community leaders or head of village then discuss with Tangguh LNG. Therefore, the perceptions do not necessarily increase social tension.				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The impact severity is classified as 'medium' because the intensity of fishery activity disturbance is quite high as well as capability of community to recover their loss of income.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is classified as 'small'. This is caused by community perceptions which is accumulated and do not necessarily lead to social tension.				
Impact Significance	**Negligible**	**Minor**	**Moderate**	**Major**	**Critical**
	The sea transportation to support mobilization of workforce, equipment and material, as well as dredging and disposal of dredging material is predicted to raise social tension related to community perception. Meanwhile, the construction of marine facilities (BOF, LNG 2 jetty and combo dock development) is predicted to cause social tension as a result of fishery activity and sea transportation, sared stones (Kumapa) and sacred house of Indigenous People disturbances. However, the impact is predicted to occur in short term priod of time (about 1-4 years) with small impact likelihood since there is a grievance mechanism in the community who will deliver their complaints first to the community leaders or head of village then discuss with Tangguh LNG. Therefore, the impact is classified as significant ('moderate') and should be managed.*				

<u>Operation Phase – Impact Prediction</u>

The dependence of local community of Bintuni Bay, especially Tanah Merah and Saengga villages, is still relatively high to the waters / sea as fish catchment area. In addition, the community also has dependency against water / sea as the main transportation access. The pressure of vessel movement by the Tangguh LNG actvities has an impact on the limited area of fishing ground and sea transportation for the community.

This impact is predicted to occur in a relatively long period of time (± 25 years since the operation phase begun). Therefore, the presence of marine facilities causes a negative perception to community, namely fishery activity and sea transportation accessibility distrubances. If the impact is not managed properly, the community perception can lead to social tension especially for community in area surrounding Tangguh LNG such as Tanah Merah and Saengga.

<u>Operation Phase – Impact Evaluation</u>

The shaped perceptions do not necessarily turn into social tensions. The mechanism in community has existed, that when there is a complaint, they will deliver it in advance to community leaders who will then discuss it with Tangguh LNG. Thus, the impact is classified as 'minor' but still need to be monitored.

Table III-191 Impact Evaluation – Operation Activities against Social Tension

Impact	*Marine facilities activities in operation phase will use Tangguh LNG as sea transportation in a high intensity for the purposes of mobilization of workforce, equipment and materials, as well as the use of sea transportation for LNG and condensate transportation. Support vessels movement is expected to give fishery activity and sea transportation accessibility disturbances of local community. Perceptions that arise as a result of these activities is predicted to cause social tension.*				
Nature of Impact	**Negative**	**Positive**			
	Social tensions related to community perception on fishery activity and sea transportation accessibility disturbances caused by support vessels movement in the operation phase of Tangguh LNG is classified as 'negative' impact.				
Type of Impact	**Direct Impact**	**Derivative Impact**	**Indirect Impact**	**Cumulative Impact**	**Residual Impact**
	Social tensions related to community perception on fishery activity and sea transportation accessibility disturbances in marine facilities activities in operation phase of Tangguh LNG				
Impact Duration	**Temporary**	**Short Term**	**Long Term**	**Permanent**	
	Vessel movement will continue to occur for approximately 25 years since the operation phase begun. During that time also the social tensions related community perception are likely to occur. Thus, the impact duration is classified as 'long term'.				
Impact Extent	**Local**	**Regional**	**Global**		
	The impact extent of social tension is significantly occur in local community living in the villages surrounding Tangguh LNG operation site.				
Impact Magnitude	**Negligible**	**Small**	**Medium**	**Large**	
	At this time, there is a variety of perception growing in the community related to Tangguh LNG activities. In addition, community expectations related to the role and contribution of Tangguh LNG in various aspects of social, economic, political, and cultural				
	Social tension related to community perception of fishery activity and sea transportation disturbances is predicted to occur in low intensity (less than once a month) during the operation phase of Tangguh LNG. At present, there is a grievance mechanism in the villages that will deliver their complaints first to the community leaders or head of village then discuss with Tangguh LNG. Therefore, the impact is categorized at the 'small' level.				
Impact Receptor Sensitivity	**Low**	**Medium**	**High**		
	Social tension related to community perception of fishery activity and sea transportation disturbances has 'medium' sensitivity because: 1. *However, there will be an alternative economic development in the agricultural sector and local businesses for the community to reduce the dependency. At present, the area of fishing ground of communities in the south are at the coastal marine, adjacent to the safety exclusion zone.* 2. *Most of community depend on sea transportation to support their mobilization. Community is still lack of good quality of infrastructure and sea transportation.*				
Impact Severity	**Very Low**	**Low**	**Medium**	**High**	**Very High**
	The dependency of fishermen in Tanah Merah and Saengga villages on fishing ground and sea transportation accessibility is still high. In fact, they will get the pressure by support vessel movement in Tangguh LNG activities. As a result, this will result impact on fishery activity and sea transportation accessibility disturbances. This impact is predicted to occur in the long term period of time (± 25 years since the operation phase begun). Therefore, the impact of community perception related fishery activity and sea transportation accessibility disturbances has a relatively 'high' impact severity.				
Impact Likelihood	**Very Small**	**Small**	**Medium**	**High**	
	The impact likelihood is classified as 'small'. This is caused by community perceptions, which is accumulated and do not necessarily, lead to social tension.				

Impact Significance	Negligible	Minor	Moderate	Major	Critical
	Community has a high dependence on ocean terittory to meet their daily needs and to mobilize between villages. On the other hand, support vessel movement for operations of Tangguh LNG directly interfere with fishing ground and sea transportation accessibility. The impact is predicted to create social tension. However, a grievance mechanism will exist in the villages that will deliver their complaints first to the community leaders or head of village then discuss with Tangguh LNG. Therefore, the perception does not necessarily raise social tension. Thus, the impact is classified as not significant or 'minor' but still should be managed.				