Summary Environmental Impact Assessment

Tangguh LNG Project in Indonesia

June 2005

CURRENCY EQUIVALENTS

(as of 1 April 2005)

Currency Unit	–	rupiah (Rp)
Rp1.00	=	$0.000105
$1.00	=	Rp9,488

ABBREVIATIONS

ADB	–	Asian Development Bank
AMDAL	–	analisis mengenai dampak lingkungan (environmental impact analysis system)
ANDAL	–	analisis dampak lingkungan (environmental impact analysis)
BOD	–	biochemical oxygen demand
CI	–	Conservation International
COD	–	chemical oxygen demand
DAV	–	directly affected village
DGS	–	diversified growth strategy
EPC	–	engineering, procurement, and construction
GDA	–	global development alliance
GHG	–	green house gas
HDD	–	horizontal directional drilling
JNCC	–	Joint Nature Conservation Committee
KJP	–	A consortium of Kellogg Brown and Root–JGC–Pertafinikki
LARAP	–	land acquisition and resettlement action plan (ADB terminology for equivalent document is involuntary resettlement plan)
LNG	–	liquefied natural gas
MARPOL Convention	–	International Convention for the Prevention of Pollution from Ships (1973)
MBAS	–	methylene blue active substances
MODU	–	mobile offshore drilling unit
MOE	–	Ministry of Environment
NGO		non government organization
PSC	–	production-sharing contract
RKL	–	rencana pengelolaan lingkungan (environmental management plan)
RPL	–	rencana pemantauan lingkungan (environmental monitoring plan)
SEIA	–	summary environmental impact assessment
TMRC	–	Tanah Merah resettlement committee
TNC	–	The Nature Conservancy
TSS	–	total suspended solid
UNDP	–	United Nations Development Programme
USAID	–	United State Agency for International Development
WCS	–	Wildlife Conservation Society
WWF	–	Worldwide Fund for Nature

WEIGHTS AND MEASURES

bbd	–	barrels per day
GJ	–	giga joule, one billion joules
ha	–	hectare
J	–	joules, measure of energy
kg/day	–	kilogram per day

kg/hr	–	kilogram per hour
km	–	kilometer
l	–	liter
m	–	meter
m^2	–	square meter
m^3	–	cubic meter
m^3/hr	–	cubic meter per hour
mg	–	milligram
mg/L	–	Milligram per liter
MJ/kg	–	mega joule per kilogram
ml	–	milliliter
mtpa	–	million tonnes per annum
NTU		nephelometric turbidity units
pH	–	measure of acidity/alkalinity
psi	–	pounds per square inch
psu		practical salinity units
tcf	–	trillion cubic feet
TJ	–	tera joule, one thousand billion joules

GLOSSARY

Ambient	–	Referring to existing or predominant conditions
Anthropogenic	–	Caused by humans
Aquifer	–	An underground layer of porous rock, sand, etc. containing water, into which wells can be sunk
Avifauna	–	Birds of a specified region or time
Ballast water	–	Water added to a vessel in order to maintain stability
Bathymetry	–	The science of measuring ocean depths in order to determine the sea floor topography
Benthic	–	That portion of the marine environment inhabited by marine organisms which live permanently in or on the bottom
Benthos	–	The forms of marine life that live on the ocean bottom
Biochemical oxygen demand (BOD)	–	The amount of dissolved oxygen needed to decompose the organic matter in wastewater
Biodiversity	–	Refers to the number of different species and the associated number of individuals living within a community
Chemical oxygen demand (COD)	–	The amount of dissolved oxygen needed to oxidize organic matter in wastewater, under acidic conditions
Coliform	–	An indicator organism, such as escherichia coli, which when present, indicates the likelihood that other, more harmful microorganisms are present
Condensate	–	Hydrocarbon which exists in a gaseous state under reservoir conditions but becomes liquid either by passage at the hole (well hole) or in surface equipment through heat and pressure processing
Desalinization	–	The process by which enough dissolved salts are removed from sea water to render it potable
Drilling mud	–	A preparation of water, clays, and chemicals circulated in oil-well drilling for lubricating and cooling the bit, flushing the rock cuttings to the surface, and plastering the side of the well to prevent cave-ins
Flaring	–	The burning-off of a gas
Flocculation	–	The aggregation into lumps, as when fine or colloidal clay particles in suspension in fresh water clump together upon

		contact with salt water and settle out of suspension; a common depositional process in estuaries
Gas condensate	–	A liquid obtained by condensation of a gas
Greenhouse gas	–	Any gas that contributes to the “greenhouse effect”, which is implicated in global warming
Grassroots	–	A complete facility erected on a virgin site
Habitat	–	The place inhabited by a plant or animal species
Hazardous waste	–	Any industrial by-product, especially from the manufacture of chemicals, which is destructive to the environment or dangerous to the health of people or animals
Horizontal directional drilling	–	A technique by which pipelines can be installed beneath an area, without the need for surface disturbance; used to install pipes under rivers, roads, and sensitive environmental areas
Jacket	–	The structural frame component of an offshore platform that provides lateral pile support
Jetty	–	A structure, such as a wharf or pier, so located as to influence current or protect the entrance to a harbor or river
Kabupaten	–	Regency
Kecamatan	–	District
Kelurahan	–	Subdistrict
Liquefaction	–	A change in the state of a substance to the liquid state by cooling or compression
Phytoplankton	–	Photosynthetic plankton
Pig	–	Typically a small device that is forcibly moved through a pipe in order to inspect it and/or to remove buildup resulting from biological growth or chemical processes
Pile	–	A major component of an offshore platform, a pile refers to the foundation members that provide vertical and lateral support
Plankton	–	Passively drifting or weakly swimming organisms in marine and fresh waters; members of this group range in size from microscopic plants to jellyfishes measuring up to 2 meters across the bell, and included the eggs and larval stages of the nekton and benthos
Processing train	–	A complete set of processing equipment arranged in a prescribed sequence
Reserves	–	The quantity of a recoverable gas, oil, or mineral calculated to exist between defined subsurface boundaries
Reservoir	–	A subsurface accumulation of natural gas or crude oil under suitable natural containment conditions
Salinity	–	The total amount of dissolved material (salt) in seawater
Savannah	–	Vegetation structure of broadly scattered trees, with under story of grass and low shrubs
Sedimentation	–	The process of breakup and separation of particles from the parent rock, their transportation, deposition, and consolidation into another rock
Trestle	–	A movable support or scaffolding usually having diagonally spreading legs
Work-over	–	To perform one or more of a variety of remedial operations on a producing oil well with the hope of restoring or increasing production. Examples of work-over operations are deepening, plugging back, pulling and resetting the liner, squeeze cementing, shooting, and acidizing
Zooplankton	–	The animal forms of plankton

NOTES

(i) In this report, "$" refers to US dollars.

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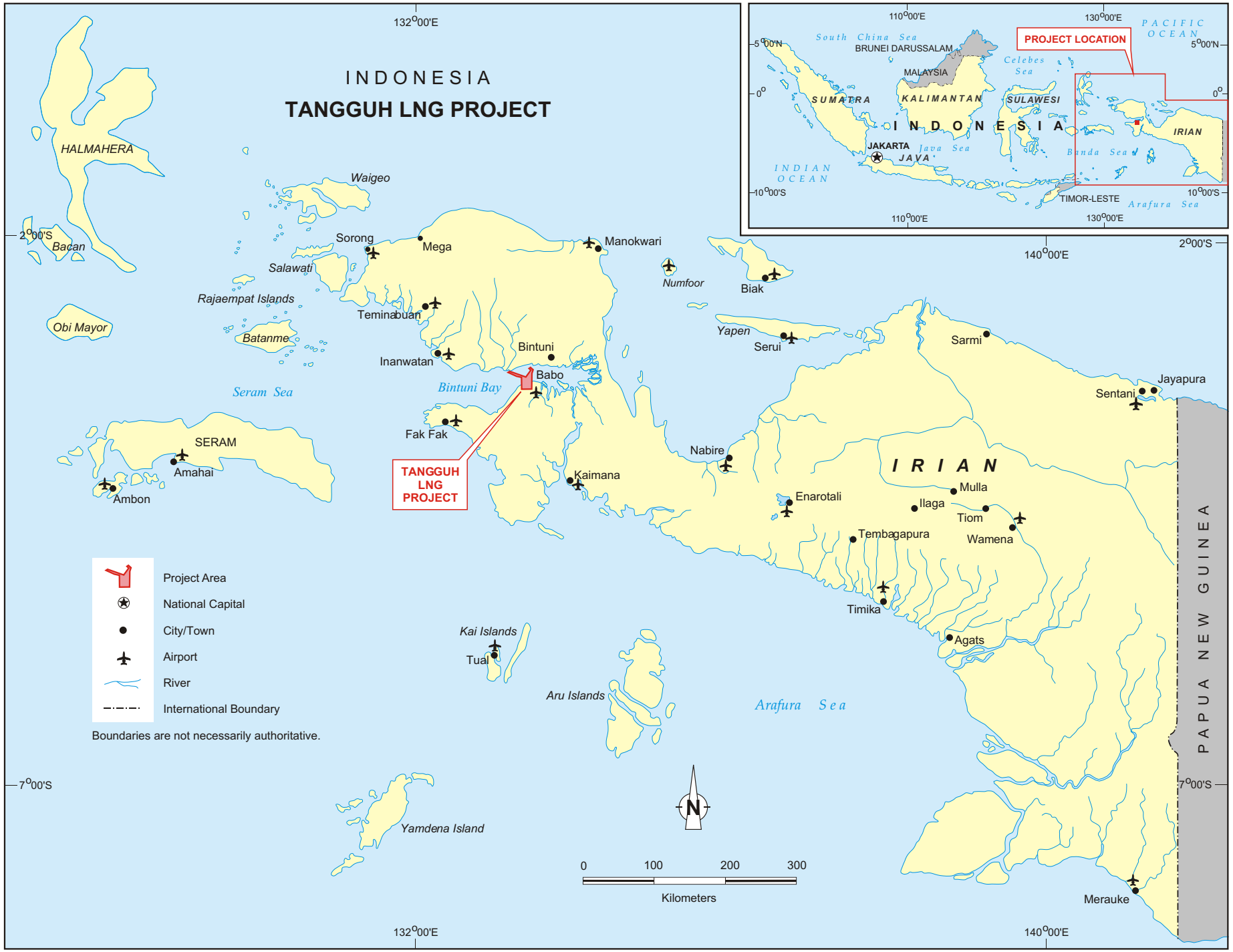
INDONESIA
TANGGUH LNG PROJECT
PROJECT LOCATION
HALMAHERA
Waigeo
Bacan
Sorong
Mega
Manokwari
Salawati
Numfoor
Biak
Rajaempat Islands
Teminabuan
Obi Mayor
Batanme
Yapen
Serui
Sarmi
Inanwatan
Bintuni
Babo
Jayapura
Seram Sea
Bintuni Bay
Sentani
Fak Fak
SERAM
Amahai
Nabire
IRIAN
TANGGUH LNG PROJECT
Kaimana
Ambon
Enarotali
Mulla
Ilaga
Tiom
Tembagapura
Wamena
Timika
Kai Islands
Tual
Agats
Aru Islands
Arafura Sea
PAPUA NEW GUINEA
Yamdena Island
Merauke
Project Area
National Capital
City/Town
Airport
River
International Boundary
Boundaries are not necessarily authoritative.
0 100 200 300
Kilometers
132°00'E
140°00'E
2°00'S
7°00'S
110°00'E
130°00'E
5°00'N
0°
10°00'S
South China Sea
BRUNEI DARUSSALAM
MALAYSIA
Celebes Sea
SUMATRA
KALIMANTAN
SULAWESI
I N D O N E S I A
IRIAN
JAKARTA
JAVA
Java Sea
Banda Sea
INDIAN OCEAN
TIMOR-LESTE
Arafura Sea
PACIFIC OCEAN

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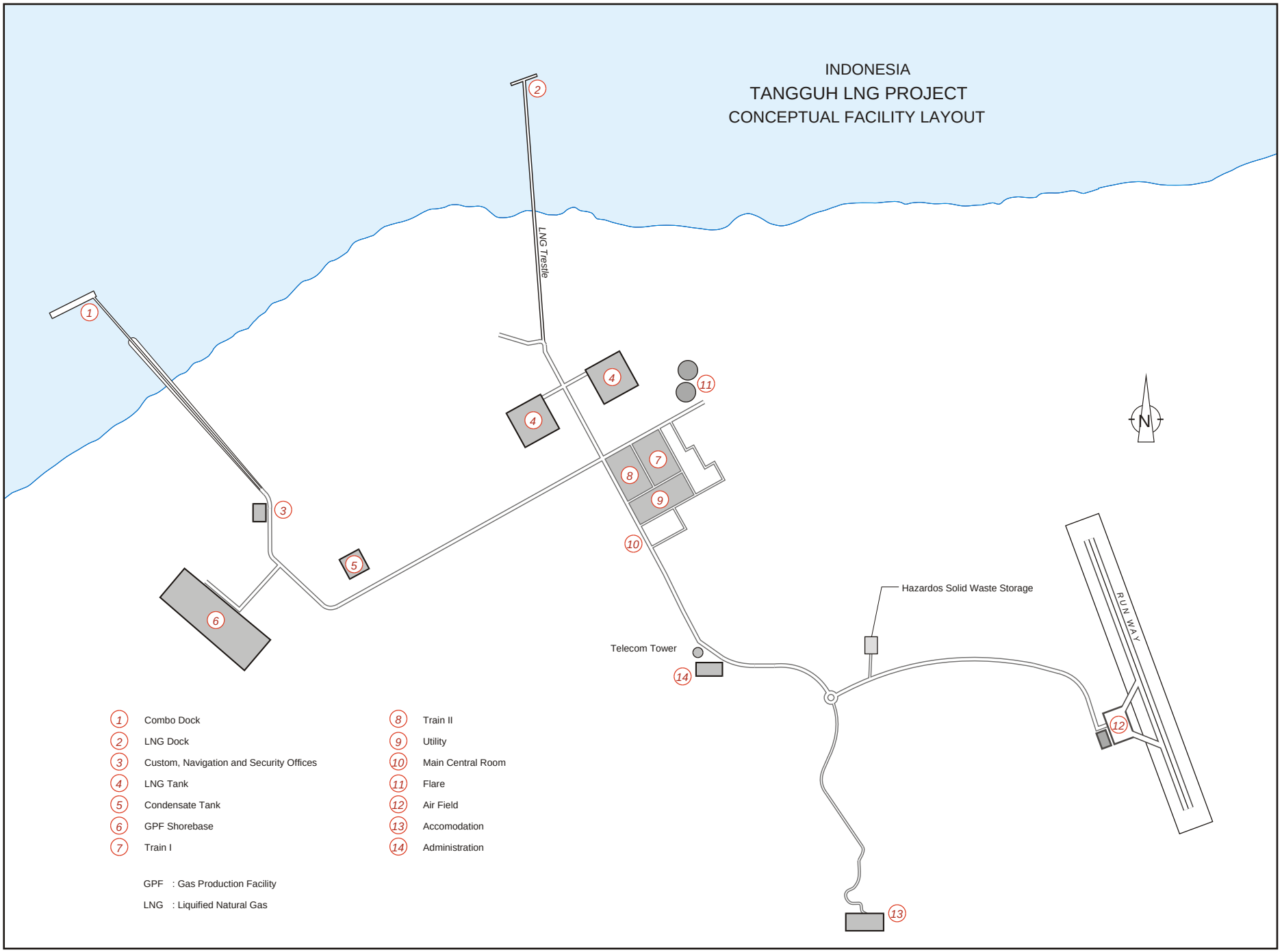
INDONESIA

TANGGUH LNG PROJECT

CONCEPTUAL FACILITY LAYOUT



1. Combo Dock
2. LNG Dock
3. Custom, Navigation and Security Offices
4. LNG Tank
5. Condensate Tank
6. GPF Shorebase
7. Train I
8. Train II
9. Utility
10. Main Central Room
11. Flare
12. Air Field
13. Accomodation
14. Administration

GPF : Gas Production Facility

LNG : Liquified Natural Gas

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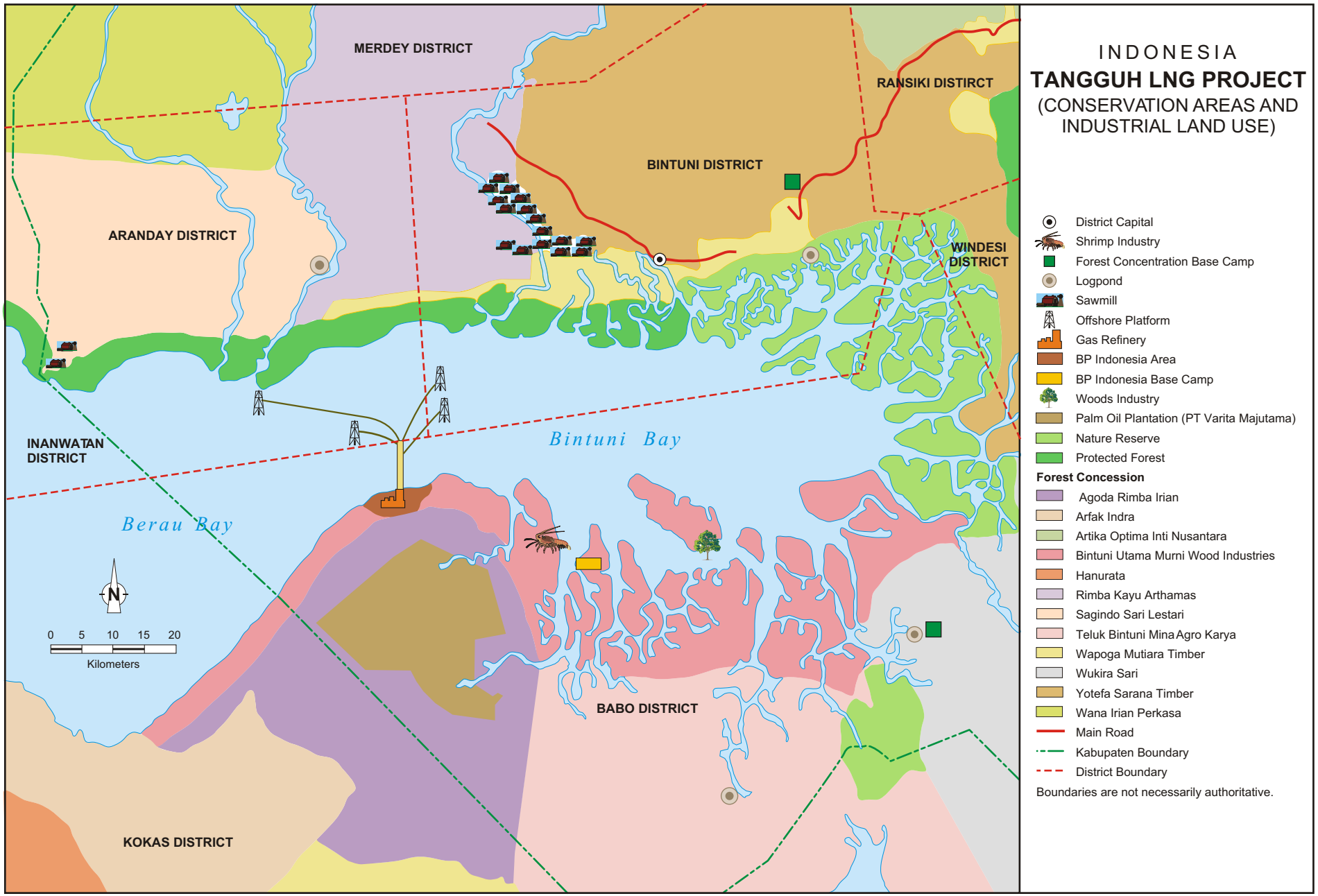
Map 2



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Map 3

I. INTRODUCTION

1. The Tangguh Liquefied Natural Gas (LNG) Project is a major greenfield development to extract natural gas from gas fields in the Berau and Bintuni bay area (Map 1) of Papua, Indonesia, and to liquefy it into LNG for shipping to export markets. The Project will include gas production facilities and LNG plant facilities, with associated infrastructure, including a seaport and airfield. Facilities will be in the districts *(kecamatan)* of Babo and Arandai in Teluk Bintuni regency *(kabupaten)*, but project activities will extend to the neighboring regencies of Fak Fak, Sorong, and Manokwari.

2. Significant volumes of gas were discovered around the Project in 1994. By 1998, substantial reserves had been delineated from six fields within three production-sharing contract (PSC) areas. The gas fields have proven reserves of 14.4 trillion cubic feet (tcf), and together with probable and possible reserves, Tangguh has the potential to yield a total of 23.7 tcf of gas. Proven reserves for each field are listed below together with shares of each PSC partner. The combined fields are considered to have the potential to support more than the two trains in the current plan and the Project may be expanded in the future.

Table 1: Proven Reserves for each Field and Shares of each PSC Partner

PSC Area	**Berau**	**Muturi**	**Wiriagar**	**Total** (tcf)	**Share** (%)
Proven Reserves (tcf)	10.25	3.08	1.04	14.37	100.00
PSC Contractors' Share (%)					
BP	48.00	1.00	37.60	5.34	37.16
Mitsubishi & INPEX	22.86	0.00	0.00	2.34	16.30
China National Offshore Oil Corporation (CNOOC)	0.00	64.77	42.40	2.44	16.96
Kanematsu Gas	12.00	0.00	20.00	1.44	10.00
LNG Japan	0.00	34.23	0.00	1.06	7.35
Nippon Oil & Japanese National Oil Corporation (JNOC)	17.14	0.00	0.00	1.76	12.23

Source: Tangguh Joint Venture Agreement, December 2002

3. The PSC partners agreed to combine their resources to enable development to proceed in the most orderly and cost-effective way. Under the Tangguh Joint Venture Agreement, BP Berau Ltd (BP) has been appointed the operator responsible for implementing the Project on behalf of the PSCs.

4. Initial development of the Project will comprise two LNG trains (equipment units that purify and liquefy gas), with the capacity to produce a total of 7.6 million tons per year (mtpa) of LNG. In addition to LNG, the Project is expected to produce condensate at the rate of 9,000 barrels per day (bpd), representing more than 3 million barrels per year. The Project has secured sufficient markets in order to launch its construction. A commitment to supply 2.6 mtpa of LNG to Fujian, People's Republic of China, was signed in 2002. This was followed by the agreement of POSCO and K-Power of the Republic of Korea in 2004 to purchase up to 0.55 and 0.80 mtpa of Tangguh LNG, respectively, for 20 years starting in 2006. On 11 October 2004, a sales purchase agreement was signed with Sempra Energy LNG Corp. for a 20-year LNG supply of up to 3.7 mtpa from Indonesia to markets in the United States and Mexico.

5. Environmental studies commenced in 1998. Subsequently, in 2000–2002, detailed environmental and social impact assessments were carried out in accordance with

Indonesia's environmental impact analysis (AMDAL) regulation. The assessments produced three documents required under the regulation:

(i) Environmental Impact Assessment (ANDAL), containing detailed analyses of environmental and social impacts;
(ii) Environmental Management Plan (RKL), containing management and mitigation plans; and
(iii) Environmental Monitoring Plan (RPL), including monitoring and compliance plans.

Appendix 1 presents an abstract of the contents of these three AMDAL documents.

6. As the Project includes components subject to different governmental jurisdictions, an integrated approach to AMDAL was adopted and the evaluation was undertaken by the Central AMDAL Evaluation Commission of the Ministry of Environment (MOE). The Project received official environmental approval of the state minister of the environment on 25 October 2002.

7. The environmental and social aspects of the Project were evaluated under the AMDAL process against Indonesian regulations and standards. Many aspects of relevant international standards were also considered. For example, several documents not required under the Indonesian AMDAL system were prepared and included as appendixes to the ANDAL and RKL. These include

(i) a public consultation and disclosure plan; and
(ii) land acquisition and resettlement plan (LARAP).

8. Emission criteria adopted represent the more stringent of Indonesian and relevant international standards.

9. This summary environmental impact assessment (SEIA)[1] has been prepared for the use of the Asian Development Bank (ADB). While the ANDAL, RKL, and RPL are the source documents on which the content of this SEIA is based, information not required under the Indonesian system has been added. Details of the final project design and the results of additional studies undertaken since the original AMDAL documents were prepared are reflected in this document.

10. This SEIA summarizes more than 8,000 pages of information presented in the AMDAL documents and reports of subsequent studies. Much of this information is highly technical and it has therefore been necessary to be selective in what is discussed in this summary. Extensive and sometimes complex issues may receive only brief treatment. Accordingly, readers requiring further information on any relevant environmental and social issues may view the detailed source documents and their appendixes.

11. The SEIA comprises nine chapters:

(i) I: Introduction, providing the background to the Project;
(ii) II: Project description, outlining the facilities to be constructed, operations, implementation schedule, and contractual arrangements;

[1] "This document summarizes the approved AMDAL (EIA report) of Tangguh Project and additional programs in line with ADB requirements. This document is only a summary of the original AMDAL report. Any details of the project environmental and social commitment on AMDAL should refer to the original AMDAL report"

(iii) III: Description of the environment, summarizing the salient environmental and social conditions;
(iv) IV: Alternatives, identifying alternatives to the Project or its components, which would have significant environmental consequences, and evaluating each alternative;
(v) V: Existing and anticipated environmental and social impacts and mitigation measures, summarizing the environmental and social impacts that have resulted or will result from project activities, and the measures adopted to mitigate adverse impacts or enhance positive impacts;
(vi) VI: Economic assessment, providing a brief overview of project economics, and the revenues that will be generated locally and nationally;
(vii) VII: Environmental management plan, summarizing the management and mitigation programs for construction, operation, and closure of the Project;
(viii) VIII: Public consultation and disclosure, summarizing the results of public consultation and disclosure undertaken as part of the AMDAL process and continuing today; and
(ix) IX: Conclusions, comparing the overall project benefits with the environmental and social costs.

II. DESCRIPTION OF THE PROJECT

A. Components

12. The Project, with a capital investment of more than $5 billion, is the largest to be developed in Indonesia for many years. It consists of five main components:

(i) gas production: production wells and platforms;
(ii) gas transmission: pipeline system linking platforms to the LNG plant;
(iii) LNG plant and associated facilities;
(iv) marine facilities: for unloading of cargo and personnel and for loading of LNG tankers; and
(v) an airfield.

13. Another project component, now completed, is the resettlement of Tanah Merah villagers from the LNG plant site.

1. Gas Production

14. Six offshore natural gas fields have been delineated. For the initial development under this project, two offshore platforms—Vorwata A and Vorwata B—will be constructed in water depths of 50–60 meters (m). To produce the initial gas requirements, up to 10 production wells will be drilled from each platform, to depths up to about 4,600 m. Subsequently, as many as 28 additional wells may be drilled from these and other platforms to sustain gas supplies as the reservoirs are depleted.

15. Each production platform will comprise an elevated deck, supported by piles driven into the seabed. A series of tubular steel jackets will provide lateral support to the piles and a framework to support producing wells. Platform facilities include communications, metering, and control systems and others to enable internal testing and cleaning of all pipelines. There will be no offshore processing facilities.

16. A safety exclusion zone will be established, which will prohibit unauthorized boats and ships from approaching within a 500 m radius of each platform.

2. Gas Transmission

17. Reservoir gas will be collected at Vorwata A and Vorwata B and flow through two subsea pipelines to the onshore receiving facilities at the LNG plant site. The Vorwata A and B pipelines will be 22 km and 15 km, respectively, and 61 cm (24 inches) in diameter. To avoid damage that may occur if the offshore pipelines are exposed, they will be placed in a trench excavated into the seabed and covered with a scour protection layer of crushed rock to a depth of 30 cm. The spoil from the seabed trench will form a temporary, unconsolidated low mound adjacent to the trench, which will be rapidly redistributed by seabed currents. During construction, temporary exclusion zones, in which anchoring and trawling activities will be excluded, will apply for a distance of approximately 500 m on each side of each pipeline. Once the pipeline installation is completed, there will only be a Safety Exclusion Zone relative to anchoring along the pipelines i.e. in a small area along the pipeline route, which will be marked on the relevant navigation charts.

18. Along the shore approach, in water depths less than 12 m, the pipelines will be buried to a depth of 2 m as required by Indonesian regulations. It is proposed to install the pipelines in this near-shore area using a combination of

(i) horizontal directional drilling (HDD) from a location onshore, for a distance of 1,000 m to an exit point on the seabed at a water depth of 6 m to 8 m; and
(ii) conventional trenching and pipeline lying over 300–400 m between the HDD exit point and a water depth of 12 m.

19. Cuttings from HDD boring, amounting to less than 200 cubic meters (m^3) of mud, will be deposited onshore. Spoil from the near-shore pipeline trench, amounting to less than 5,000 m^3, will be transported by barge to a deep water (more than 50 m) disposal site offshore.

20. Adverse ground conditions could possibly preclude HDD, in which case the shore crossing would be completed using conventional trenching and backfilling.

3. LNG Plant and Support Facilities

21. Site preparation for the LNG plant will require importation of earth and rock material from quarries elsewhere in Indonesia. An estimated 780,000 m^3 of earth-fill, sand, gravel, and rock will be transported to site. Site earthworks construction will produce an estimated 3.5 million m^3 of surplus earth-fill, which will be placed in a topographic depression east of the LNG plant site.

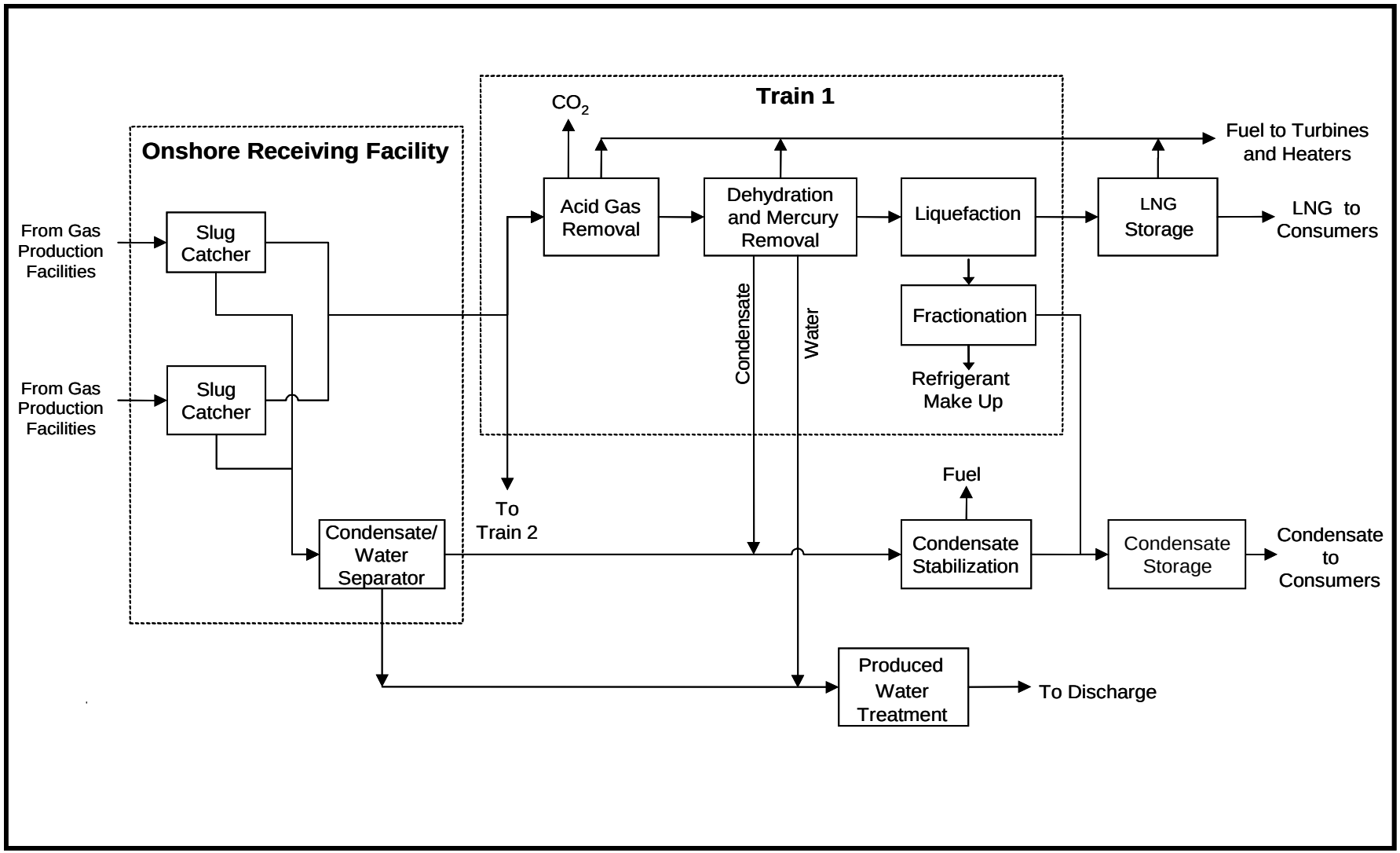
22. The generalized gas and condensate preparation process is depicted in Figure 1, and the layout of facilities is in Map 2. The main process elements are the following:

(i) onshore receiving facility, where the natural gas stream will be separated into gas, hydrocarbon condensate, and water, and which will serve both LNG trains;
(ii) gas purification facilities, comprising an acid gas removal unit, which removes CO_2, a dehydration unit, and a mercury removal unit, which are required to avoid freezing problems and aluminium attack on the main cryogenic heat exchanger; and
(iii) gas liquefaction facilities, which remove heavier components of the produced gas and liquefy the remaining gas. Each train includes a liquefaction unit and a fractionation unit. A condensate stabilization unit will serve both LNG trains.

23. LNG from the liquefaction unit will be stored at near-atmospheric pressure in large storage tanks. For the initial two train development, two tanks will be installed, each with

approximately 170,000 m^3 capacity. Condensate, including product from the onshore receiving facility and the fractionation plant, after passing through the stabilization unit, will be stored in a 20,000 m^3 condensate tank.

Figure 1: Generalized Gases and Condensate Process



24. Other support facilities associated with the LNG plant include

(i) solid waste disposal systems;
(ii) fire protection systems;
(iii) flare and venting for gaseous emissions;
(iv) effluent treatment system to collect and treat potentially contaminated waste streams from throughout the LNG plant site;
(v) water supply system to meet the operation requirements of 41 cubic meters per hour (m^3/hr); and
(vi) utilities, including steam turbine electric power generators with an installed capacity of 105 megawatts (MW) (3 x 35), and fuel, steam, compressed air, and nitrogen systems.

25. Initial planning, based on an early assumption that freshwater was in short supply, included a reverse osmosis seawater desalination plant to provide project requirements. This remains the basis of current water supply proposals. The desalination plant would utilize the reverse osmosis process to produce 41 m^3/hr of freshwater. Recent studies suggested that potential supplies of fresh water could be obtained from groundwater aquifers around the plant site. The Project has considered with MOE the possibility of conducting an 18-month groundwater utilization pilot program but has concluded that this cannot be achieved within the project schedule.

26. In-plant infrastructure will include control rooms, maintenance workshops, warehouses, a laboratory, break and prayer rooms, fire and emergency stations, electrical substations, water and electrical reticulation and distribution facilities, instrument stations, and analyzing shelters. Operational infrastructure will include a customs office; administration buildings; security office; clinic; incinerator; and a housing area, including accommodation units, cafeteria, mosque, church, commissary, and recreational facilities.

4. Marine Facilities

27. The marine facilities will comprise the following:

(i) construction jetty: a temporary, land-backed wharf to be used for unloading barges during construction;
(ii) combo dock: for off-loading fuel and cargo, transferring personnel, and shipping condensate; and
(iii) LNG dock: where the LNG tankers will berth while being loaded.

28. The combo dock will be approximately 1,050 m from the shore at a water depth of 8.5 m. Two configurations being considered are

(i) a rock-fill causeway extending 750 m from the shore and linked to the dock by a 300 m long trestle structure, and
(ii) a trestle structure 1,050 m long.

29. The LNG dock will be at the end of a 1,300 m trestle structure at a water depth of 13.5 m (lowest astronomical tide). Dredging of a temporary channel through the mud flats will be required to provide barge access to the pioneer dock (temporary construction jetty). Channels may also be dredged parallel to the combo and LNG dock approaches, and a temporary causeway may be constructed to facilitate erection of the LNG dock trestle approach. In total, up to 350,000 m^3 of dredged spoil may be produced. Disposal areas for dredged spoil have been identified offshore in water depths exceeding 50 m.

30. LNG will be loaded into LNG tankers with expected capacities of 85,000–165,000 m^3. An estimated 104 shiploads will be required to transport 1 year's LNG production, based on two trains, which means an average of one ship to be loaded every 3 days. At 10,000 m^3/hr, loading times for each tanker should be approximately 14 hours.

31. During operations, an offshore safety exclusion zone of 695 hectares (ha) will surround the marine facilities, including an area extending 620 m from all sides of the LNG dock, plus an area extending 120 m from the combo dock. The zone distances have been based on risk analyses, including dispersion of hypothetical leaks during loading of LNG and condensate, and an area required for a tanker turning basin with a diameter of 750 m in front of the LNG dock.

5. Airfield

32. Aircraft landing facilities will be needed to enable transport of personnel, equipment, and materials to the project site. If an airfield is constructed at Tangguh, it will not be open for public use. The airfield facilities will include a 1,300 m runway, designed to handle 50-passenger aircraft and C130 cargo airplanes that are not fully loaded. Associated facilities will include a helipad, parking apron, hangar, fuel storage and distribution system, fire-fighting equipment, terminal building, control tower, and navigation equipment. Other regional airstrips may be used to transport personnel to Papua, and marine transport would then be used to move the personnel to and from those airstrips.

33. The airfield is expected to be built early in the construction stage, during which it is expected to handle 33 flights per month. During operations, usage is expected to decline to about 15 passenger flights and 8 cargo flights each month.

34. The Project is evaluating the possibility of upgrading the Babo Airstrip and subsequently extending the runway to 2,000 m as needed, instead of building the airfield within Tangguh LNG site.

6. Land Acquisition and Resettlement

35. The 3,266 ha property, where the LNG plant and other onshore facilities will be located, has been acquired from the landowners after extensive consultations. The Project has initiated a resettlement program for residents of Tanah Merah located on the acquired land. At the outset, the Project's willingness to undertake a resettlement program was based on a commitment to achieve internationally recognized standards in resettlement. Accordingly, internationally recognized resettlement experts were recruited to guide project development and the land acquisition and resettlement action plan (LARAP) implementation.

36. The resettlement program involves the physical relocation of the Tanah Merah community (127 households) to two locations to the west of the village: the new Tanah Merah village (101 households) and a new settlement at Onar (26 households). The proximity of the new settlements to the villages of Saengga (94 households) and Onar Lama (36 households) requires that these host communities be included in various aspects of the resettlement program.

37. In addition to acquisition of the 3,266 ha, the Project was required to obtain a release for this property from the Ministry of Forestry. As part of the forestry release conditions, the Project is required to bear the costs of rehabilitation (revegetation) of an area of 6,984 ha of replacement forestry within the forest group known as Jakati or in another location. The Project and the Provincial Forestry Office will agree the costs and procedures required to carry out such rehabilitation.

B. Wastes Generated

1. During Construction

38. Various types of wastes will be generated during construction of project facilities, including

(i) cutting and fluids from well drilling;
(ii) spoil from dredging for pipelines and docks;
(iii) an estimated surplus of 3.5 million m^3 of earth excavated as part of site preparation activities, to be placed in an area east of the LNG site;
(iv) scrap metal, sand-blasting residues, and packaging wastes; and
(v) solid and liquid wastes from construction personnel.

The nature and quantities of these construction wastes are shown in Appendix 2.

2. During Operation

39. Natural gas contains various components, some of which require separation or removal to produce saleable LNG and concentrate products. Details of the mass balance showing inputs to and outputs from the LNG plant are given below:

Input (kg/h)	
Feed gas	1,536,752
Boil-off gas	44,118
Make-up water	8,122
Output (kg/h)	
Acid gas (mainly CO_2)	389,680
Fuel gas	124,319
Condensate for export	42,875
Produced water	60,788
LNG for export	1,009,626
LPG (C2 and C3) for own use	3,198

40. Major wastes generated from natural gas production and liquefaction include

(i) produced water separated from the natural gas;
(ii) acid gases, predominantly CO_2, separated from the natural gas;
(iii) emissions from stationary sources of combustion power generation facilities;
(iv) contaminated storm runoff,
(v) sewage, and
(vi) desalination effluent.

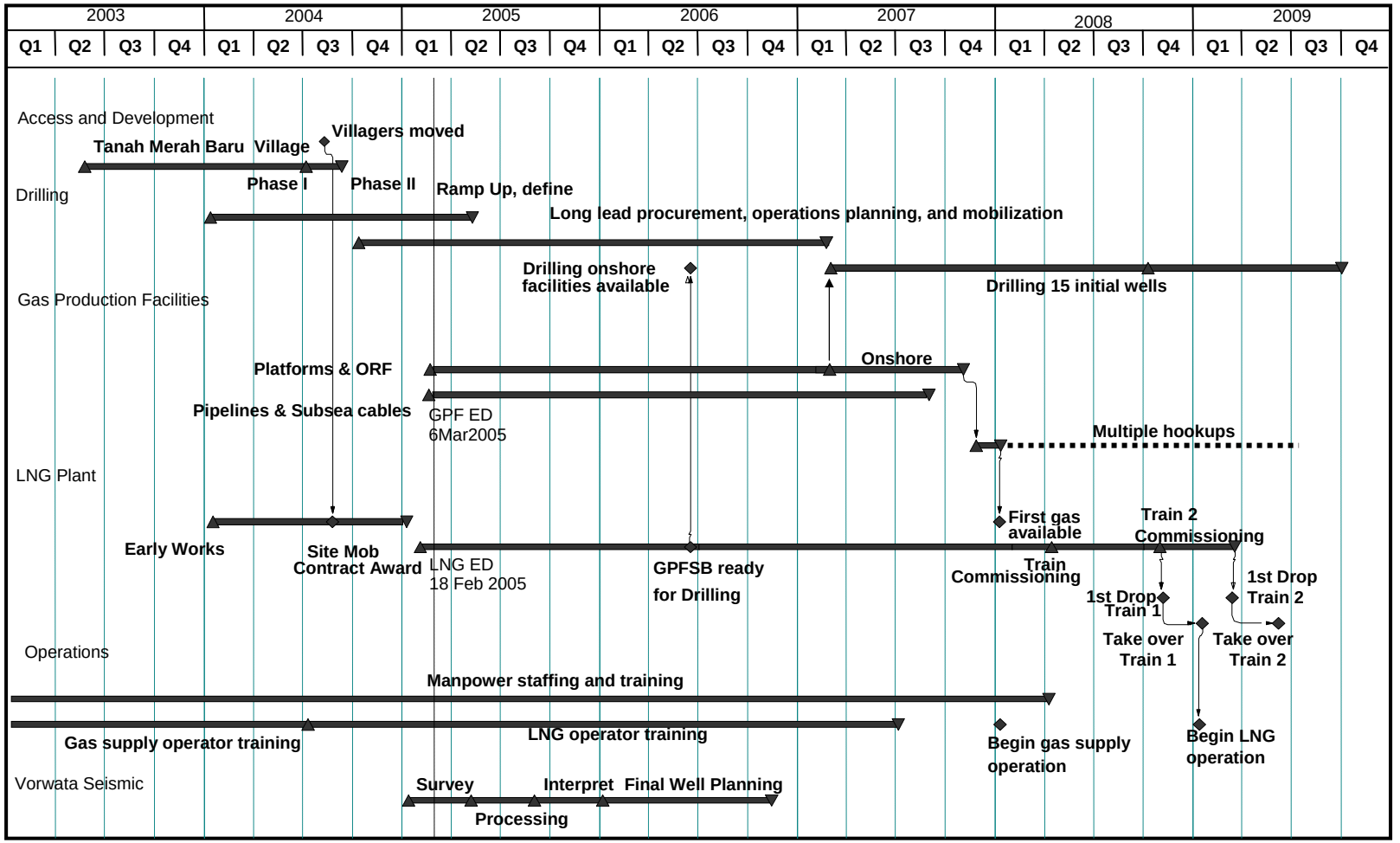
41. The nature, estimated quantities, and sources of these and other operational wastes from the LNG plant are listed in Appendix 3.

42. Small quantities of a variety of hazardous or toxic wastes will also be produced, requiring careful treatment and disposal. These are identified and characterized in Appendix 4. Where appropriate, these materials will be incinerated at the on-site incinerator. Hazardous wastes not suitable for incineration will be transported to an existing off-site licensed hazardous waste treatment and disposal facility in Bogor.

C. Project Schedule

43. The major steps involved in project execution are shown in Figure 2, which also shows the anticipated timeline for completion of the initial two train development. The Project is in the initial stage of implementation. Most of the major contracts have already been awarded (paras. 47 and 48). Construction for resettlement of people from Tanah Merah village has already been carried out. A property fencing contract is being implemented by a local Papuan contractor. Major works are in various initial stages of implementation. Commissioning of the first LNG train is expected to commence in early 2008, with first LNG production on fourth quarter of 2008. The second train is expected to be completed within 6 months of completion of the first train. Tangguh has sufficient sales purchase agreements for trains 1 and 2 to support operations through 2035.

Figure 2: Implementation Schedule



D. Implementation Arrangements

1. Contracts

44. The main project construction involves three engineering, procurement, and construction (EPC) contracts which are

(i) The LNG plant,
(ii) offshore platforms, and
(iii) pipelines.

45. The LNG plant contract includes

(i) LNG processing and storage facilities;
(ii) marine facilities;
(iii) accommodations;
(iv) administrative offices;
(v) drilling shore base;
(vi) airfield; and
(vii) ancillary facilities such as roads, communications, and waste management installations.

46. The offshore platforms contract includes all platform facilities except for gas production wells. The pipelines contract covers the gas delivery pipelines from the platforms to the LNG site, including the shoreline crossing.

47. The LNG plant contract was awarded to a consortium of Kellogg Brown and Root, JGC and Pertafinikki (KJP), with an effective date of 18 February 2005. KJP will prepare project designs, call tenders, award contracts, procure all equipment and materials, supervise construction activities, and commission the plant and test the performance of the various LNG plant components. To mitigate schedule risk, the Project has commenced the early work program in early 2004 with KJP. The program includes engineering design, preparing contracts for long lead items, early site preparation and establishing fly-camp, and marine and land surveys. The first stage of the marine and land survey has been completed, and a camp built to house the initial construction workforce.

48. The offshore platforms and pipeline contracts were awarded on 4 March 2005 to PT Saipem Indonesia. A separate contract will be awarded for drilling of gas production wells.

49. Many of the major structures and items of plant and equipment, such as the offshore platforms, will be fabricated at existing construction facilities elsewhere in Indonesia. These items will be transported to the site using barges and, in the case of onshore items, offloaded at the construction jetty for erection on site. Some of these items require lengthy lead times. The major contracts to be awarded and likely timing of awards are listed below.

(i) Jack-up drilling rigs: first quarter 2006
(ii) Shorebase management for drilling activities: first quarter 2006
(iii) Oil country tubular goods: August 2005

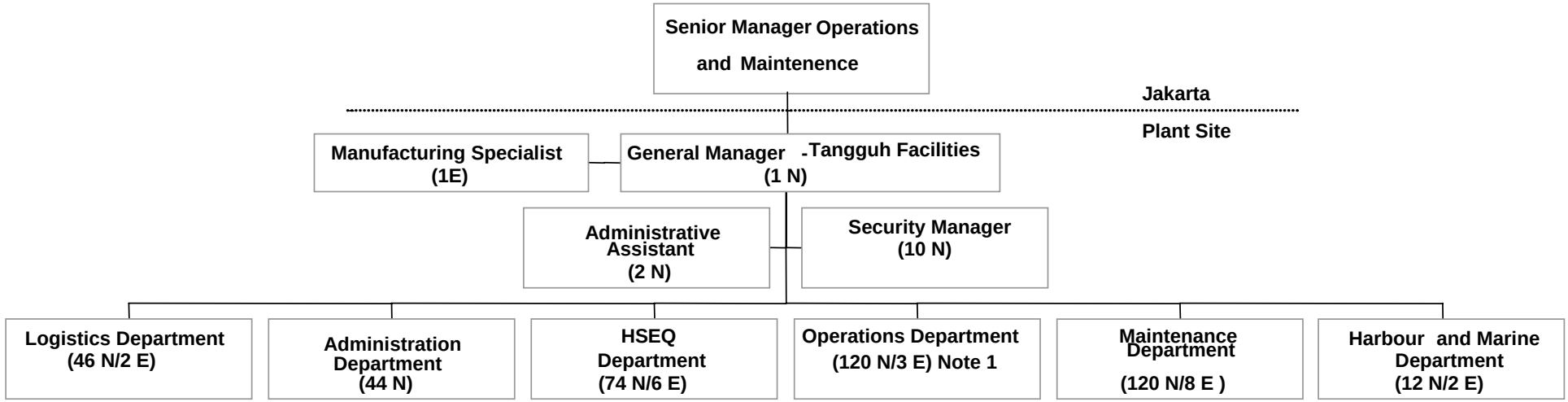
50. All project contractors and subcontractors will be required to abide by the project's environmental and social policies and to observe the environmental and social commitments made in the approved integrated AMDAL documents. To this end, environmental and social clauses are included in all construction contracts.

2. Project Management and Operations

51. BP, as the operator, is responsible for overall management of the Tangguh development, including construction, drilling, reservoir management, and operations. To support this responsibility, the Project has recruited a team of 232 professional and support staff members, based mainly in Jakarta and at the Tangguh site. As activities increase within the next 5 years, the project team is expected to increase to 700 people, with many positions being site-based. Figure 3 is an organization chart showing overall management of the project, including environmental and social impact management.

Figure 3: Organization Chart Overall Management of Project Facilities

Summary Site Facilities Management



Total Plant: 437

LNG:
Total nationals: 416
Total expats : 21
Total: 437

Total TPC or direct contract national: 240
Total TPC or direct contract expatriates:11
Total BP National employee: 176
Total BP Expatriate employee: 10

One Rotation on Site: 236

Note 1: Includes GPF Operations Personnel
Does not include Jakarta Office(2 BP)

E = Expert
HSEQ = health, safety, and environmental quality.
LNG = Liquified Natural Gas
N = National
TPC = Third Party Contract

52. Involvement of the EPC contractors and their subcontractors will be phased out as the facilities are commissioned and the project's operations team takes over the operating functions of the Project.

E. Employment

53. The construction workforce is expected to expand to about 1,700 people by the end of 2005, and to peak at 5,800 during 2007. The Project is committed to hiring local people for all the positions for which they are qualified. All construction contractors will be required to maximize hiring of local labor to the extent permitted by the skills required. As a result, at least one person from each of the 700-800 households in the nine directly affected villages, will be offered a position at some stage during construction. Overall, at least 2,000 Papuans are expected to be employed during the main EPC construction phase. These employment numbers are related only to Tangguh site activities. Many jobs will be created in other parts of Indonesia. For example, the platforms are expected to be fabricated in Banten Province and require employment of up to 800 people for approximately 9 months. The pipeline coating is expected to be produced in Batam and will employ about 300 people for 2 to 3 months.

54. Operations of plant facilities will require a site workforce of approximately 450 people to allow for rotation of personnel. Job opportunities will become available during the operation stage for support and general maintenance services. Recruitment and training of the project's operations team, including local villagers, has already commenced. The Project employs 28 Papuans on the operations team, who are undergoing a 3-year training program in LNG operations at the Bontang LNG facility. During the initial operations stage, the number of Papuans is expected to meet or exceed AMDAL requirements, not including the additional personnel needed for the support service contractors' workforce. The percentage of Papuans in the workforce is expected to increase steadily over the life of project as more local people are trained. The project's target is 85% Papuan content in the project workforce after 25 years of operations.

III. DESCRIPTION OF THE ENVIRONMENT

A. Physical Environment

55. The Project is on the north coast of the Bomberai Peninsula, extending into Berau and Bintuni bays (Map 3). These bays together comprise a 200 km long, 25 km wide, semi-enclosed body of water, open only to the west, which separates Bird's Head Peninsula to the north from the remainder of Papua. The topography bordering Berau and Bintuni bays to the south is characterized by low relief. Within the project area, the terrain is flat to gently undulating, with several low east–west trending ridges extending to 50 m above sea level. Extensive swamps border the coast and extend inland along the significant estuaries. Further east, extending around the eastern and southern perimeter of Bintuni Bay, these swamps form a vast mosaic of islands and promontories, separated by estuarine channels.

56. The project area is largely covered by unconsolidated quaternary alluvial and littoral deposits (predominantly silts and clays), which unconformably overlie sandstones and shales of the Pleistocene Tusuwai sandstone. This unit conformably overlies siltstones, mudstones, and sandstones of the Upper Miocene–Pleistocene Steenkool formation. While the Berau and Bintuni bay area is tectonically relatively stable, it experiences ground vibrations from time to time, resulting from major earthquake events, with epicenters generally more than 100 km to the east.

57. The climate of the project area is monsoonal, with high temperature and humidity throughout the year. The wet season, corresponding to the northwest monsoon, extends from December to March, while the dry season, corresponding to the southeast monsoon, extends from May to October. Rainfall totals exceed 3,000 mm in an average year, distributed among all months, with February the wettest, and August-September the driest, and considerable year-to-year variation. Average monthly minimum temperatures at Tanah Merah range from 20.0°C to 23.5°C, while average monthly maximum temperatures range from 33.0°C to 37.3°C. Humidity is consistently high, averaging more than 85%. During the northwest monsoon, winds are typically light at 1.5–5.5 meters per second (m/sec), and predominantly from the north, northwest, and west. During the southeast monsoon, winds are typically light from the northwest in the mornings, becoming moderate at 3.5–7.5 m/sec from the south to southeast during the afternoon. As would be expected, air pollutants measured from samples collected at the Tangguh site are at very low concentrations, indicating clean air.

58. The main perennial rivers in the project area are the Manggosa, which forms the eastern boundary of the LNG property, and the Saengga, which parallels the western LNG property boundary, about 1.5 km to the west. Both flow north into Bintuni Bay. Drainage from the site is predominantly to the Saengga via several intermittent, west-flowing streams. Tidal influence extends for several kilometers upstream of the mouth of the Saengga, contributing to salinity, particularly during the dry season. In general, the quality of surface waters upstream of tidal influence is good, with the exception of coliform bacteria, which are commonly present at concentrations exceeding Indonesian standards.

59. The depth to groundwater ranges from less than 1 m to 22 m, with significant seasonal variation. Several permeable, water-bearing formations exist within 150 m of the surface. Water quality is variable but of generally good quality. Some shallow water around the villages exhibits contamination from anthropogenic sources, evidenced by the presence of bacteria, and significant concentrations of ammonium and nitrate. Shallow groundwater, accessed by means of wells excavated by hand, is a significant source of domestic water for villages. The Project has developed water supplies for the new Tanah Merah village, Onar hamlet, and Saengga village, with high-quality water pumped from bores extending to depths of 40–100 m.

60. Berau and Bintuni bays comprise a large expanse of shallow water, exhibiting some estuarine characteristics, including substantial variation in salinity and high concentrations of suspended particulates, particularly during the wet season. Water temperature ranges from 24°C to 30°C throughout the bays, and salinity generally ranges from 26 to 32 psu. Suspended particulate concentrations commonly reach 200–300 milligram per liter (mg/L) close to the shore, with even higher concentrations near the seabed. Suspended sediment levels decline rapidly away from the shore as a result of flocculation and deposition. Tides are semidiurnal with an astronomical range of approximately 4 m. Currents are tidally driven, with a maximum speed of 1.9 meter per second (m/sec) measured in the study area. Waves are generally wind-generated and smaller than those in more exposed locations.

B. Biological Environment

61. The project area is within a biologically diverse and ecologically valuable region. The northern Bomberai Peninsula is a center for high floristic endemism. The lowland rainforest, although widespread in Papua, including the project area, is considered to be the least documented system in Indonesia and at risk because of logging. Of particular ecological importance are the mangrove swamps, which form a fringe around the shore of Berau and Bintuni bays, and occupy much of the large, estuarine mosaic at the head of Bintuni Bay (Figure 4). Of this area, 158,364 ha is protected within the Cagar Alam Teluk Bintuni (nature reserve) 80 km east of the project site (Map 3). The nature reserve and protected forest are separated by the Wasinn River. Another nature reserve—Wagura Kote—was proposed by the Ministry of Forestry in 1996 but has not yet been decreed.

62. Onshore and offshore areas are far from pristine, having been subject to exploitation of various kinds, some of it intensive. For example, prawn fishery in Berau and Bintuni bays has been heavily exploited over recent years by commercial fishing companies. A recent fishery study, sponsored by the Project, indicates that harvesting at levels above the sustainable yield has led to a substantial decline in catch rates in recent years. Onshore, logging is the most intrusive activity, and most of the area north and south of the bays is covered by forestry concessions. A large tract of 60,000 ha of lowland rainforest, cleared in 1998–2000 for an oil palm plantation (Map 3), extends as close as 2 km to the southeast corner of the project area.

63. Five main vegetation types occur in the 3,266 ha project area and surrounds, as shown in Figure 4 and described below:

(i) Lowland forest covers an estimated 68% of the area. This diverse forest consists of several layers. The canopy is typically 25–30 m high, with occasional emergent trees up to 50 m, and includes a wide range of tree species, including several commercially valuable ones.

(ii) Swamp forest covers about 14% of the project area. This predominantly freshwater forest has relatively low diversity and is dominated by Nypa palms (*Nypa fruticans*) and sago palms (*Metroxylon sagu*), the latter being a dominant component of the canopy. Diversity increases with distance inland, away from tidal influences.

(iii) Beach forest occupies sandy rises behind the mangrove forest, and covers about 9% of the project area. A low scrub zone adjacent to mangrove grades into a dense forest that includes a diverse array of trees, including important regional timber species.

(iv) Savannah covers only about 5% of the project area but a major part of the 379 ha LNG plant site area. This vegetation community has very low diversity, apparently as a result of adverse soil and drainage conditions. Several tree species are present, while the ground cover includes grasses, sedges, ferns, and insectivorous plants. Larger areas of savannah exist outside the property area to the west.

(v) Mangrove swamp covers about 4% of the project area but is much more extensive to the east. Three distinct zones are present: the avicennia-sonneratia zone along the seaward side; the Brugiera-rhizophora zone, and the sago and peat swamp zone on the hinterland side, above the high-tide level.

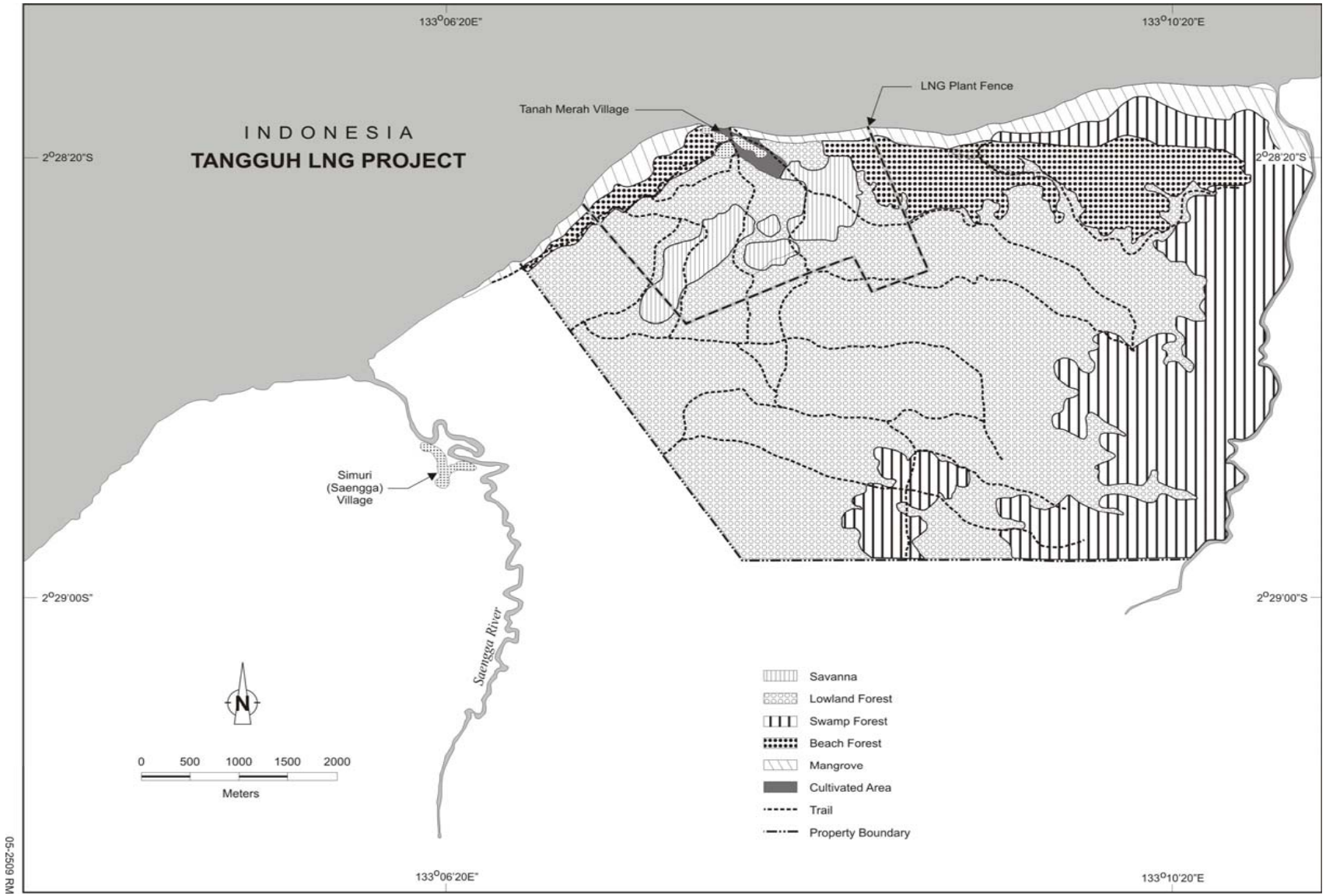
64. In 2002, 412 plant species were recorded during the 2-week flora and fauna survey, undertaken after the AMDAL surveys. Plants recorded from the study area include five (plus possibly two more) species new to science, and five significant range extensions (Appendix

5). This is believed to reflect the lack of previous botanical work in the region rather than any rarity among the subject species.

65. A total of 35 species of amphibians and reptiles were identified during the survey, including 9 frog, 20 lizard, and 6 snake species. While additional species are undoubtedly present, the study identified fewer species than similar surveys elsewhere in New Guinea. This may reflect the lower variety of habitat types than in areas of higher relief. Two of the frog species and one lizard have never been described. Noteworthy species are listed in Appendix 5.

66. Of the 75 terrestrial mammal species that could potentially be present in the project area, based on known distributions and habitat preferences, only 11 were recorded during the survey: 4 marsupials, 4 bats, and 3 rodents, all widespread and common. Mammal species recorded from the area, or likely to be present, are listed in Appendix 5.

Figure 4: Vegetation Map



67. With 578 known species, the avifauna of New Guinea are among the most diverse in the world. A total of 140 bird species were recorded from the project area during a 2-week ornithological survey. Additional species undoubtedly occur in the area. The diversity is comparable to that found in other lowland areas from studies involving similar levels of effort. Three threatened bird species, including two species of cassowary and six restricted range species have previously been reported from the Berau and Bintuni bay area (Appendix 5). None of these species was sighted during the ornithological survey, although at least one of the cassowary species is known to occur.

68. New Guinea is home to at least 340 freshwater fish species. The 2-week fish survey of streams in the project area yielded 17 species from freshwater sites and a further 22 from estuarine sites. These results indicate that the fish fauna of the Tangguh area is more depauperate than in similar areas previously studied. All species recorded occur elsewhere, but the Tangguh records represent range extensions for nine of the fish species. Abundance and diversity of the fish fauna are generally lower in the upper reaches of streams.

69. A total of 49 genera of marine phytoplankton were identified during the ANDAL studies, from 13 near-shore stations and 4 offshore stations in Berau and Bintuni bays. Little difference was detected in either abundance or diversity between onshore and offshore locations. A total of 51 genera of zooplankton were identified from dry and wet season marine surveys undertaken for the ANDAL. Considerable differences in species diversity and abundance were recorded between sampling sites. In general, much lower numbers of genera were recorded during the wet season survey.

70. Benthic fauna, as recorded from the dry and wet season marine surveys, showed marked differences between offshore and near-shore sites, but little seasonal variation was apparent. Near-shore sites yielded a much more diverse and abundant assemblage of organisms. From the dry season survey, the numbers of taxa collected from each site ranged from 1 to 21, while numbers of organisms ranged from 10 to 1,160 individuals/m^2. The wet season survey yielded 1 to 23 taxa per site, with 6 to 3,388 individuals/m^2.

71. Other groups of marine organisms have not been specifically surveyed for this project, although data have been obtained from local fishermen. Considerable data have been compiled from the literature, particularly relating to commercially valuable species. Six peneid prawn species occur in the bays and are exploited by local fishermen as well as commercial fishing operators. Local people use a wide variety of near-shore fish species and crustaceans. Published data indicate that Berau and Bintuni bays are home to 66 marine fish species, 23 (additional) marine and brackish water species, and 35 (additional) brackish water species.

72. Based on secondary information and consultation with local community and some of conservation organizations, initial project assessment was that the project activities will pose no threat to marine mammals, turtles, and reptiles, as well as their habitats, or their breeding areas. Representatives of each group undoubtedly occur in Bintuni Bay. The humpback dolphin is reported to be common. Other cetaceans may be present. Five species of sea turtle are known from Papuan waters and may feed in the bays. The presence of almost continuous fringing mangroves restricts potential breeding sites for marine turtles, which require sand beaches for nesting. Two species of marine crocodile are known to be present. The Project plans to conduct an additional fauna survey in 2005, to include marine mammals, turtles, and crocodiles. The data will supplement the existing baseline data and provide the basis for assessing the need for mitigation measures to minimize project impacts on marine fauna. Additional flora and fauna field surveys will be undertaken within the project area in accordance with commitments made in the RPL. The first, scheduled for 2007, will include a survey of intertidal avifauna.

C. Sociocultural Environment

73. The Project is in the Teluk Bintuni regency (*kabupaten).* The LNG plant site and surrounding property are in Babo district (*kecamatan)*, and the offshore facilities in Aranday district. Based on the AMDAL social survey data in 2001, Babo has a population of 9,754 in 22 villages to the south of Berau and Bintuni bays; Aranday, 7,321 in 9 villages to the north. Areas and populations of villages in Babo and Aranday are given in Appendix 6.

74. The main sources of livelihood or income in Babo district are sago production, hunting, farming, fishing, and laboring. Private company employment is concentrated in and around the town of Babo. In Aranday, sago processing, fishing, and agriculture are the main pursuits, with some private sector employment in Wiriagar, Mogotira and Kampung Baru.

75. The Sumuri tribe, comprising 18 clans, is distributed among the villages of Saengga, Tanah Merah, and Tofoi, along the south coast of Bintuni Bay. The area north of the bay is occupied by the several tribes including Sebyar, which comprises 26 clans. Although originating from several different ancestral lineages, the clans share a common recent history, together with a common language, customs, and culture. The Sumuri have a history of mobility, relocating readily in response to changing circumstances. Seasonal migration also occurs in some settlements, based on seasonal fishing patterns.

76. The Project has, during the AMDAL process, categorized nine villages as "directly affected"[2] using various criteria, including implementation of exploration-phase seismic work, necessity of physical relocation and loss of land, proximity to the proposed development, and the possibility of future impacts based on possible offshore development locations. The term directly affected is project and context-specific. The nine directly affected villages (DAVs) are the following:

(i) Babo
  (a) Tanah Merah
  (b) Saengga
  (c) Tofoi

(ii) Arandai
  (a) Wiriagar
  (b) Mogotira
  (c) Tomu
  (d) Ekam
  (e) Taroy

(iii) Kokas district, on the south coast of Berau Bay
  (a) Otoweri,

77. These DAVs support 700–800 households. In addition to those listed above, 24 villages have been identified that may be indirectly affected to some extent by the Project, based on proximity to project activities.

[2] The term ”directly affected” was adopted before ADB’s involvement in the Project. “Directly affected villages,” as used by the Project, encompasses those that experience direct and indirect (e.g., economic) impacts, and therefore differs from ADB’s “affected persons” as defined in ADB’s involuntary resettlement policy (ADB. 2003, Operations Manual. Bank Policies, OM Section F2/BP/29 October 2003. *Involuntary Resettlement*, Manila)

78. Until recently, livelihood for the Sumuri was based on harvesting of sago, crop production from shifting cultivation of forest plots, collection of forest products, hunting, and fishing. While agriculture and forest use continue, their importance has declined in favor of income-generating activities such as prawn harvesting and wage employment. Agriculture, which is used mainly to provide subsistence consumption needs, includes cultivation of household gardens, and of forest plots, usually close to village settlements. Forest plots are considered to belong to the family responsible for their cultivation only for the duration of the cultivation activities.

79. Based on traditional rights, each clan has access and usage rights to marine resources directly in front of their lands. In practice, however, village residents share rights to access and utilize resources under the jurisdiction of clans. The system also allows fishermen to harvest resources from areas belonging to other clans, with payment for such usage rights. Prawn harvesting is a main activity among the Sumuri and provides the main source of cash income. The southeast monsoon season (April to November) is the time of most intensive prawn harvesting.

80. Islam and Christianity are the major religions in the Tangguh area, with Islam predominating in most north shore villages, and Christianity more widely practiced in south shore villages. Many villages include Catholics, Protestants, and Muslims, although some villages or hamlets adhere to a single religion. Traditional belief systems also exist in these communities. There is no history of major interreligious conflict among communities in the area.

81. Sacred sites in the LNG site include

(i) village cemeteries,
(ii) an offshore group of rocks known as *Batu Kumapa*, and
(iii) various land-based ancestral sites.

82. The Project has been engaged in lengthy and extensive consultations with the Soway, Simuna and Wayuri clans and the Tanah Merah community to address issues associated with the sacred sites. As a result of these consultations the Project has: (i) agreed to relocate the combo dock to avoid impacting the Batu Kumapa sacred rocks (ii) agreed to maintain the cemeteries on the LNG site and developed cemetery access agreements with the resettled Tanah Merah community to allow periodic access; (iii) supported clan-level activities associated with protection of sacred sites in the new Tanah Merah village and Saengga, and; (iv) facilitated appropriate adat ceremonies for the Soway clan which led to the relocation of a number of sacred rocks to an agreed upon location.

83. The villages have limited infrastructure or access to public services. Education facilities and teachers are limited and literacy levels are below national averages. Similarly, health services are limited; for all major health indicators, local populations are below provincial and national averages, with diseases and illnesses relating to nutritional deficiencies and poor sanitation. Most villages are not accessible by road. Boats provide the main means of transportation.

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84. In 2001, the Project surveyed attitudes toward the Project as part of the AMDAL consultation process in all DAVs: 90% of 230 respondents approved of the Project, with the remainder disapproving or having no opinion. The lowest approval rating was from residents of Wiriagar and Mogotira villages on the north shore, apparently disappointed that the LNG plant was not to be constructed in their area. Of 208 respondents from other villages, 86% approved while 14% either disapproved or had no opinion.

D. Socioeconomic Environment

85. The quality of housing, village facilities, and services is poor. The typical house has flooring and walls of rough-hewn timber, with nipa palm thatch, or galvanized iron roofing. The house comprises a living room, often also used as sleeping quarters, one or two bedrooms, and an open or detached kitchen that often also serves as a dining room. Households do not have reticulated water supplies. People bathe at wells or in rivers and source drinking water from rivers, wells, and springs. Households do not have septic waste disposal systems and, consequently, sanitation is poor.

86. Based on 2002 AMDAL data, household incomes of villages near Berau and Bintuni bays covered under the AMDAL social study area vary widely between villages, with average household incomes ranging from Rp324,000 to Rp2881,000 per month.

87. Investment projects in the Berau and Bintuni bay area have been mainly in the fisheries and forestry sectors. At the time of the AMDAL surveys, a major Indonesian conglomerate, the Djayanti group, operates in both sectors. A major new forestry venture is proposed to produce pulp and panel board, and a new 50,000 ha oil palm plantation is also proposed. Babo district has 469,914 ha of production forest (including limited production forest, enabling only selected logging, and convertible forest, which can be used for oil palm and other plantations), and 161,297 ha of protected and conservation forest. The entire area south of Berau and Bintuni bays between Toweri village and the nature reserve at the east end of Bintuni Bay is covered by five forestry concessions. Forestry activities of other parties outside the LNG property are likely to continue to the east and south of the property boundary.

88. Several transmigration projects have been developed around the Tangguh site. Two villages—Babo SP1 and SP 2, with 925 families occupying 1,850 ha—are associated with the existing oil palm development. Up to six additional villages for 2,650 more families may be established for future stages of this transmigration project. Another large transmigration project, with villages designated SP1 to SP7 Bomberai, is near Kampung Tomage (Toweri village), south-southwest of the LNG site. This project is based on agriculture, with each family receiving 2 ha of agricultural land.

IV. ALTERNATIVES

A. The Need for the Project

89. The Project is critically important at the local, provincial, national, and international levels. Locally, the Project will provide significant short- and long-term training and job opportunities, plus improvements to infrastructure, health, and education, which should substantially improve the lives of people living in the Berau and Bintuni bay area. At the provincial level, the Project will provide a large revenue stream to be used by the provincial government for the benefit of its people. At the national level, as well as providing revenues to the national government, the Project will maintain Indonesia's position as a major supplier of LNG, offsetting declining exports as the Arun and Bontang LNG projects become depleted. At the international level, the LNG supplied by the Project will help meet the growing need for clean fuels to minimize air pollution and emissions of greenhouse gases.

B. Alternative Project Designs

1. Alternative Project Sites

90. During 1996 and 1997, a thorough site selection process was carried out. Initially, 17 broad sites were identified within 250 km of the gas fields. These sites were

(i) Karakra, on the north coast of Berau Bay;
(ii) Mogotira and Weriagar, on the north coast of Bintuni Bay;
(iii) Tapas, on the north coast of Berau Bay;
(iv) Saengga/Tanah Merah, on the south coast of Bintuni Bay;
(v) Ofuweri, on the south coast of Berau Bay;
(vi) Flur, on the south coast of Berau Bay;
(vii) Goras, on the south coast of Berau Bay;
(viii) Ogar Island, off the south coast of Berau Bay;
(ix) Kokas, on the south coast of Berau Bay;
(x) Siang, on the south coast of Berau Bay;
(xi) Bagam, an inlet near the mouth of Berau Bay;
(xii) Teluk Suweri, on the southwest tip of Fak Fak Peninsula;
(xiii) Fak Fak, on the south coast of Fak Fak Peninsula;
(xiv) Tanjung Urkadin, in Sebakor Bay;
(xv) Maiwawa, in Kamrau Bay;
(xvi) Megai, in Arguni Bay; and
(xvii) Wariup, in Sarera Bay, on the east coast of the Bird's Head Peninsula.

91. At the initial site selection stage the broad Saengga site included Tanah Merah, which at the time was administratively still part of Saengga village.

92. A screening process was used to reduce the number of potential sites. Sites were eliminated if one or more of the following conditions applied:

(i) proximity to area of environmental sensitivity, such as a nature reserve;
(ii) clearly excessive development costs due to excessively long pipelines or difficult site conditions;
(iii) requirement for gas pipeline to traverse extensive tracts of mountainous terrain;
(iv) absence of deep water near the site, requiring substantial dredging or excessively long jetty structures;
(v) port facilities would involve sites of rapid accretion or mobile seabed sediment, which would require repeated dredging to maintain shipping access;
(vi) the presence of physical features such as swamps or cliffs, which are not amenable to site preparation.

93. While five of these six criteria are based on engineering feasibility and cost considerations, environmental concerns tend to parallel engineering constraints. Sites or routes involving the most difficult terrain require more construction effort and disturb the environment more. Based on a series of desk studies and field investigations, each site was screened for these conditions. Thirteen of the sites were eliminated for reasons shown in Appendix 7, leaving a short list of four sites—Karaka, Saengga/Tanah Merah, Ogar, and Kokas—for further, more detailed evaluation.

94. The short-listed sites were evaluated in terms of engineering suitability, social acceptability, environmental acceptability, and relative costs. Of the four sites on the short

list, Saengga/Tanah Merah was clearly preferred, as it is the only one that meets all four criteria.

95. Once the Saengga/Tanah Merah site had been accepted as the preferred location, there remained more detailed options for precise location and layout of LNG facilities. Two suitable locations for the LNG plant were identified within the broad Saengga/Tanah Merah site. These were the area of a flat savannah adjacent to Tanah Merah village, and another large area of flat savannah around 6.4 km to the southwest. The Tanah Merah location provides several advantages, such as

(i) proximity to deep water, requiring a jetty of only 1,100 m in length;
(ii) a seabed relatively free of sand waves and areas of sedimentation, minimizing dredging requirements;
(iii) a relatively narrow mangrove fringe;
(iv) the presence of a shoreline bluff providing storm protection; and
(v) good ground foundation and drainage.

96. The Tanah Merah location was preferred to the Saengga location for its engineering, environmental, and cost factors. The Saengga location would not need relocation of Tanah Merah and resettlement of its people, so it was preferred for its social factors. When the inhabitants of Tanah Merah turned out to be receptive to relocation and resettlement, Tanah Merah became the clearly preferred site.

2. Alternative Gas Cleaning

97. Two alternatives were considered for operations to be carried out on the offshore platforms:

(i) a minimum facilities option, in which the produced gas, condensate, and formation water would be transported from the platforms to the onshore LNG plant; and
(ii) an offshore dehydration option, in which separation and dehydration processes would be carried out on the platforms, with dual pipelines required to deliver gas and condensate to the LNG plant.

98. The minimum facilities option has been selected for its simplicity and lower cost. This option avoids the need to discharge produced water at the offshore platforms, and does not require power generation and accommodation facilities on the platforms. Essentially, with this option, there will be no atmospheric emissions or liquid effluent discharges from routine offshore production operations.

3. Alternatives for Waste Disposal

99. Alternatives for disposal of drilling fluids and drill cuttings are

(i) discharge to the sea from each drill site; and
(ii) re-injection into subsurface formations.

100. The re-injection option has been selected, subject to field trials to confirm its technical feasibility. Re-injection will not be possible for fluids and cuttings from the first well at each platform site, but is expected to be used for all subsequent wells. Accordingly, re-injection is expected to reduce the quantities of drilling wastes discharged to the environment by more than 90%.

101. Alternatives for disposal of carbon dioxide, separated from the natural gas stream are

(i) discharge to the atmosphere, and
(ii) re-injection into a deep subsurface formation.

102. While re-injection of carbon dioxide has not been carried out at most natural gas development projects, this measure has been increasingly suggested as a means to minimize release of greenhouse gas emissions. On the other hand, re-injection requires favorable subsurface conditions and a thorough assessment of environmental impacts. The costs of re-injection are significant.[3] Further technical feasibility studies of this option are being undertaken by the Project, the results of which are scheduled for completion in 2010. Current planning for the Project does not include re-injection of CO_2.

4. Alternatives for Gas Pipeline Routes

103. Two alternatives have been considered for pipeline routes connecting the production platforms with the onshore LNG facilities. These are

(i) a single pipeline from Vorwata A to Vorwata B platforms, and then on to the LNG site, over a total distance of 20 km; and
(ii) dual pipelines, 22 km and 15 km, respectively, from Vorwata A and Vorwata B platforms to the LNG site.

104. The dual pipeline option has been selected based on reliability of supply, which is a critical consideration for the Project and its customers. With this option, each pipeline can be shut down temporarily, for inspection or maintenance, without significantly reducing supply of gas to the LNG plant. Marginally higher construction impacts are associated with the selected alternative, as are higher construction costs, but these are judged to be acceptable in achieving the required reliability of supply.

5. Alternative Gas Pipeline Construction Methods

105. Standard practice in the offshore oil and gas industry is to lay pipelines beneath the seabed, overlain by a layer of crushed rock, to provide weight to resist buoyancy forces, and to protect against scour that could otherwise expose the pipe. Two options exist for burial of the pipeline:

(i) excavation of the pipeline trench by jetting or dredging, followed by laying of the pipeline into the open trench, and back-filling with rock protection; and
(ii) laying of the pipeline on the seabed, followed by trenching/pipe lowering, by means of an underwater “plough,” and then placement of a covering layer of crushed rock.

106. Selection of construction method depends on a variety of considerations, the most important being seabed conditions and subsea soil properties. The preferred construction method has not yet been selected. However, whichever method is selected, there will be little difference in environmental impacts. Jetting or dredging may generate more suspended sediment than ploughing; however, the near-seabed environment carries high suspended sediment concentrations under normal conditions.

[3] Based on one study, the cost of carbon dioxide (CO_2) re-injection would be about $40-$60 per ton for a 500 MW gas or coal-fired power plant. (Wallce, David. 2000. Capture and Storage of CO_2 What Needs to Be Done? Sixth Meeting of the Conference of the Parties to the Convention on Biological Diversity (COP 6), The Haque, 13–24 November.)

107. For the shoreline crossing, alternatives include

(i) horizontal directional drilling; and
(ii) open trenching, followed by pipe laying and back-filling.

108. Environmentally, HDD is preferred as it avoids disturbance of the shoreline ecosystems. HDD can not be carried out in all circumstances. The subsurface conditions must allow the drilling to proceed without significant deviation. Unsuitable conditions include solid barriers that cannot be drilled through or that act like a wedge, diverting the drill string. The pipeline contract specifies use of HDD, and trenching in the near-shore zone would only be carried out in the unlikely event that HDD proves to be unsuccessful.

6. Alternatives for Produced Water Management

109. Two alternatives have been considered for disposal of produced water:

(i) treatment, to remove hydrocarbons, and discharge to the Bintuni Bay from a depth of 13 m below sea level, at the LNG dock; and
(ii) re-injection, with or without treatment, into permeable subsurface formations.

110. Environmentally, re-injection may be preferred over marine discharge. However as the produced water will be treated to meet stringent effluent quality standards, the marine disposal alternative is also environmentally acceptable. The base case, on which existing designs are based, is for treatment and marine discharge. However, further studies of possibilities for re-injection will be carried out.

V. EXISTING AND ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

A. Environmental Standards and Guidelines

111. The Project is required to meet a wide range of Indonesian environmental standards, including standards for

(i) noise,
(ii) atmospheric emissions,
(iii) water quality (freshwater and marine), and
(iv) sanitary wastes.

The applicable Indonesian standards are tabulated in Appendix 8.

112. Several environmental media or activities have no Indonesian standards. These include onshore soils, marine sediments, and seismic survey activities. The Project will follow Dutch standards for soils and sediments, and for seismic surveys, the Joint Nature Conservation Committee (JNCC) Guidelines for minimizing acoustic disturbance to marine mammals.

Standards that will apply to atmospheric emissions are shown below, together with prevailing Indonesian and World Bank standards.

Table 2: Ambient Air Standards

Pollutant[a]	Averaging Time	Indonesia[b] ($\mu g/Nm^3$)	WHO[c] ($\mu g/Nm^3$)	Project ($\mu g/Nm^3$)
Carbon monoxide (CO)	1 hour	30,000	—	30,000
	24 hours	10,000	—	10,000
Hydrocarbon	3 hours	160	—	160
Nitrogen oxide (NO_x)	1 hour	400	190-320	320
	24 hour	150	—	150
	Annual	100	—	100
Particulate matters (PM_{10})	24 hours	150	—	150
Particulate matters ($PM_{2.5}$)	24 hours	65	—	65
	Annual	15[3]	—	15
Sulphur dioxide (SO_2)	1 hour	900	—	900
	24 hours	365	100-150	150
	Annual	60	40-60	60
Total suspended particles (TSP)	24 hours	230	150-230	230
	Annual	90[d]	80-90	90

Note: -- signifies no designated ambient air quality guideline,

[a] Only CO, NO_x, SO_2, and hydrocarbon measured for gas exploitation activities; all parameters except hydrocarbon measured for LNG Plant activities.

[b] Reference: Government Regulation No. 41 of 1999 regarding Control of Air Pollution (Peraturan Pemerintah No. 41 Tahun 1999 Tentang Pengendalian Pencemaran Udara).

[c] Reference: As published in the World Bank, 1998, *Pollution Prevention and Abatement Handbook*, Washington.

[d] These Indonesia $PM_{2.5}$ and TSP standards were originally indicated to apply to a 1 hour averaging time.

Source: Tangguh project, 2002, *Integrated AMDAL study*

Standards that will apply to liquid effluent discharges are shown below, together with Indonesian and World Bank standards.

Table 3: Effluent Standards

Pollutant Parameter	**Indonesian Standards**[e] mg/L	**World Bank Guidelines**[f] mg/L	**Project Standards**[g] mg/L
Biochemical Oxygen Demand $(BOD)_5$	—	50	50
Free Chlorine[a]	1		1
Maximum Discharge Temperature Offshore	45°C [b]	Increase < or = 3C°[h]	Increase < or = 3C° and not > 45°C
Oil and Grease (mineral)	50[c] 25[b]	29 (offshore)[i] 20 (onshore)	29 20
pH	6-9 [b]/[c]	6-9	6-9
Sulfide	—	1	1
Total Phenol		1	1
Total Suspended Solids[j]	—	50	50
Total Toxic Metal	—	5	5[d]

Note: All the discharge limits are in mg/L except for pH.

[a] Only relevant to sewage discharges that have been treated with chlorine (Kep 52/MENLH/10/1995).

[b] Liquid waste standard for integrated LNG and LPG refinery activities.

[c] Liquid waste standard for Oil and Gas Exploration Activities (offshore).

[d] Includes antimony, arsenic, beryllium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium, vanadium, and zinc.

[e] Minister of Environment Decree No. 42/MENLH/10/1996 Waste Water Standard for Oil and Gas Industry.

[f] World Bank, 1998, *Pollution Prevention and Abatement Handbook*, Washington D.C.

[g] Project Standards were chosen on a basis of most conservative between the references and in compliance of Indonesian Regulations.

[h] The effluent should result in a temperature increase of no more than $3C^0$ at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 m from the point of discharge

[i] *Oil and Gas Development (Offshore)* (International Finance Corporation Environmental, Health, and Safety Guidelines, 2000).

[j] During the construction activities the TSS concentration will be higher.

Source: Tangguh Project, 2002*, Integrated AMDAL Study*.

B. Environmental Impacts and Mitigation Measures

1. Surveys and Construction Phase

a. Surveys, Exploration, and Evaluation Drilling

113. Pre-construction activities have included seismic surveys, exploration and evaluation drilling, topographic and bathymetric surveys, engineering site investigations, environmental surveys (including socioeconomic and sociocultural surveys), and groundwater investigations. These activities have been largely completed, except for some of engineering investigations, which are still under way. These have been relatively unobtrusive compared to those that will occur during construction. Additional seismic surveys are also proposed, which could inconvenience nearby communities and affect large mammals. JNCC guidelines will be followed to minimize these risks. Mitigation measures include keeping watch for marine mammals, ceasing activities if marine mammals are within 500 m of survey activities, and using a low-energy start-up approach to sonic emissions.

b. Land Clearing and Site Preparation

114. The major onshore physical and ecological project impacts will occur during construction, particularly from clearing of vegetation and subsequent earthworks activities for the LNG plant, housing, airstrip, and marine facilities. Of the 3,266 ha acquired for the LNG property, land-clearing operations will affect an estimated total of 642 ha (19.7%):

(i)	LNG plant	379 ha
(ii)	LNG infrastructure including housing	35 ha
(iii)	Marine facilities and onshore pipeline	26 ha
(iv)	Airfield	127 ha
(v)	Perimeter fence	38 ha
(vi)	Disposal area for surplus excavated materials	37 ha

115. Should it be decided to exclude the airfield and associated access road, the total area to be cleared would be reduced by about 140 ha. Construction earthworks, comprising foundation excavations, placement, and compaction of engineered fill and grading for drainage purposes will be carried out over much of the cleared areas.

116. The areas of each terrestrial vegetation type that will be cleared during construction within the LNG property boundary, including the airfield, the perimeter fence and the area for disposal of excavated materials, are estimated to be the following:

(i)	Lowland tropical forest	410 ha
(ii)	Beach forest	72 ha
(iii)	Savannah	123 ha
(iv)	Mangroves	<1 ha
(v)	Swamp forest	11 ha
(vi)	Cultivated	25 ha

117. Of these vegetation types, the lowland tropical forest is the most diverse. However, the mangroves provide an important habitat, and resources from both beach forest and swamp forest are utilized by local people. Large areas of each vegetation type will be retained in an undisturbed condition within the 3,266 ha project property. Most of this area will be protected by a security fence around the perimeter of the property. However, about 10 ha of swamp forest containing sago resources will be excluded from the fenced area to allow for continued harvesting by the traditional owners. As exploitation of the tropical lowland forest continues outside the property boundary, the 2,624 ha of vegetation

remaining within the property boundary may become an important area for conservation of biodiversity.

118. All habitats and vegetation types are widespread in the region, and no species of flora or fauna are confined to the project property. Accordingly, the Project will not have significant impacts on the biodiversity of the region. The perimeter fence may, however, reduce genetic diversity of some terrestrial mammals confined in the project property.

119. Land clearing and earthworks activities will decrease soil stability, increase soil erosion, introduce suspended sediment into streams draining the sites, and deposit sediment in the receiving waters, mainly the Saengga River and the near-shore margins of Bintuni Bay. These impacts will be temporary and can be readily minimized.

120. Mitigation measures to be applied to land clearing and site preparation will include applying reduced impact logging principles; minimizing the area of disturbance; salvaging timber removed during land clearing; applying temporary erosion control measures, including wind-rows, contour banks, and furrows; followed by landscaping, planting, paving and construction of run-off collection, drainage, and a discharge control system. These measures will be prescribed, as appropriate, in the relevant contracts.

c. Construction of Land Facilities

121. The LNG plant and associated facilities will be erected in the prepared areas. Delivery of construction materials will increase sea traffic in Berau and Bintuni bays, and onshore activities will generate noise, dust, light (at night), and minor emissions from vehicles and other heavy equipment. These activities will add to the terrestrial biological impacts that resulted from land clearing. Erosion and sedimentation impacts will diminish as the landscaping and drainage systems are completed.

d. Construction of Marine Facilities

122. The major marine physical and ecological impacts will result from drilling of gas production wells and laying of subsea gas delivery pipelines and earthworks associated with construction of the marine facilities. Within the marine environment, a total of 191 ha will be disturbed, including

(i) LNG dock, combo dock, and approaches: 22 ha;
(ii) offshore platforms (two) and production wells: 3 ha; and
(iii) offshore pipelines (37 km total length): 166 ha.

123. The construction activities will disturb the seabed sediments, temporarily increasing turbidity and the concentration of suspended sediments in the immediate areas and in the direction of current flow, before the sediments redeposit on the seabed. These impacts are not considered to be serious, because high turbidities and high concentrations of suspended sediment are natural features of these environments, particularly near the coast and seabed.

124. Drilling mud and cuttings from the initial production well at each platform will be discharged at the site; mud and cuttings from subsequent wells will be re-injected, except for the 24-inch hole section. The total quantities anticipated to be discharged at each site are estimated at about 3,100 m^3 for drilled cuttings and about 20,000 m^3 for drilling fluid. The coarser cuttings are expected to deposit close to the platform where they may form low mounds, while the finer-grained mud, which is nontoxic, may be transported by currents, before depositing in areas of lower current velocity.

125. Disturbed areas should be readily recolonized by the same assemblage of marine benthic organisms that occupied the areas before construction. Fish and large marine animals such as turtles, dolphins, and crocodiles are all mobile and adaptable, and can readily avoid the construction area and therefore will not be harmed by construction activities..

126. Produced water from well clean-up and testing of production wells will be disposed of using the drill cutting re-injection system at the well sites. Water used for hydro-testing of pipelines will be discharged to the sea. All effluents will meet Indonesian discharge standards (Appendix 8).

127. Spoil dredged from shallow water sections of the gas pipeline and amounting to less than 5,000 m^3, will be transported by barge to designated areas in the middle of Berau and Bintuni bays, where the spoil will be discharged. This will result in a temporary surface plume of turbid water, with the sediment settling rapidly to deposit on the seabed close to the point of discharge. Criteria for selection of spoil disposal areas were that they be seabed depressions, with water depths exceeding 60 m, and with substrates of fine-grained seabed sediment. Modeling studies indicate that the dredged spoil will deposit in these areas. The presence of fine-grained sediments similar to the dredged spoil should ensure that recolonization by benthic fauna will be rapid. Care will be taken to ensure that the sediments are not discharged in rocky seabed habitats, which could be damaged by fine sediment.

e. Resettlement

128. The Project required relocation of the Tanah Merah community to new settlements near the host villages of Saengga and Onar. Other communities are also impacted as a result of project activities. (To address these issues, the LARAP is being updated to conform with ADB's involuntary resettlement guidelines.)

129. A total of 200 ha has been acquired for resettlement, outside the project property. Of this, 100 ha is for the new Tanah Merah village and 100 ha for Saengga village. Housing and community facilities have been developed on about 30ha of land cleared in Tanah Merah and 6 ha of land at Saengga. The remainder of the Tanah Merah land consists partly of swamp and partly of dry land, which will be developed for vegetable gardens and agro-forestry. A further 6–8 ha of land has been utilized at Onar to build the new Onar village.

130. The resettlement program aims to "resettlement with development" with households achieving better livelihoods than if the resettlement had not occurred. In addition to the development of new settlements, the Project is implementing a livelihood reconstruction program that includes reestablishment and development of agriculture, fisheries, and microenterprises. Education, vocational training, project-related employment, and health are also being addressed. Details are in the LARAP.

f. Construction Workforce

131. Construction of the LNG plant and associated facilities is expected to provide 5,800 temporary jobs on site. Preference will be given to job applicants from the nine DAVs (para. 76). However, as many of the requisite skills are not available locally, a significant part of the workforce will be recruited from other parts of Indonesia.

132. To ensure the fair distribution of opportunities, at least one construction job will be offered to each DAV household. Construction of the new settlements at Tanah Merah and Onar for resettlement of villagers from Tanah Merah has already been completed using labor from Tanah Merah and Saengga. A total of 60 villagers have already been trained in building skills. The construction jobs have the potential to significantly boost local incomes, enabling

improved living standards, health, and education. This will continue a trend that commenced during project activities before construction. As part of recruitment, prospective construction workers will undergo medical testing to confirm their health and fitness for site employment prior to mobilization. Medical facilities have also been established on site to provide on going medical care. These measures will also help to minimize the risk of diseases being introduced that could infect people in the local communities.

133. Introduction of a large construction workforce from outside the region has the potential to cause a variety of social problems. Additional problems could arise from outsiders visiting the site area seeking jobs and business opportunities. Interaction between the workforce and neighboring villagers, apart from those employed on the Project, will be minimized by the following:

(i) During and after construction, unauthorized outsiders will be discouraged from traveling to the site or its vicinity. The Project will not allow people other than its employees, contractors, and authorized Government personnel to use the airstrip or marine facilities.
(ii) A workforce management plan will require recruitment of nonlocal workers, payment of wages, and rest and recreation to be handled in the regional growth centers of Manokwari, Sorong, and Fak Fak, making it difficult for nonlocal construction workers to either remain in or return to the project area once their employment ceases.
(iii) Except for workers from the DAVs, the workforce will be accommodated within the LNG property, without access to nearby villages, with subsequent return to regional growth centers when site work has been completed.

134. The Project has been a catalyst for the diversified growth strategy (DGS), now adopted by the Government and the United Nations Development Programme (UNDP), to

(i) ensure that the Bird's Head region of Papua derives benefits from the Project,
(ii) mitigate in-migration and growth in areas without the capacity to assimilate such growth, and
(iii) manage project-induced developments.

135. The DGS includes the specific objective of ensuring that the project's "multiplier effects" will occur away from the project area, at locations with the capacity to accommodate the resulting growth. Components of the DGS include

(i) program to strengthen local business capacity; and
(ii) promoting development of new enterprises to provide goods and services required by the Project.

2. Operations Phase

a. Process Operations

136. Operations of the LNG plant and associated facilities will produce emissions and effluents, as identified and quantified in Appendix 3. Numerical modeling has demonstrated that atmospheric concentrations resulting from these emissions will be well within applicable standards.

137. CO_2 emissions will include "field" emissions representing CO_2 removed from the natural gas, and "plant" emissions produced by combustion of fuel gas to provide the energy for the LNG plant operations. Field emissions under the two-train scenario, will amount to 3 million tons of CO_2 each year; under a conventional energy generation scenario, an

additional 2.3 million tons per year would result from fuel combustion. Energy efficiency initiatives incorporated in the design will reduce the combustion emissions by 0.63 million tons per year, so that overall CO_2 emissions will be 4.67 million tons per year.

138. CO_2 emissions are of concern as they are implicated in global warming. The total CO_2 emissions from the Project are roughly equivalent to those emitted by a 650 MW black coal-fired power station. However, there will be significant offsets for these emissions. In countries where the gas will be sold, "clean" LNG will replace "dirty" fuel such as coal, leading to lower emissions of greenhouse gases for equivalent amounts of energy generated. Emissions of CO_2 from gas-fired power stations are two to three times less than for coal-fired plants of equivalent capacity. A gas-fired power station of 1,000 MW capacity would save more than 3 million tons per year of CO_2 emissions, compared to a black coal-fired plant, and even more if compared to a brown coal-fired plant.

139. The main liquid wastes will be formation water separated from the gas stream at the LNG plant at the estimated rate of 500,000 m^3 per year (about 1,370 m^3 per day), and desalination liquid residue generated at the rate of 464,000 m^3 per year (about 1,270 m^3 per day). Both will be discharged to the sea from the LNG dock trestle after onshore treatment to remove hydrocarbons in the case of formation water. These effluents will meet applicable World Bank and Indonesian discharge criteria. The disposal of desalination plant residue into the marine environment is an acceptable practice as it will not cause localized significant increase in salinity.

140. In the management of solid wastes, the operations will observe the principles of "reduce, reuse, and recycle." An incinerator will be installed for disposal of combustible wastes, including oily wastes, and a sanitary landfill will be constructed for other, non-hazardous solid wastes. Both these facilities will be constructed and permitted in accordance with the MOE requirements. Residues from the incinerator, together with any noncombustible hazardous or toxic wastes, will be transported to the existing, licensed toxic waste treatment and disposal facility at Bogor. Appropriate pollution control facilities and measures will be implemented at these solid waste management sites to ensure that treatment and disposal will not cause significant contamination of soil, surface water, or groundwater.

b. Shipping

141. For the two-train operations, average numbers of shipping movements will be two LNG tankers per week, plus two condensate tankers per month, or a total of approximately 128 shipping arrivals each year. Ballast water from LNG and condensate tankers will be discharged from the tankers and replaced outside the entrance to Berau Bay. As ballast water does not contact the gas or condensate storage areas, it will not be contaminated by hydrocarbons. However, ballast water could introduce potentially damaging foreign marine organisms. The tanker operators will be required to adhere to international treaties on the disposal of ballast water which, while not guaranteed to preclude the introduction of foreign organisms, will minimize the risks.

c. Marine Structures

142. Following construction of the gas production platforms and LNG trestle, the subsea structures will become colonized by marine organisms, which will attract other species, resulting in a local increase in diversity. This "artificial reef" effect has been documented at offshore development sites throughout the world and is generally considered to be beneficial.

143. The project installations and activities are not expected to adversely affect marine mammals, turtles, or crocodiles. This conclusion is based on the following considerations:

(i) While marine mammals and turtles consume a wide variety of foods (e.g., sea grass for dugong and green turtles, jelly fish for other turtles, fish for dolphins), none of these foods will be affected by the Project.
(ii) Turtles require sand beaches for nesting, and such beaches are not present in the vicinity of project activities.
(iii) Crocodile habitat is widespread throughout the coast of Berau and Bintuni bays, where it occupies several hundred square kilometers, but less than 1 ha of this habitat will be disturbed by the Project.
(iv) These large marine animals are all mobile and adaptable and can readily avoid areas of intensive activity such as construction sites.
(v) Other similar projects have operated in proximity to the same or similar fauna, without adverse impacts.

144. If a solid causeway is incorporated into the combo dock, it will modify the coastal sediment transport process. Modeling studies indicate that deposition will occur along both sides of the causeway, locally extending the intertidal area. The same studies indicate the potential for shoreline erosion about 1 km east of the combo dock. If a solid causeway is built, this area will be closely monitored and, if erosion occurs, shoreline protection measures will be installed. If, on the other hand, the combo dock comprises only the trestle structure, shoreline sediment transport will not be affected.

d. Exclusion Zones

145. As a safety precaution, exclusion zones will be established around each production platform, along the subsea pipeline corridors, and around the marine facilities. The total area of the exclusion zones will be about 4,555 ha. The 695 ha exclusion zone around the marine facilities will reduce the area available to local people for harvesting of prawns, and will decrease accessibility to areas of sago and other resources. This will result in additional pressure on the remaining accessible areas for these resources. Livelihood impacts of these restrictions and associated mitigation measures are described in the LARAP. Mitigation measures documented in the LARAP include assistance to develop alternative livelihood activities, technical assistance to obtain access to more distant resources, and facilitation of onshore access to a large area of sago in the northeast corner of the project property.

146. The exclusion zones will reduce the area available to commercial fishing operations. However, the total areas excluded, amounting to 4,555 ha, represent less than 0.5% of the Berau and Bintuni bay area. Ships and boats can still pass the pipeline corridor as long as they do not drop their anchors or trawls.

e. Workforce

147. The Project, at its initial two-train development, will directly employ about 450 people with a wide range of skills, of whom about 250 will be on site at any one time. Employees will work on rotational schedule, where the employees will return to their homes or places where they were hired at the end of each work period. Workers will be housed in single-status accommodation within the LNG property. The Project will favor local people, in particular those from the nine DAVs. When operations start, people from the DAVs are expected to fill all the 42 unskilled positions, 25 of the 50 low-skilled positions, and 3 of the skilled positions. Workers from other parts of Papua are expected to fill 92 positions when operations start, meaning that 31% of jobs in the initial operations workforce will be performed by Papuans. The Papuan workforce is expected to increase to 62% after 10 years, and to 85% after 25 years (including 10 supervisory positions filled by people from the DAVs). These are target

figures on which training programs will be based. Training of local people to fill key positions in the operations workforce has already commenced. Project employment will therefore provide a major benefit to people from the DAVs, and significant benefits to people from elsewhere in Papua: household incomes will increase, leading to improvements in health, welfare, and education throughout the project-affected communities.

148. In addition to the direct employment, the Project will provide opportunities for local enterprises to undertake short- and long-term service contracts, providing more jobs for local people.

149. During construction, the prospect of well-paid jobs will attract people from elsewhere in Indonesia. In-migration of large numbers of people seeking work could overwhelm local communities and cause major social problems. The Project will thus continue the same recruitment, workforce management, and diversified growth policies established for the construction phase.

f. Social and Economic Aspects

150. The Project has established community development programs, which include the following:

(i) Sponsorship of community action plans in the DAVs and the district towns of Babo and Arandai. Funding of $30,000 per DAV per year for 10 years has been allocated, with the proceeds to be spent on projects selected by the communities themselves, with the assistance of non government organizations (NGOs). Development of the district towns is supported by an annual allocation of $10,000. This program commenced in 2002. Projects already completed, including boardwalk swamp crossings and improved household sanitation, are listed in Appendix 9.
(ii) A community-based enterprise initiative aimed at broadening the economic base in parts of the Bird's Head region outside the DAVs. The Project's contributions will include training, capacity building, and microfinance.
(iii) Contributions to the improvement of health and education facilities and services in the Berau and Bintuni bay area.
(iv) Assistance to build the capacity of local, district and regional governments.

151. The Project will generate direct and indirect economic benefits, locally, regionally, and nationally. During construction, and to a lesser extent in the operations phase, significant numbers of local people from the DAVs will be employed, resulting in a substantial rise in household incomes. The main multiplier effect from the Project is expected to occur in the regional growth centers of Fak Fak, Manokwari and Sorong, leading to increased business opportunities and stimulating economic activities in those areas.

152. The Project is expected to generate revenues to the Government of at least $7 billion from production sharing and taxes. In accordance with the Papuan Special Autonomy Law, 70% of the post tax revenues will be returned to the province, which will be reduced after period of 25 years to 50%. Major revenues will commence 8 years into the Project (2016), after cost recovery. From 2019, over $100 million per year should be available to the provincial government which may be used to improve infrastructure and government services. These revenues should ensure that substantial lasting socioeconomic benefits throughout the province will result from the Project.

g. Induced Development

153. It is expected that the Project will not induce significant secondary industrial development in the immediate vicinity of the project area as particularly all LNG will be exported.

154. The DGS aims to ensure that the project benefits, including any induced developments, are distributed throughout the Bird's Head in Papua while promoting awareness and capacity to manage induced change. The DGS has been formally adopted by the Papuan government at the provincial and regency levels and is being supported by various agencies, including UNDP. U.S. Agency for International Development (USAID) has implemented programs in the Birds Head that complement the DGS. Key elements of the DGS include

(i) spatial planning,
(ii) workforce management,
(iii) empowerment of Papuan business,
(iv) management of in-migration, and
(v) building of community awareness of potential changes and promotion of their capacity to proactively manage change.

155. The DGS focuses on promoting the development of regional growth centers, including Fak Fak, Sorong, and Manokwari, because they already have well-developed infrastructure and services and will be the focus of many project-induced changes (e.g., in-migration, workforce management, procurement, etc.).

h. Biodiversity Action Plan

156. The Project has entered into partnership with national and regional government agencies, academic institutions, international aid agencies, and NGOs, including The Nature Conservancy (TNC), Conservation International (CI), Wildlife Conservation Society (WCS), World Wide Fund for Nature (WWF), USAID Coastal Resource Management Partnership, University of Papua, and Bogor Agricultural University, to undertake the Bird's Head Biodiversity Action Plan, which involves the following components:

(i) support a conservation training and resource center;
(ii) contribute to a Berau and Bintuni bay land-use atlas;
(iii) support Bintuni mangrove reserve management;
(iv) assess Bintuni Bay fisheries' health;
(v) support a book on Papua, as part of the Ecology of Indonesia series;
(vi) conduct a site flora and fauna survey;
(vii) conduct an energy and biodiversity initiative, and
(viii) support, as a charter member, the Papua Conservation Fund.

C. Cumulative Impacts

157. Although the Project, as currently approved, involves two LNG trains, there is sufficient natural gas resources available to support further expansion. Plot plant space has been reserved at the site for future expansion. Expansion beyond two trains would require new AMDAL studies. However, based on the information, some preliminary conclusions can be made about the additional impacts that would result and the capacity of the environment to absorb these impacts. Expansion of the Project to this configuration would involve

(i) no additional land acquisition,
(ii) minimal additional land clearing within the LNG plant area,

(iii) construction of two additional LNG docks and possible a permanent condensate loading facility,
(iv) the gas and liquid emission increasing proportionately with the feed gas rate,
(v) creation of up to 3,000 additional jobs at peak construction for each subsequent future train and about 50 additional personnel for the operations workforce for each new train,
(vi) increased annual revenues to government, and
(vii) economies of scale with reduced unit costs.

158. Only a small increase in the Project "footprint" would be involved. Atmospheric emission rates and liquid discharge rates would increase substantially, requiring that treatment capacities be increased commensurately. For LNG plant effluents, the quantities involved may require separate, additional seawater intake and effluent discharge systems for future trains, but treatment to meet discharge standards will ensure that the receiving environments are not adversely affected. Expansions would occur incrementally, one or two trains at a time, enabling the effects of each expansion to be measured and the effects of subsequent expansions to be projected.

VI. ECONOMIC ASSESSMENT

A. Project Cost and Expenditure

159. The capital cost for two LNG trains and associated gas production facilities is estimated at $5 billion. Operating expenditures for the two trains are estimated at $54 million per year.

160. The cost of impact reduction measures and environmental management safeguards included in the capital cost is impossible to estimate accurately, as many environmental measures such as wastewater treatment are incorporated as a matter of routine without separately accounting for their costs. Significant environmental components of the project capital costs include an estimated $7 million for re-injection of drilling mud and cuttings, and $12 million for horizontal direct drilling to minimize mangrove damage. In addition to this, there will be additional environmental expenditures in relation to the ongoing environmental studies and program.

161. Environmental, social and resettlement expenditures to date, including costs for AMDAL studies, biodiversity programs, subsequent environmental surveys, social programs and resettlement project exceeds $61.7 million. A budget allocation of $62 million has been committed by the Project for the next 5 years for environmental and social programs covering the construction and early operations phases. This amount excludes environmental expenditures within the construction contracts.

B. Economic Costs and Benefits

162. Ideally, economic assessment in the context of environmental impact assessment of this Project should determine its economic soundness, capturing all externalities, especially its environmental costs and benefits. The Project will yield direct and indirect economic and social benefits. This section will focus on the economic costs and benefits of the project's environmental impacts. However, it is difficult in practice to place economic value in monetary terms on environmental impacts. Therefore, the results of economic analysis in this section can only reflect part of the picture.

163. The Project will consume the following environmental resources and services:

(i) Exclusion, for the duration of the Project, of 3,266 ha of forest from economic uses, of which about 642 ha will be cleared for project facilities;
(ii) Exclusion, for the duration of the Project, of about 4,555 ha of sea area from fishing activities and navigation;
(iii) discharge of residual amounts of pollutants into the marine environment, the atmosphere, and land;
(iv) discharge into the atmosphere about 4.67 mtpa of CO_2.

164. The exclusion of 3,266 ha will help conserve the remaining 2,624 ha of forest. The reforestation of 6,984 ha will further offset the impacts of clearing 642 ha of forest. Likewise, the marine exclusion zone will help conserve fishery resources, which are now overexploited in the bay.

165. Where possible, the Project has made attempts to offset or compensate for the social cost of restriction on the use of the exclusion zone and forest areas. For example, the potential loss of livelihood for people from Tanah Merah has been compensated for by a wide variety of initiatives, as detailed in the LARAP.

166. The discharge of small quantities of residual pollutants into the environment and the ecosystems will not create significant impacts on environmental quality and the ecosystems. Therefore, the economic cost of waste disposal, if it can be determined, will not be significant.

167. The discharge of 4.67 mtpa of carbon dioxide will contribute to the global greenhouse gas emissions. However, this environmental cost will be offset by the environmental benefits to be gained by replacing coal or oil with LNG. The net quantity of carbon dioxide, sulfur dioxide, nitrogen oxides, and particulates that could be reduced by replacing 14.4 mtpa of coal (heating value of 28 mega joule per kilogram (MJ/kg]) with 7.6 mtpa of LNG would be

(i) carbon dioxide, 19.31 mtpa;
(ii) sulfur dioxide, 294,625 mtpa;
(iii) nitrogen oxides, 127,414 mtpa; and
(iv) particulates, 536,671 mtpa.

The calculations are in Appendix 10.

168. The economic value of carbon dioxide, sulfur dioxide, and nitrogen oxides was estimated from past data on trading prices. As particulates are not traded, their economic value was assumed to be equal to the removal cost for typical coal-fired power plants (or avoidable cost). The total economic value of these environmental benefits would be about $959 million per year. This would give a net present value of the total environmental benefits over the project life of about $10,378 million, assuming a project life of 20 years and a discount rate of 8%.

169. The environmental benefit net present value (NPV) figure could serve only as an indicative figure and would be much on the low side because of the following:

(i) The trading prices of sulfur dioxide, nitrogen oxides, and carbon dioxide were used instead of the much higher figures of treatment costs (avoidable costs). Strictly speaking, the treatment cost should be used as the international trading markets would not be able to absorb all the pollutants.
(ii) The figures used in calculating benefits were deliberately kept low since they were not adjusted to 2005 prices.

170. The environmental benefits of the Project indicate substantial global environmental benefits.

VII. ENVIRONMENTAL MANAGEMENT PLAN

171. A comprehensive environmental management plan (RKL) and environmental monitoring plan (RPL) were formulated and approved by the Indonesian authorities as part of the AMDAL process. The abstract of the RKL and RPL is presented in this section.

A. Mitigation Measures

1. Construction Phase

172. The main potential construction phase impacts and mitigation measures to be implemented are summarized below:

Table 4 : Main Potential Construction Impacts and Mitigation Measures

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
Land clearing	Loss of vegetation and loss of timber resources as a result of land clearing	• Minimize "footprint" • Harvest usable timber • Minimize impacts from tree cutting and land clearing • Compensate traditional resource owners and the Ministry of Forestry for loss of resources in accordance with the applicable forestry regulations	• Clearing is restricted to land required. • Timber utilization project has been developed to manage usable timber harvested from LNG site for productive use. • The reduced impact logging principle is applied. • Payments are made to traditional resource owners, tax (PSDH), and Reforestation Fund (DR) in accordance with the applicable forestry regulations.	The Project and EPC contractor for LNG plant construction
Land clearing	Reduction in faunal habitats, biodiversity, and genetic diversity	• Minimize "footprint" • Conserve the remaining area	Biological surveys, with management as necessary, based on survey results	The Project, assisted by consultants
Land clearing	Loss of ecologically	Minimize mangrove disturbance	• Siting of facilities to avoid mangroves	The Project and EPC

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
	valuable mangrove habitat		where possible • Selection of the HDD method for pipeline installation across shoreline (assuming it proves technically feasible)	contractors for the LNG plant and pipeline construction
Land clearing and earthworks	Soil instability, erosion, and sediment transport due to earthworks	• Select a site with low relief • Implement erosion control measures	• Minimize the need for cut and fill • Land clearing and grading following establishment of erosion protection measures • Erosion protection using vegetative matting and mulches, velocity reduction barriers, retaining walls, and sediment retention basins • Temporary stabilization, by seeding and/or mulching, applied to areas that would otherwise remain in a disturbed condition for more than 90 days • Long-term stabilization of areas between facilities will be by sheeting with crushed rock, or paving for those areas that may be subject to traffic, and landscaping together with top-soiling and replanting with local plant species, for other areas • Installation of engineered run-off control and drainage system, with scour	The Project, and EPC contractors for LNG plant and pipeline construction

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
			protection as appropriate	
Marine construction	Adverse effects on marine organisms due to generation and dispersal of turbidity or suspended sediment	Generally not required as the areas involved and biota are naturally subject to high turbidity or suspended sediment levels.	Mud excavated from shallow water portions of the gas pipeline will be deposited in deep water, in areas that are first surveyed to ensure that they comprise only soft mud seabed, i.e., without hard rocky substrate.	The Project, EPC contractor for pipeline construction
Drilling of production wells	Contamination and burial of marine organisms by accumulation of drilling mud and drill cuttings on the seabed around offshore platforms	Adopt best practices in environmental management of oil and gas drilling	• Only nontoxic drilling mud will be used, except in reservoir intervals, where low-toxicity mud will be used. • Low-toxicity mud used for drilling through reservoir intervals will be recovered and returned to the manufacturer for recycling. • A toxicity test will be conducted on this fresh mud sample to ensure that the mud to be used is not categorized as hazardous material. For the first well at each platform, a used mud sample and a cutting sample will be taken when the well reaches final depth for toxicity tests. If the mud and cutting do not pass the test, the Project will consult with MOE and MIGAS to	The Project, and drilling contractor

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
			determine what management approach complies with the regulations. • Except for the first well at each platform site, mud and cuttings will be re-injected into sub-seabed formations.	
Workforce recruitment	Potential dissatisfaction or conflicts among local residents as a result of unrealized employment expectations Note: The potential for this impact will continue during operations.	Integrated social programs involving community consultation, job, training, and conflict resolution	• Provision of education programs and vocational training in building skills • Improvement of sanitation and health facilities • Employment policies to ensure that at least one construction job is offered to each household in the DAVs • Community consultation, public participation, and conflict management • Development of conflict resolution and grievance procedures	The Project, and all EPC and other contractors
Workforce recruitment	Overwhelming of local communities due to influx of people seeking jobs Note: The potential for this impact will continue during operations.	Adoption of strategies and policies to minimize the risk of induced development close to the project site	• Implementation of the diversified growth strategy • Workforce management plan, with recruitment, most payroll and R&R functions carried out in regional growth centers • Provision of assistance, including	The Project, and all EPC and other contractors

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
			capacity building for leaders in local villages	
Workforce deployment	Social or cultural problems due to interaction of traditional villagers with construction workforce Note: The potential for this impact will continue during operations.	Minimize opportunities for interaction	In accordance with the closed camp policy, the non local construction workforce will be confined within the LNG property.	The Project, and all EPC and other contractors
Perimeter fence around LNG property	Isolation of small populations of some species of wildlife within the fenced area could result in nonviable populations or eventual reduction in genetic diversity. (On the other hand, the protection afforded by the fence could benefit these species.) Note: These impacts will continue through operations.	Manage the uncleared part of the project property to conserve ecological values	• Vegetation and fauna within the project "footprint" will be monitored before any land clearing, and again after completion of land clearing. • Areas surrounding the cleared areas will be monitored during project years 2, 4, 7, 10, 15, and 20, unless results indicate the need for more frequent monitoring. • Management of habitats and wildlife will be based on results of the monitoring.	The Project
Displacement of Tanah Merah	Loss of livelihoods, reduced access	• Resettlement • Compensation • Development of	• Implementation of a comprehensive LARAP to	The Project

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
villagers	to resources.	alternative livelihoods	compensate for and provide substitutes for losses. • Provision of alternative access to resources. • Provision of training and construction employment.	

Source: Tangguh Project, 2002, *Integrated AMDAL Study*

2. Operations Phase

173. The main potential impacts during operations and mitigation measures to be implemented are summarized below:

Table 5 : Main Potential Impacts During Operations and Mitigation Measures

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
LNG plant operations - atmospheric emissions.	• Combustion emissions adding SO_x and NO_x. • Emission of CO_2 and H_2S waste gas contributing to "greenhouse effect".	• Minimization of flaring. • Minimization of GHG produced in LNG operations. • SO_2 concentration will be within standard, so that no SO_2 removal will be required.	• During LNG loading, boil-off gas will be recovered. • GHGs reduced by use of waste heat, reductions in vent and flare streams, and use of efficient gas turbines. • Low NO_x burners • H_2S removed by oxidation.	The Project
LNG plant operations – liquid effluent discharges.	Water pollution due to discharge of contaminated liquids; e.g. formation water, storm-water, and brine from the desalination plant.	Treatment to meet Indonesian and relevant World Bank wastewater discharge standards.	• Hydrocarbons removed from produced water by gravity separation, hydrocyclone and skimmer. • Oily contaminants removed from oily process water and contaminated site run-off by means of a corrugated plate	The Project

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
			interceptor. • Desalination plant effluent mixed with 14.2 times volume of sea water.	
LNG plant operations -- disposal of solid wastes	Contamination of soils, surface waters or groundwater by solid wastes.	Implementation of comprehensive solid waste management plan involving re-use, re-cycling and appropriate treatment.	• Hazardous (B3) wastes will be burnt in a licensed hazardous waste incinerator on-site or sent to the licensed treatment/disposal facility in Bogor, in accordance with Indonesian requirements, • Recyclable wastes such as metal cans, plastic and glass, will be segregated and sent to a recycling facility, • Non-B3, non-recyclable combustible wastes will be incinerated at the site, • Sanitary wastes will be treated in a sewage treatment plant, • Putrescible wastes will be composted, and • Other inert solid wastes will be placed in an on-site sanitary landfill facility.	The Project
LNG plant operations	Noise causing disturbance to local communities.	Use of low noise emission equipment.	Modeling shows noise will not exceed standards; therefore no additional mitigation is required.	

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
LNG plant operations.	Onshore spillage of condensate or other hazardous liquid Potential contamination of soil and/or groundwater.	Implementation of Spill Prevention, Containment and Control Plan.	Measures include: • secondary containment around all storage tanks. • Instrumentation to prevent over-filling. • monitoring systems to detect malfunctions • emergency response procedures.	The Project
Aircraft movements	Disturbance to local communities	Modeling shows noise will not exceed standards; therefore no mitigation is required.	Not required	
Shipping movements	Introduction of exotic organisms from discharge of ballast water.	Ballast water disposal will be in accordance with the MARPOL Convention.	Ballast will be discharged and replaced outside entrance to Berau Bay.	The Project, Shipping Companies.
Operations of Marine Facilities	Offshore spillage of condensate or diesel fuel, contamination of sea water.	Implementation of Spill Prevention, Containment and Control Plan.	Measures include: • close supervision of loading and unloading. • instrumentation to prevent over-filling. • monitoring systems to detect malfunctions. • emergency response procedures.	The Project, and Shipping Companies.

Project Activity	Issues and Potential Impacts	Mitigation Measures	Means of Implementation	Responsible Party
Project Community Development Program This commenced prior to the construction phase	Concentration of benefits in DAVs causing resentment in non-DAV communities.	Community development programs designed to spread benefits beyond the DAVs.	• The Project is implementing community development programs, including contributions to health and education programs, to benefit communities in the broader Berau-Bintuni bays area (see Appendix 9 for examples of Community actions already implemented), • Substantial employment benefits will be available in the regional growth centers, • Major project revenues flowing to the province from 2019, should lead to substantial improvements in infrastructure and government services throughout the province. • An indigenous people development plan is being developed to address this.	

Source: Tangguh Project, 2002, *Integrated AMDAL Study*

B. Environmental Management System

174. Each EPC contractor will be required to develop an environmental management system (EMS) in line with ISO 14001. As the approved RKL is still broad because it was prepared for the entire project, each EPC contractor will be required to translate the RKL into an environmental management plan specific to each contract. For example, KJP, the EPC contractor for LNG plant construction, has already prepared such a plan to address

(i) air quality management;
(ii) water management;
(iii) solid waste landfill;
(iv) waste management plan:
  (a) hazardous,
  (b) non-hazardous,
  (c) combustible,
  (d) noncombustible, and
  (e) organic;
(v) spill prevention and control;
(vi) environmental health management:
  (a) hazard communication,
  (b) chemical and physical agents,
  (c) public health, and
  (d) material handling;
(vii) land conservation:
  (a) erosion sedimentation and storm water,
  (b) tree harvesting and land clear and grub,
  (c) cut and fill,
  (d) on site nursery,
  (e) temporary drainage,
  (f) coastal area protection,
  (g) inland location,
  (h) dust control, and
  (i) dredging and cutting disposal:
(viii) night lighting;
(ix) flora and fauna protection plan;
(x) noise mitigation;
(xi) mobilization and demobilization;
(xii) environmental inspection, audits, and reporting; and
(xiii) environmental awareness.

175. Detailed engineering design, including physical planning, will incorporate sound environmental design criteria and practices, and mitigation measures prescribed in the environmental management plan. The sound environmental management practices and mitigation measures will be prescribed in the contracts with each EPC contractor, and their implementation will be legally binding on the EPC contractor and its subcontractors. In addition to environmental mitigation measures, all the EPC contractors and subcontractors will be required to follow the project's policies and procedures for recruitment of employees and workforce codes of conduct. Examples of relevant contract clauses are included in Appendix 11. Items to be addressed will be different for each different contract and will be based on each contractor's activities and their potential environmental impacts.

C. Monitoring and Auditing

176. Compliance and impact monitoring will be carried out during construction and operations in line with the requirements and proposed monitoring program in the RPL approved by the Indonesian authorities. The monitoring covers air quality (ambient and emissions), water quality (ambient and effluent discharges), noise, flora and fauna, marine biota, and a wide range of socioeconomic and sociocultural parameters. The monitoring locations, parameters, and frequencies are specified in the RPL and summarized below. As the approved RKL is still broad because it was prepared for the entire project, each EPC contractor will be required to translate the RPL into an environmental monitoring plan specific to its contracts and related to the construction schedules. Each EPC contractor will be responsible for monitoring the effects of activities under its control, under supervision

provided by the Project. At 6-monthly intervals, the results of environmental monitoring will be collated by the Project, and presented in a report distributed to the responsible national and provincial government authorities, including

(i) Ministry of Environment (central Government);
(ii) The regional environmental impacts control agency (BAPEDALDA) for Papua and Irian Jaya Barat provinces;
(iii) BAPEDALDA and environmental agencies for Teluk Bintuni, Sorong, Fak Fak, and Manokwari regencies;
(iv) Directorate General of Oil and Gas;
(v) Directorate General of Sea Communications; and
(vi) Directorate General of Air Communications.

177. Adherence to environmental policies, procedures, and management plans, as committed to in the approved AMDAL, will be subject to 6-monthly internal audits. External audits will be carried out each year by independent auditors.

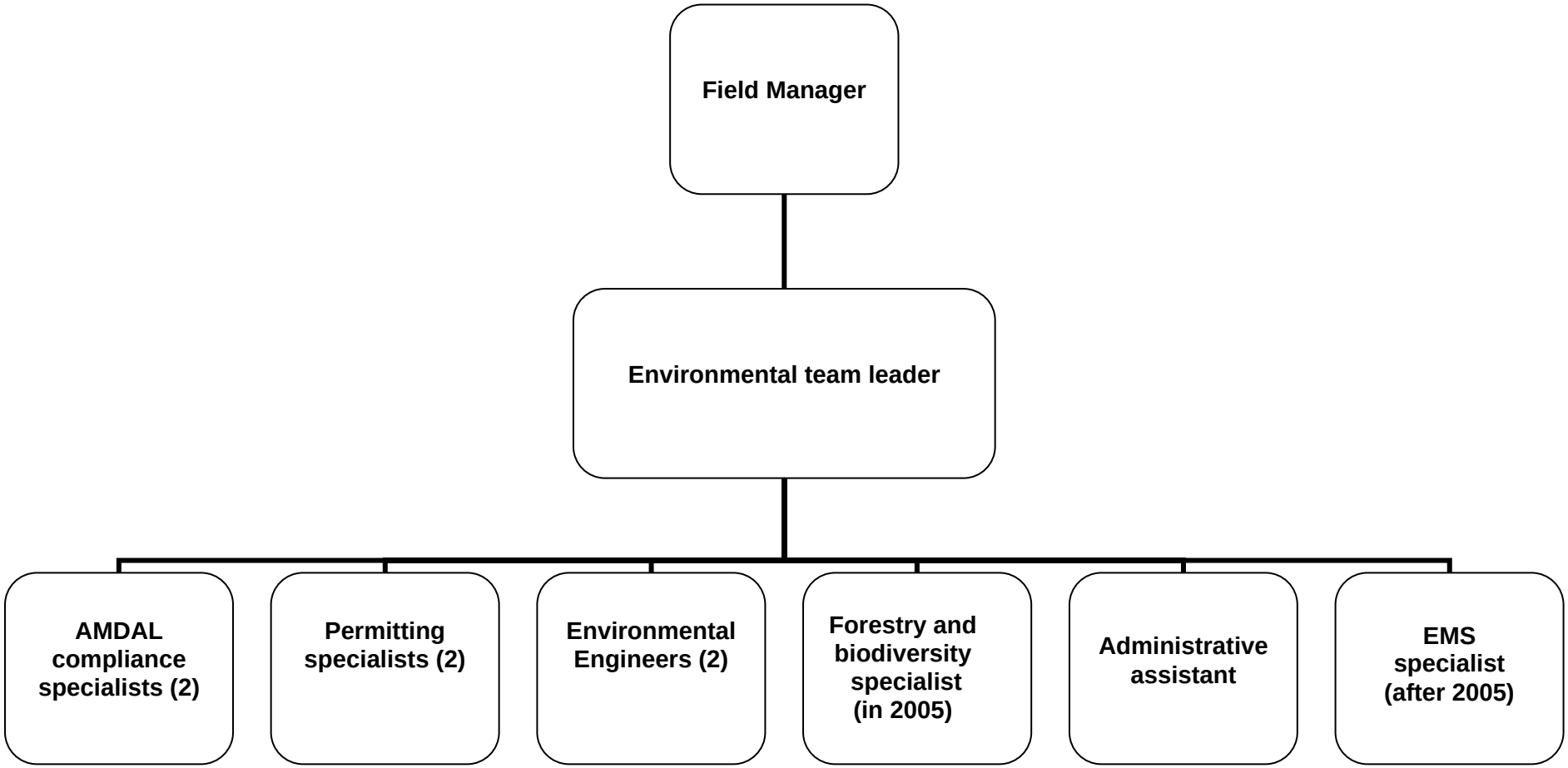
D. Organization

178. The composition and reporting relationships of the project environmental team for the construction and operations phase are shown in Figures 5 and 6, respectively. The responsibilities of the environmental team will include

(i) provision of assurance on project environmental performance to ensure compliance with the AMDAL, applicable Indonesian regulations, and BP environmental expectations;
(ii) review of project designs in relation to environmental matters;
(iii) supervision of activities with potential environmental effects;
(iv) supervision of construction stage environmental management and monitoring, and implementation of operations stage management and monitoring programs;
(v) maintenance of environmental management systems and documentation, including revisions as appropriate, based on the results of monitoring;
(vi) reporting of environmental compliance to relevant agencies of the national government;
(vii) interface with government authorities; and
(viii) troubleshooting, should this be required as a result of unforeseen circumstances.

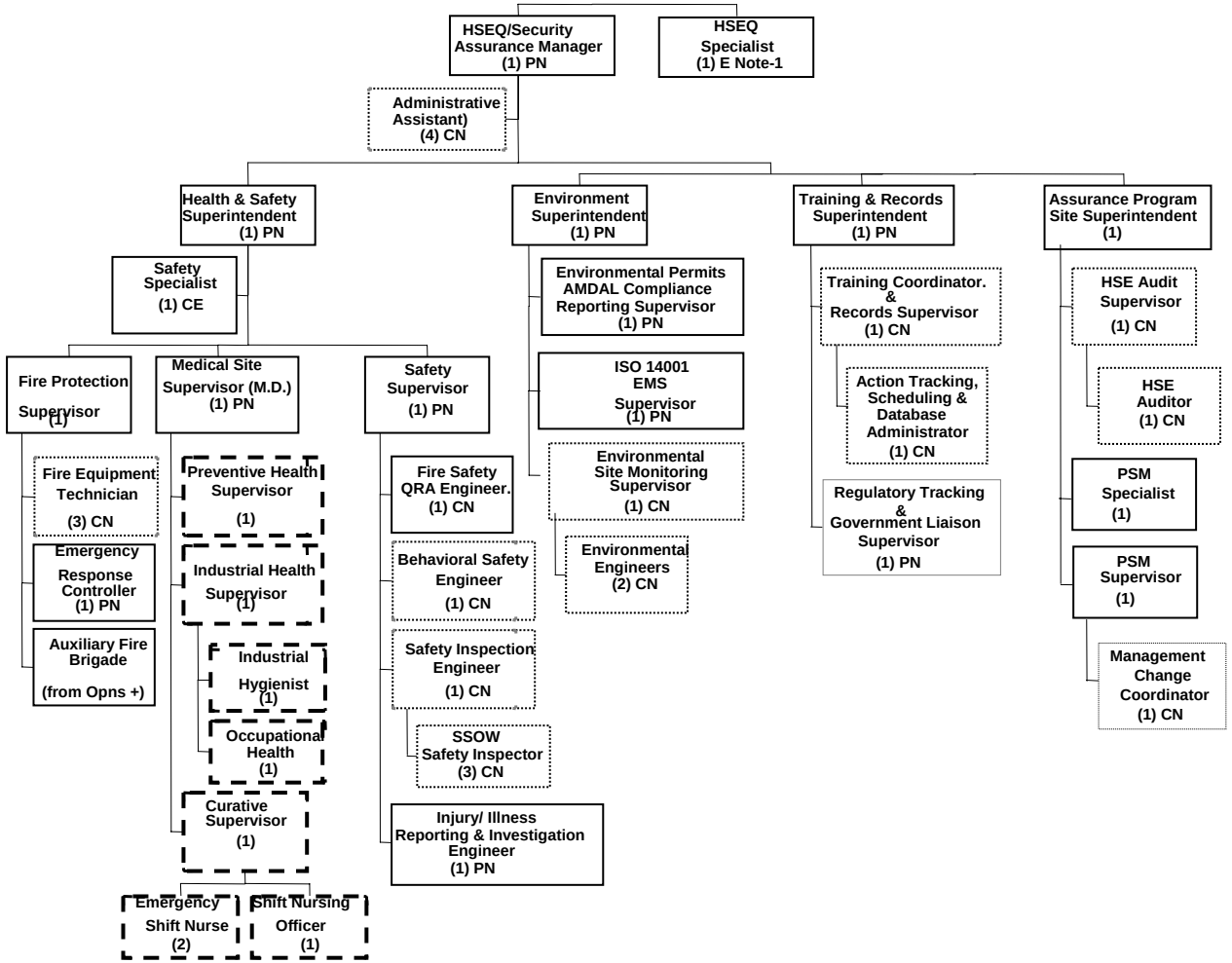
179. A separate integrated social program team will be responsible for all social aspects of the Project, including community liaison, community development programs, and AMDAL social compliance.

Figure 5: Environmental Team, Organization, Construction Phase



AMDAL = Analisis mengenai dampak lingkungan
EMS = Environmental Management System

Figure 6: Environmental Team, Organization, Operations Phase



VIII. PUBLIC CONSULTATION AND DISCLOSURE

180. Extensive public consultation and disclosure have been carried out since the project's inception. As part of the AMDAL process, public consultation occurred

(i) during preparation of the terms of reference for the studies;
(ii) in the process of obtaining baseline data for the AMDAL study;
(iii) after drafts of the ANDAL, RKL, and RPL impact had been prepared;
(iv) during formal hearings conducted by the AMDAL Commission, in Jakarta and Papua; and
(v) following AMDAL approval.

181. At least 1,622 people in the villages and towns registered their names and participated in the consultations. More than 1,600 comments have been received from the public, including NGOs and local communities. These comments were addressed in the final AMDAL and have been discussed with local communities and NGOs. Appendix 12 gives the names of the towns and villages where the consultations took place, the dates of consultations, and the number of people who registered as attending the consultations (not counting the onlookers).

182. Consultation and disclosure were achieved by a variety of means, including

(i) public announcements provided through the printed and electronic media at the national and local levels;
(ii) consultations with interested groups in Jakarta and in Papua;
(iii) preparation of information materials targeted at different stakeholder groups;
(iv) presentations to various stakeholder groups, including local communities, local government, community leaders, NGOs, local universities, and media;
(v) addressing the concerns of affected people by means of workshops at which information was provided on the nature of the project, environmental, and social impacts, and proposed management measures and monitoring plans;
(vi) consultations with local NGOs participating in site tours, and national and international NGOs;
(vii) capacity building in DAVs: as part of the AMDAL public consultation process, elected representatives were trained by local university and government specialists to enhance understanding of the Project and the AMDAL process;
(viii) a study tour of the Bontang LNG facilities in East Kalimantan by community representatives; and
(ix) addressing of concerns raised through the pubic consultation process related to environmental and social programs.

183. Specific consultations were carried out on resettlement of villagers from Tanah Merah. These included

(i) a series of meetings with local government in 1999;
(ii) establishment, in April 1999, of a guidance team under Government decree;
(iii) consultations and socialization meetings and discussions with landowners, villagers, and tree and crop owners to explain the project requirements and to obtain responses from those potentially affected; and
(iv) establishment of the Tanah Merah resettlement committee (TMRC) in 2001.

184. The TMRC comprises 15 members elected by villagers, and has three divisions: (i) law and administration, including formal law and *adat* law; (ii) community development, including farming, forestry, fisheries, cooperatives, industry, and women's empowerment; and (iii) relocation and resettlement. Since its inception, the TMRC has worked in

partnership with the Project in planning and implementing the resettlement project, including selection of resettlement locations, design, construction, and management of the transition.

185. Public consultation and disclosure will continue for the duration of the Project, with the means changing to meet changing circumstances. A public consultation and disclosure plan was formulated and included as an appendix to the RKL. As the capacity of local people increases, the Project will seek their involvement in aspects of environmental management and monitoring. The Project provides annual briefings to NGOs in London; Washington, DC; Australia; and Papua, providing a forum to update interested parties on environmental and social programs.

186. Support for the Project has been overwhelmingly positive, with a survey conducting as part of the AMDAL social survey in 2000, indicating 90% of 230 respondent from the DAVs in favor of it. As the Project proceeds, grievances will inevitably arise, possibly because of misunderstandings, unrealized expectations, or unforeseen developments. An important component of public consultation as the Project moves into the construction stage will be grievance identification and conflict resolution. The Project has formulated a conflict resolution plan to ensure that

(i) grievances are identified as early as possible, so that they can be addressed before they develop into conflicts,
(ii) all grievances are reported immediately to the appropriate project personnel,
(iii) actions in response to grievances are communicated promptly and explained thoroughly to all those involved, and
(iv) follow-up will be provided to assess the success of actions in resolving grievances.

187. The Project is working with the center for research on inter-group relation and conflict resolution (CERIC) to develop a detailed implementation plan for conflict resolution. This detail plan is being developed based on background research and preliminary study performed by a local NGO (Yayasan Satu Nama). A workshop will be held with local communities and other stakeholders to obtain input on traditional customs so that conflict can be solved using local wisdom. Additional consultation procedures applying specifically to resettlement are detailed in the LARAP.

188. Grievances will be documented as part of the environmental monitoring program and reported in the 6-monthly AMDAL compliance reports to relevant government institutions.

IX. CONCLUSIONS

189. The Project represents a major step in the economic development of Indonesia and will be particularly important in the development of Papua, where significant employment opportunities will be generated. Sales of LNG and condensate will add to Indonesia's gross national product and generate foreign exchange. Taxes and the government share of revenues can be used to improve infrastructure and government services, particularly in Papua. In addition, the Project will yield substantial global environmental benefits by replacing coal or oil. Based on these environmental benefits, the Project was found to be economically sound.

190. Key environmental issues include the need to protect air and water quality; and effects on terrestrial, freshwater aquatic, intertidal, and marine ecosystems. Social issues include the effects of land acquisition and resettlement on local communities, avoidance of induced development in areas without the capacity to accommodate it, and ensuring that the project benefits are equitably distributed.

191. Extensive and intensive environmental and social input has been included in planning for the Project. The DGS, developed in conjunction with UNDP, governments, and NGOs, will lead to development of existing growth centers in Papua and Irian Jaya Barat provinces and will increase the capacity of local and provincial government and NGOs to support ongoing community and social programs.

192. The Project, as designed, minimizes the risk of adverse environmental and social impacts. A wide range of environmental protection measures and safeguards have been incorporated to protect against adverse impacts to the physical, biological, and social components of the environment. A variety of initiatives have been implemented to ensure that local people, particularly those directly affected by the Project, will benefit substantially from it. Community development programs implemented by the Project, together with revenues it produces, should result in major lasting improvements to the health and welfare of people throughout Papua.

ABSTRACT OF THE CONTENTS OF AMDAL DOCUMENTS

A. Environmental Impact Analysis (ANDAL)

1. This Environmental and Social Impact Assessment (ESIA) document is voluminous, with about 1,073 pages of text and 1,937 pages of appendixes.

1. Text

2. The text contains six chapters and a bibliography. The abstract of the content of each chapter is presented below.

a. Background

3. This introduction chapter has 30 pages. It begins by providing background information on the evolution of the Project leading to the ESIA or in Indonesian known as Analisis Mengenai Dampak Lingkungan (AMDAL) stage. The subsequent text is presented in four sections. The first section reviews various existing laws and regulations relevant to the Project and its ESIA. The second section discusses the Government's policy framework for environmental management and key provisions relevant to environmental assessment. The third short section briefly presents the Term of Reference (TOR) for the ESIA. The fourth and last section discusses the purpose and benefits of the AMDAL study.

b. Methodology of Study

4. Chapter 2 has 40 pages. It describes in details the study methodology covering the following topics: identified environmental issues, the study area, data collection and analysis, methods for forecasting significant impacts, and methods for evaluation significant impacts.

c. Planned Tangguh LNG Project Activities

5. Chapter 3 has 224 pages. It gives brief presentation on the project objectives and benefits followed by detailed description of project activities and their relationship with the surrounding social and economic activities. The information provided in this chapter is good educational material for readers who are not familiar with technical aspects of the LNG industry. Its reading is a must for reviewers of this ESIA document.

d. Existing Environment

6. With 395 pages of text, chapter 4 is the longest chapter. It devotes 198 pages to describing the physical and biological environment of the project area, and 62 pages for the social environment focusing on the villages considered to be directly affected by the Project. The last 35 pages provide information on economic activities in the study area existing at that time.

e. Forecasting of the Significant Impacts

7. Chapter 5 has 220 pages. It identifies potential project impacts and predicts their magnitudes using mathematical models and professional judgement based on 7 criteria to determine the impacts as stipulated under Indonesian AMDAL regulations. The analysis is divided into impacts during the preconstruction, construction, operational, and decommissioning phases. The analysis covers impacts on environmental quality and ecological consequences, and social impacts, including resettlement.

f. Evaluation of the Significant Impacts

8. This final chapter has 137 pages. The first 64 pages discuss the significance of environmental and ecological impacts. The next 38 pages discuss social impacts, including health and safety aspects. The subject of cumulative impacts is also analyzed separating into the cumulative impacts of the Project, cumulative impacts of non-project activities and potential future impacts.

g. Bibliography

9. This 17 page section lists about 208 reference materials.

2. Appendixes

10. With 1,937 pages, the appendixes have to be compiled and presented in a separate volume. It contains 19 appendixes, of which 15 provide detailed technical information to back up the findings in the main text. Examples of the technical materials presented are results of surveys, specific technical reports, and results of modeling of air quality, noise, and water quality. The largest appendix is on water quality modeling, with which seven separate subjects with a total length of about 1,035 pages.

B. Environmental Management Plan (RKL)

11. This Environmental Management Plan (EMP) document is also voluminous, with 784 pages consisting of 196 pages of text and 588 pages of nine appendixes.

1. Text

12. The text contains three chapters and a bibliography. The abstract of the content of each chapter is presented below:

a. Introduction

13. The introductory chapter begins by summarizing project activities. It presents the objectives of the RKL and environmental and social philosophies and policies of the Project. Finally, it discusses the application of the RKL.

b. Approach to Environmental Management

14. This chapter discusses technological, social and economic, and institutional approach in environmental impact management. For the technological approach, the discussion first covers gas production options, then continues to analyze various alternative technical measures to deal with the issues of waste management and disposal, land management, noise and light management, offshore seismic activities, emergency response system, and spill prevention control and countermeasure plan. For the social and economic approach, the document discusses the diversified growth strategy (DGS) and various measures to mitigate impacts on the directly affected villages, including land acquisition and resettlement and indigenous peoples' development. The institutional approach covers implementation arrangements and institutional setup for effective implementation of the RKL, including mechanisms for conflict resolution.

c. Environmental Management Plan (RKL)

15. The final chapter presents environmental management plan for each group of project activities, including gas exploration, gas transmission, LNG plant, seaport, airfield, and resettlement activities. Each environmental management plan covers the pre-construction, construction, operation and post-operation or decommissioning phases. The discussion continues on to cost aspects of environmental management and monitoring, but no cost estimates are provided. The chapter ends by presenting organization for implementing the RKL, mechanisms for supervision and reporting, and a short bibliography.

2. Appendixes

16. The document has nine appendixes. The first provides a summary of the environmental management plan. Each remaining appendix presents a plan or activities for each specific subject. The topics covered are workforce management program, recognition program for directly affected villages, program for other stakeholders' interests, procedure for conflict resolution, indigenous peoples development plan, land acquisition and resettlement action plan, and public consultation and disclosure plan. These topics are in line with social safeguard requirements of international lending agencies.

C. Monitoring and Compliance Plan (RPL)

17. The RPL is the shortest of the three AMDAL documents but still contains 254 pages of text and appendixes.

1. Text

18. The text contains 127 pages for two chapters and a short bibliography. The abstract of the content of each chapter is presented below:

a. Introduction

19. This chapter provides a brief background on the Project and its activities, and brief information on directly affected and indirectly affected villages. It then provides background on the RPL, its objectives, and its application.

b. Environmental Monitoring Plan

20. Chapter 2 is the only main chapter of the document, containing about 120 pages. It presents an environmental monitoring plan for each group of project activities in line with the environmental management plan (RKL). The objective on monitoring is to assess the effectiveness of environmental management measures specified in RKL and to provide feedback for continuous improvement. The plan covers environmental and social impacts and the four phases of the Project.

2. Appendixes

21. There are two appendixes containing 127 pages. Appendix A is the main appendix with 118 pages. It summarizes chapter 2 in several tables. Appendix B presents Indonesian standards in 12 tables.

NATURE AND QUANTITIES OF WASTES GENERATED DURING CONSTRUCTION

Table A2.1: Wastes from Gas Development Activities

Item		Estimated Total Quantity	Treatment Facility (if applicable)	Disposal Route
Air	Hydrocarbon flaring during well clean-up	104,000 tons	Hydrocarbons converted to CO_2 in closed flare system	Discharged from MODU's elevated flare tip
	Combustion emissions – large stationary machinery	11,500 tons	None required	Discharged from exhaust system
	Combustion emissions – moving sources	22,400 tons	None required	Discharged from exhaust system
	Fugitive emissions (at 4,500 psi)	200 tons	None	Discharged from maintenance vents
Solid Wastes	Synthetic based muds	1,055 m^3	Mud recycled until unsuitable	To supplier
	Synthetic based cuttings	655 m^3	Mud shaken off cuttings	Re-injected/Discharged
	Water based muds & cuttings	8,600 m^3	None	Re-injected/Discharged
	Angular grit (for blast cleaning)	5 tons	Recycled until unsuitable	Returned for recycle, to on-site landfill, consumed during use
	Nonhazardous waste	3,000 m^3	Reuse, recycle, shipped to shore	To on-site landfill and incinerator
	Hazardous waste	250 m^3	Prepared for export. Drums used for delivery of new oil used to export used oil	To certified hazardous waste landfill
	Organic waste	500 m^3	Shipped to shore	To on-site landfill
	Scrap metal	300 tons	Recycled	To off-site recycler or back to fabrication yards
	Scrap metal	5 m^3	Dropped objects	Overboard
	Cement grout if required for piling	24 m^3	None	Overboard
Liquid Wastes	Produced formation and process water	nil*	To onshore receiving facility	Discharged
	Sanitary waste – MODU heavy lift vessel	nil	Biological treatment unit	Water discharged
	Sanitary waste – boats	12,000 m^3	None	Discharged
	Hydrotest water	1,000 m^3	Recycled for reuse	Discharged
	Deck drains/oily water/stormwater/washdown	3,000 m^3	To skimmer tank	Hydrocarbons to tanks on workboat for disposal at a certified location, water overboard
	Lube Oil	84,000 L	Prepared for export. Drums used for delivery of new oil used to export used oil	To certified used lube collector
	Oil/diesel spills	nil	Clean up	To certified hazardous waste landfill

* The word nil is used in this case to refer to a very small quantity. There will potentially be a very small quantity of oil/diesel spilled. The spilled oil/diesel will be cleaned up, and the recovered volumes will be sent to a hazardous waste facility.

Source: Tangguh Project. 2002. *Integrated AMDAL Study*

Table A2.2: Construction Wastes from Gas Transmission

Item		Estimated Total Quantity	Treatment Facility (if applicable)	Disposal Route
Air	Combustion emissions – large stationary machinery (dredgers & support, marine diesel consumed)	16,800 tons	None required	Discharged from exhaust system
	Combustion emissions – moving sources (pipe lay barge & support boats, marine diesel consumed)	19,320 tons	None required	Discharged from exhaust system
Solid Wastes	Sanitary waste sludge	5 m^3	Biological treatment unit	To on-site landfill
	Other organic waste	200 m^3	Shipped to shore	To on-site landfill
	Nonhazardous waste	600 m^3	Reuse, recycle, shipped to shore	To on-site landfill and incinerator
	Hazardous waste	75 m^3	Prepared for export. Drums used for delivery of new oil used to export used oil	To certified hazardous waste landfill
	Scrap metal	5 m^3	Dropped objects	Overboard
	Trench spoil (displaced soil)[a]	2,528,000 m^3	None	Either in-situ or disposal in deep water
	Drill muds from HDD	42,000 m^3	None	Overboard
	Drill spoil from HDD	1,500 m^3	None	On-site
Liquid Wastes	Sanitary waste – pipe lay vessel	3,600 m^3	Biological treatment unit	Water discharged overboard
	Sanitary waste – boats+dredger	5,400 m^3	None	Overboard
	Hydrotest water	35,000 m^3	None	Discharged
	Lube oil	26,000 L	Prepared for export. Drums used for delivery of new oil used to export used oil.	To certified hazardous waste landfill
	Oil/diesel spills	nil[b]	Clean up	To certified hazardous waste landfill

[a] 2,453,000 m^3 of sandy (non-cohesive) sediment; 75,000 m^3 of muddy (cohesive) sediment.

[b] The word nil is used in this case to refer to a very small quantity. There will be a very small quantity of oil/diesel spilled. The spilled oil/diesel will be cleaned up, and the recovered volumes will be sent to a hazardous waste facility.

Source: Tangguh Project. 2002. *Integrated AMDAL Study*

Table A2.3: Pre-Construction and Construction Wastes from LNG Plant, and Other Onshore Facilities.

Item		Estimated Total Quantity	Treatment Facility (if applicable)	Disposal Route
Air	Combustion emissions – large stationary machinery	10,000 tons	None required	Discharged from exhaust system
	Combustion emissions – moving sources	5,000 tonnes	None required	Discharged from exhaust system
	Fugitive emissions	1,000 tons	None	Discharged[b]
	Dust	50,000 m^3	Watering to minimize dust	Discharged
	Incineration – combustible material	710[c] tons	None	Discharged
	Hydrocarbon flaring during initial start-up	200,000 tons	Hydrocarbons converted to CO_2 in flare system	Discharged from elevated flare tip
Solid Wastes	Angular grit (for blast cleaning)	20 tons	Recycled until unsuitable	To on-site landfill
	General Non hazardous waste	100,000 m^3	Reuse, recycle, incinerate[a]	To on-site landfill
	Hazardous waste	850 m^3	Prepared for export; drums used for delivery of new oil used to export used oil; estimate includes Hg removal beds	To certified off-site hazardous landfill
	Organic waste	3,000 tons	Composted	Used in planting around site
	Rock debris	minimum	None required	Debris used as fill in roads, walkways
	Scrap metal	400 tons	Recycled	To off-site recycler
	Scrap metal	100 m^3	Prepared for export	To certified off-site hazardous landfill
Liquid Wastes	Produced formation and process water	100,000 m^3	Produced water treatment plant	Discharged
	Seawater extraction/desalination brine	50,000,000 m^3	None required	Discharged
	Sanitary waste	2,000,000 m^3	Biological treatment unit	Discharged
	Hydrotest water/wash down water[d]	100,000 m^3	Recycled for reuse	Discharged
	Chemically contaminated water	15,000 m^3	Neutralization pit	Recycled to holding pond
	Surface drains/oily water/stormwater	10,000 m^3	Oily water treatment	Recycled to holding pond
	Oil/diesel spills	nil[e]	Clean up	To certified off-site hazardous landfill

[a] Approximately 30,000 m^3 incinerated.

[b] A program of monitoring and preventative maintenance will be used to minimize emissions.

[c] Total organic carbon, 562 tons; CO, 75 tons; particulate matter 56 tons; SO_2 , 9 tons; and NO_X, 8 tons.

[d] It is estimated that the wash down equipment will include the use of a 4,800-m^3 chemical solution made up of 36 tons of soda ash, 6 tons of trisodium phosphate, demineralized water, and 1,100 L of H_2SO_4.

[e] The word nil is used in this case to refer to a very small quantity.

Source: Tangguh Project. 2002. *Integrated AMDAL Study*

NATURE AND QUANTITIES OF WASTES GENERATED DURING OPERATIONS

Table A3.1: Operational Wastes from the LNG Plant, Sea Port, and Airfield.

Source		Estimated Annual Quantity	Treatment Facility (if applicable)	Disposal Route
Air[d]	Flaring & venting (hydrocarbons)	50,000 tons	Hydrocarbons converted to CO_2 in flare system	Discharged from elevated flare tip
	Combustion emissions – large stationary machinery[c]	14,000 tons	None required	Discharged from exhaust system
	Combustion emissions – moving sources	36 tons	None required	Discharged from exhaust system
	Fugitive emissions	200 tons	None	Discharged[b]
	Incinerator – combustible material[e]	72 tons	None	Discharged
Solid Wastes	General non-hazardous waste	7,500 m^3	Reuse, recycle, incinerate[a]	To on-site landfill
	General hazardous waste	250 m^3	Prepared for export; largest volumes are Hg removal catalysts	Recycled or to certified off-site hazardous landfill
	Biological sludge	5 m^3	From sanitary waste treatment system	Incinerated
	Organic waste	100 tons	Composted	Used in planting around site
	Medical waste	3 tons	Prepared for export	To certified off-site hazardous landfill
Liquid Wastes	Produced formation and process water	500,000 m^3	Onshore receiving facilities/produced water treatment plant	Discharged
	Desalination unit effluent	7,000,000 m^3	Premixed with larger volume of ambient salinity seawater	Discharged
	Sanitary waste	55,000 m^3	Sanitary waste treatment unit	Water discharged, sludge incinerated
	Production & utilities chemicals	150,000 m^3	Neutralization pit	Discharged
	Oily water	20,000 m^3	Oily water treatment plant	Discharged
	Storm water		None required	Natural watercourse
	Oil/diesel spills	nil[f]	Clean up with appropriate equipment/materials; soiled clean-up materials prepared for export	To certified off-site hazardous landfill

[a] Approximately 3,000 m^3/year incinerated.
[b] A program of monitoring and preventative maintenance will be used to minimize emissions.
[c] This figure does not include CO_2 in the feed gas.
[d] Acid gas stream contains CO_2 (95%), water vapor, hydrocarbon vapor, and H_2S and other sulfur-bearing compounds (0.19%). See Table 3.22 for more details on LNG plant air emissions.
[e] Total organic carbon = 56 tons, CO = 8 tons, PM = 6 tons, NO_X = 1 ton, and SO_2 = 1 ton.
[f] The word nil is used in this case to refer to a very small quantity.
Source: Tangguh Project. 2002. *Integrated AMDAL Study*

HAZARDOUS WASTES

Category	Source	Type of Waste	Quantity (Max)	Unit	Occurrence
Solid Wastes Containing Heavy Metals	Pig receiver	Scale sludge	0.5	m^3/month	Pigging operation
	Amine mechanical filter	Filter element	1.0	m^3/3 years	Shutdown schedule
	Amine carbon filter	Filter element	60.0	m^3/3 years	Shutdown schedule
	Amine polishing filter	Filter element	1.0	m^3/3 years	Shutdown schedule
	Dehydration molecular sieve bed	Molecular sieve	61.0	m^3/3 years	Shutdown schedule
	Dehydration molecular sieve after filter	Filter element	1.0	m^3/3 years	Shutdown schedule
	Mercury removal molecular sieve bed	Molecular sieve catalyst	63.7	m^3/3 years	Shutdown schedule
	Laboratory waste	Expired chemicals	0.5	m^3/year	
	Subtotal		**69.1**	**m^3/year**	
Solid Wastes Containing Hydrocarbons	Corrugated plate interceptor	Bottom sludge	1.0	m^3/year	Normal operation
	Recovered oil tank	Bottom sludge	1.0	m^3/year	Normal operation
	Subtotal		**2.0**	**m^3/year**	
Solid Wastes Containing Infectious Agents	Medical center	Clinical waste	8.0	kg/day	Normal operation

Source: Tangguh Project. 2002. *Integrated AMDAL Study*

NOTEWORTHY FLORA AND FAUNA SPECIES

Table A5.1: Noteworthy Plant Species Recorded From the Tangguh Study Area

Species	Notes
Barringtonia josephstaalensis Takeuchi	Occurs as a relatively common understory plant in swamp forest. Previously known from only one location, in Madang Province, PNG.
Croton sp. Nov., aff. *C. vigilans* Airy Shaw	A small shrub to 0.5 m, in lowland forest
Glochidion daviesii Tacheuchi sp. Nov. ined., aff. *G. beehlerii* Takeuchi.	Occurs as a tree up to 15 m. in lowland forest and swamp forest.
Macaranga sp. Nov., aff. *M. aleuritoides* F. Muell.	Tree from lowland forest
Scaevola burnetii Takeuchi sp. Nov. ined., aff. *S. angulata* R. Br.	Occurs as uncommon shrub occurring in savannah clearings, between fern thickets and on bare ground.
Trichomanes sens. Lat.	Unusual and possibly new species
Leucas zeylanica (L.) R. Br.	Shrub from lowland forest and disturbed sites. Not previously recorded from Papua.
Aglaia pleiojuga Takeuchi sp. nov. ined.	Tree from swamp and lowland forests
Hypserpa laurina (F. Muell.) Diels.	Climbing plant from lowland forest. Previously only known from Australia and southwestern PNG.
Conandrium rhynchocarpum (Scheff.) Mez.	Tree occurring in lowland forest. Previously known only from the Moluccas.
Octamyrtus insignis Diels.	Tree, occurring in beach, swamp, and lowland forests. Previously recorded from several, widely separated sites in west New Guinea. Has showy flowers.
Syzygium ubogoensis Takeuchi sp. nov. ined., aff. *H. oreadum* Diels.	Tree occurring in swamp and lowland forests. Previously known only from Southern Highlands of PNG.
Freycinetia bomberaiensis K.L. Huynh sp. nov. ined.	A new species
Helicia bintuni Takeuchi sp. nov. ined., aff. *H. oreadum* Diels.	Moderately common tree in LNG plant area
Acronchia dimorphocalyx Hartley.	Endemic to Papua. Previously known from only two locations. Common subcanopy plant in lowland hill forest.
Zanthoxylum nitidum (Roxb.) DC.	Climbing plant from lowland forest. Widely distributed but uncommon in New Guinea.
Guioa pteropoda Radlk., or aff.	May be new species. Tree from lowland forest.
Jagera javanica (Bl.) Kalkman subsp. *javanica*	Tree to 20 m from lowland forest
Keraudrenia corollata (Steetz) Druce	A rare shrub from open environments in savannah
Aquilaria filarial (Oken) Merr.	Tree from lowland forest. Has potential commercial value for its aromatic properties.
Gmelina sp.	Tree from lowland forest. Flowers not collected. Genus not confirmed.
Xyris bancana Miq. sens. lat.	Occurs in savannah

Table A5.2: Noteworthy Amphibians and Reptiles

Species	Notes
Cophixalus sp.	A microhylid frog closely related to *C. biro.* Inhabits lowland forest. New species.
Hylophorbus sp.	A ground-dwelling microhalid frog. Likely to be a new species.
Litoria sp.	Tree frog from Lowland forest, may be new species.
Emoia sp.	Common frog on floor of lowland forest. May be new species.

Source: Tangguh Project. April 2003. *Flora and Fauna Survey of the Tangguh LNG Site, Papua Province, Indonesia*

Table A5.3: Mammal Species Reported From Tangguh Project Area

Species	Notes
Tachyglossus aculeatus - Short-snouted Echidna	Reported from AMDAL study but believed more likely to be *Zaglossus bruijni.*
Zaglossus bruijni - Long-snouted Echidna	Known to occur in Bird's Head region.
Myoictis melas -- Three-striped Dasyure	Widespread in lowland forest.
Peroryctes raffrayanus -- Raffray's Bandicoot	Widespread but uncommon in lowland forest.
Echymipera kalubu -- Common Spiny Bandicoot	Common in lowland forest and gardens.
Isoodon macrourus -- Short-nosed Bandicoot	Savannah dweller. No records west of Meraucke.
Spilocuscus maculatus -- Common Spotted Cuscus	Common arboreal dweller of lowland forest.
Phalanger orientalis -- Brown Cuscus	Lowland forest.
Pseudochirulus canescens -- Lowland ringtail Possum	Widespread but uncommon.
Thylogale brunii -- Brush Wallaby	Report in ANDAL represents a range extension. May have been *Thylogale browni.*
Macropis agilis -- Agile Wallaby	Previously reported but considered unlikely to occur.
Dorcopsis muelleri -- Western Forest Wallaby	Lowland forest. Protected species.
Dendrolagus goodfellowi -- Goodfellow's Tree Kangaroo	Probably an erroneous record.
Dendrolagus inustus-- Grizzled Tree-kangaroo, and *D. ursinus* -- Vogelkop Tree-kangaroo	Either or both species could occur in low numbers in lowland forest. Protected species.
Macroglossus minimus -- Common Blossom Bat	Widespread and abundant in lowland forest.
Nyctimene albiventer -- Common Tube-nosed Fruit Bat	Widespread and common in lowland forest.
Dobsonia spp. -- Fruit Bats	Several species occur in the region, in lowland forest.

Species	Notes
Pteropus spp. -- Flying Foxes	Lowland habitats.
Cervus timorensis -- Deer	Introduced species.
Paramelomys platops -- Lowland Melomys	Endemic rodent. Widespread and common.
Paramelomys naso -- Western Long-nosed Melomys	Endemic rodent.
Rattus cf tanezumi -- Asian House rat	Introduced species.

Source: Tangguh Project. April 2003. *Flora and Fauna Survey of the Tangguh LNG Site, Papua Province, Indonesia*

Table A5.4: Noteworthy Birds from Tangguh Project Area

Species	Comments
Casuarius casuarius -- Southern Cassowary and *Casuarius appendiculatus* -- Northern Cassowary	At least one of these species is present in lowland forest near the LNG site.
Talegalla fuscirostris -- Red-billed Brush-turkey and *Talegalla cuvieri* -- Black-billed Brush-turkey	At least one of these species is present, probably *T. cuvieri.*
Harpyopsis novaeguineae -- New Guinea Harpy Eagle	Vulnerable species.
Probosciger aterrimus -- Palm Cockatoo	Scarce.
Paradisaea minor -- Lesser Bird of Paradise	Widespread, common.
Manucodia atra -- Glossy-mantles Manucode	Widespread, common.
Seleucidis melanoleuca -- Twelve-wired Bird of Paradise	Uncommon.
Cicinnurus regius -- King Bird of Paradise	Uncommon.
Ptiloris magnifica -- Magnificent Riflebird	Widespread, common.

Source: Tangguh Project. April 2003. *Flora and Fauna Survey of the Tangguh LNG Site, Papua Province, Indonesia*

AREAS AND POPULATIONS OF VILLAGES IN BABO AND ARANDAY DISTRICTS

Village	Area (ha)	Number of Households	Population
Babo District			
Wamesa I (Idoor)	408	61	349
Wamesa II (Yakati)	309	65	313
Yansey	309	35	262
Mamurana	408	31	153
Kuri I (Naramasa)	108	45	211
Kuri II (Sarbe)	795	36	188
Obo	795	18	85
Wagura	108	335	796
Irarutu I	780	59	191
Tugrama	231	41	226
Sara	231	27	112
Warganusa I	227	35	203
Warganusa II	227	82	378
Irarutu III (Babo town)	802	388	1,379
Riendo	771	66	276
Irarutu II	771	119	546
Yaru	433	42	237
Aroba	343	89	485
Sidomakmur	170	292	1,137
Tofoi*	500	775	1,511
Tanah Merah*	467	79	368
Saengga (Simuri)*	467	57	345
Kokas District			
Toweri (Onar)*		36**	189**
Aranday District			
Taroy*		72	253
Kampung Baru		128	632
Aranday		75	363
Kecap		115	574
Manunggal Karya		110	599
Tomu*/Ekam*		183	876
Sebyar Rejosari		266	815
Wiriagar*/Mogotira*		167	1,781
Kali Tami		108	514

Note: The household/population figures pre-date the resettlement of Tanah Merah village.
* Denotes directly affected village.
** Excludes Tomage hamlet.
Source: Tangguh Project. 2002. Social Baseline Survey for the *Integrated AMDAL Study*

SCREENING OF ALTERNATIVE LNG SITES

Site	Location	Reason For Elimination
Karakra	North coast of Berau Bay	
Mogotira/Weriagar	North coast of Bintuni Bay	Extensive mud flats and shallow water, requiring excessively long jetty.
Tapas	North coast of Berau Bay	Excessively long jetty required
Saengga/Tanah Merah	South coast of Bintuni Bay	
Ofuweri	South coast of Berau Bay	Excessively long jetty required
Flur	South coast of Berau Bay	Excessively long jetty required
Goras	South coast of Berau Bay	Combined with Flur site
Ogar Island	Off the south coast of Berau Bay	
Kokas	South coast of Berau Bay	
Siang	South coast of Berau Bay	Combined with Kokas site
Bagam	An inlet near the mouth of Berau Bay	High costs due to difficult site preparation requirements and long pipelines
Suweri Bay	Southwest tip of Fak-Fak Peninsula	High site preparation costs, long pipeline
Fak-Fak	South coast of Fak-Fak Peninsula	High site preparation costs, long pipeline
Urkadin Point	On Sebakor Bay, west side of Bomberai Peninsula	Involves extensive construction in swamps
Maiwawa	Kamrau Bay, east side of Bomberai Peninsula	Involves extensive construction in swamps
Megai	Arguni Bay, east side of Bomberai Peninsula	Excessively long pipelines required
Wariup	Sarera Bay, east coast of Bird's Head Peninsula	Involves extensive pipeline construction through mountainous terrain

Source: Tangguh Project, 1998, Feed Preparatory Phase Final Report, Vol 9A-Site Selection Studies

APPLICABLE INDONESIAN STANDARDS

Table A8.1: Ambient Seawater Quality Standards for the Tangguh LNG Project

Parameter	Unit	Standard Quality Minister of Environment Decree No. Kep.02/MENKLH/I/1988, Attachment VII		New Standard Quality* Minister of Environment Decree No. Kep.51/MENKLH/2004, Attachment III,
		Tolerated	Demanded	
Physical				
Color	Color Unit (CU)	≤50	≤30	-
Odor	--	Natural	Nil	Natural
Turbidity	NTU	≤30	≤5	<5
Clarity	M	≥3	≥5	Coral : > 5 (< 10 % annual variation for euphotic depth) Mangrove : - Sea grass : >3 Natural
Suspended Solids	mg/L	≤80	≤25	Coral : 20 (< 10 % annual variation for euphotic depth) Mangrove : 80 Sea grass : 20
Floating Objects	mg/L	nil	nil	Nil
Oil Layer	--	nil	nil	Nil
Temperature	ºC	natural	natural	Natural Coral : 28 – 30 Mangrove : 28 – 32 Sea grass : 28 – 30
Chemistry				
pH	--	9	6.5 – 8.5	7 – 8,5 (< 0.2 unit deviation)
Salinity	%	=/- 10% natural	natural	Natural
				Coral : 33 – 34 $‰_o$

Parameter	Unit	Standard Quality Minister of Environment Decree No. Kep.02/MENKLH/I/1988, Attachment VII		New Standard Quality* Minister of Environment Decree No. Kep.51/MENKLH/2004, Attachment III,
		Tolerated	Demanded	
				Mangrove: ≤ 34 $‰_o$
				Seagrass: 33 – 34 $‰_o$
Dissolved Oxygen	mg/L	>4	>6	5 – 6 (> 80 – 90 % DO Saturated)
Biochemical Oxygen Demand (BOD_5)	mg/L	≤45	≤25	20
Chemical Oxygen Demand (COD)	mg/L	≤80	≤40	-
Ammonia Total (NH_3 -N)	mg/L	≤1	≤0.3	0.3
Phosphate (PO_4-P)	mg/L	-	-	0.015**
Nitrat (N-NO_3)	mg/l	-	-	0.008 (max. 0.002)**
Nitrite (N-NO_2)	mg/L	Nil	nil	-
Cyanide (CN^-)	mg/l	-	-	0.5 (max. 0.05)
Sulfide (H_2S)	mg/L	0.2	<0.5	0.01
PAH (Poly Aromatic Hydrocarbon)	mg/l	-	-	0.003
Mineral Oil (Petroleum)	mg/L	≤5	nil	-
Phenol Compounds	mg/L	≤0.002	nil	0.002
PCB Total (Polychlor Bifenil)	Mg/l	-	-	0.01
Surfactan (Detergent)	Mg/l MBAS	-	-	1
Oil & Grease	Mg/l	-	-	1
Pesticide	Mg/l	-	-	0.01
TBT (Tri Butil Tin)	Mg/l	-	-	0.01
Arsenic	mg/L	≤0.01	0.0026	0.012
Cadmium	mg/L	≤0.01	0.00002	0.001
Copper	mg/L	≤0.06	0.001	0.008
Hexavalent Chromium	mg/L	≤0.01	0.0004	0.005

Parameter	Unit	Standard Quality Minister of Environment Decree No. Kep.02/MENKLH/I/1988, Attachment VII		New Standard Quality* Minister of Environment Decree No. Kep.51/MENKLH/2004, Attachment III,
		Tolerated	Demanded	
Lead	mg/L	≤0.01	0.00002	0.008
Mercury	mg/L	≤0.003	0.0001	0.001
Nickel	mg/L	≤0.002	0.007	0.05
Zinc	mg/L	≤0.1	0.007	0.05
Biology				
Coliform (total)	MPN/100 ml	-	-	1000
Pathogen	Sel/100 ml	-	-	Nil
Plankton	Sel/100 ml	-	-	Un bloom

Note: * Minister of Environment Decree No. Kep 51/2004, Attachment III – Guidelines for Determination of Environmental Quality Standards for Marine Biota.

Table A8.2: Current Indonesia and World Bank Emissions Limits and Recommended Limits for the Tangguh LNG Project

No	Source	Parameter	Emission Standard Minister of Environment Decree No Kep. 13/MENLH/3/1995, App VB mg/m^3 [mg/Nm^3]	New Emission Standard Minister of Environment Decree No Kep. 129/MENLH/ 2003, App III (mg/Nm^3)
1	Boiler	Particulate	-	300
		Sulfur Dioxide(SO_2)	800 [873]	1,200
		Nitrogen Dioxide (NO_2)	1,000 [1092]*	1,400
		Opacities	-	40%
		Total Reduced Sulfur (H_2S)	35 [38.2]	-
2	Flare Stack	Opacities	-	40%
		Sulfur Dioxide(SO_2)	800 [873]	-
		Nitrogen Dioxide (NO_2)	1,000 [1092]*	-
		Total Reduced Sulfur (H_2S)	35 [38.2]	-
3	Turbine Gas	Nitrogen Dioxide (NO_2)	1,000 [1092]*	400
		Opacities	-	
		Total Reduced Sulfur (H_2S)	35 [38.2]	
		Sulfur Dioxide(SO_2)	800 [873]	

Note: * Previous standard formed as Nitrogen Oxides or NOx.
Source: Source: Tangguh Project. 2002. *Integrated AMDAL Study*

Previous Emission Standards as presented in AMDAL

Notes:

1. Reference: Minister of Environment Decree No. Kep 13/MENLH/3/1995, Appendix VB on Emissions Standards from Stationary Sources (Kepmen LH No. Keputusan President No. 13/MenLH/3/1995 Tentang Baku Emisi Sumber Tidak Bergerak).
2. Reference: emissions limit for onshore oil and gas production facilities, as published in the World Bank *Pollution Prevention and Abatement Handbook*, 1999.
3. Signifies no designated limit.
4. This NO_x emissions limit pertains to gas-fired sources.
5. This emissions limit pertains to sulfur oxides.
6. Odor is not to be offensive at the receptor end. H_2S at the property boundary should be less than 5 mg/m^3.
7. The gas volume associated with the Indonesia emissions limit is determined at a pressure of 1 atmosphere and at a temperature of 25 degrees centigrade. The value in brackets [ ] is the original Indonesia emissions limit expressed in mg/Nm^3 (determined at a pressure of 1 atmosphere and at a temperature of 0 degrees centigrade).

Pollutant or Parameter	**Indonesia[1] Maximum Limit[7]** (mg/m^3) [mg/Nm^3]	**World Bank[2] Maximum Limit** (mg/Nm^3)	**Tangguh Maximum Limit** (mg/Nm^3)
Nitrogen oxides (NOx)	1,000 [1092]	320[4]	320
Sulfur dioxide (SO_2)	800 [873]	1,000[5]	873
Total reduced sulfur (H_2S)	35 [38.2]	30	30

Table A8.3: Sanitary Waste Standards for the Tangguh LNG Project

Parameter	Minister of Environment Decree No. Kep 52/MENLH/I/1995.	New Standards Minister of Environment Decree No. Kep 112/2003.
	Maximum Content (mg/L)	Maximum Content (mg/L)
BOD5	30	100
COD	50	-
pH	6.0 – 9.0	6.0 – 9.0
TSS	50	100
Oil and Grease	-	10

Source: Tangguh Project. 2002. *Integrated AMDAL Study*

STATUS OF COMMUNITY ACTION PLANS (DECEMBER 2004)

Summary of the CAPs Implementation in DAV

Table A9.1: Summary of the Evaluation of CAP Implementation in Tomu Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Bridge construction	Done	5 bridges was constructed under the Project and 3 gates through community effort. Benefit for 775 people.
2.	Provision of fishery equipment	Done	62 unit boat machines
3.	Jetty construction	Done	
4.	Mosque renovation	In progress	
5.	PBM proposal negotiation	Done	
6.	12 villages inter community dialogue	Not yet	
7.	Latrine facilities	Done	57 units; not planned in CAP 2003

Table A9.2: Summary of the Evaluation of CAP Implementation in Ekam Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Walkway construction	Done	▪ 562 meters was constructed ▪ Less community participation ▪ No participation from local government
2.	Latrine facilities	Done	▪ 68 units ▪ Less community participation ▪ No participation from local government
3.	Provision of fishery equipment	Done	96 units boat machines
4.	Scholarship	Done	Total 35 students ▪ Elementary school: 9 students ▪ Junior high school: 17 students ▪ High school: 8 students ▪ University: 1 student

Table A9.3: Summary of the Evaluation of CAP Implementation in Weriagar Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Walkway	Done	796 meters; Less community participation.
2.	Provision of fisheries equipment	Done	990 prawn nets
3.	Engine boat maintenance training	Done	8 participants
4.	Generator	Done	1 unit, maintenance training completed
5.	Sewing machine	Done	3 units
6.	Sewing training	Done	Completed
7.	Cooking training	Done	167 women from Weriagar and Mogotira attended
8.	Mosque renovation	Done	
9.	Scholarship	Done	

Table A9.4: Summary of the Evaluation of CAP Implementation in Mogotira Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Walkway	Done	1,158 meters was constructed
2.	Provision of fisheries equipment	Done	442 fishery nets, 10 unit outboard engine
3.	Engine boat maintenance training	Done	9 participants
4.	Generator	Done	1 unit, maintenance training completed
5.	Kiosk management training for women	Done	
6.	Establishment of 3 kiosk	Done	
7.	Cooperation management training	Done	
8.	Provision of school furniture	Done	
9.	Church renovation	In progress	
10.	To prevent sea abrasion/erosion	In progress	

Table A9.5: Summary of the Evaluation of CAP Implementation in Taroy Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Jetty construction	Done	
2.	Provision of fisheries equipment	Done	
3.	Boat engine maintenance training	Done	Attended by 15 participants
4.	Latrine for each household	Done	
5.	Clean water	Done	8 water tanks installed
6.	Generator	Done	1 generator submitted to community, training completed
7.	Mosque renovation	In progress	
8.	Health Clinic construction	Done	

Table A9.6: Summary of the Evaluation of CAP Implementation in Tofoy Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Kiosk construction	Done	
2.	Kiosk management training	Done	
3.	Clean water	Done	2 towers, 4 wells and tanks was installed

Table A9.7: Summary of the Evaluation of CAP Implementation in Toweri Village

No.	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Mosque construction	Ongoing	
2.	School renovation	Ongoing	
3.	Provision of school furniture	Ongoing	

Summary of the Community Development Program in Non-DAVs

Table A9.8: Summary of the Evaluation of CAP Implementation in Irarutu III Village

No	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Water wells renovation	Done	
2.	Bridge construction	Done	
3.	Credit Union	On going	

Table A9.9: Summary of the Evaluation of CAP Implementation in Sebyar Rejosari Village

No	2003 CAP Priority Program	**Evaluation** (Last update Dec 2004)	Remarks
1.	Provision of fishery equipment	Done	
2.	Provision of generator and construction of generator house	Done	2 units
3.	Provision of seeds	Done	
4.	Provision of sport equipment	Done	

CALCULATIONS OF NET REDUCTION IN POLLUTANTS ACHIEVED IN REPLACING COAL WITH LNG

Table A10.1: Calculation of CO_2 Emissions

No.	Item	Quantity	Unit
(1)	LNG production	7.60	mtpa
(2)	CO2 produced	4.67	mtpa
(3)	Carbon content,% by weight	75.00	% by weight
(4)	CO2 produced from combustion of LNG	20.90	mtpa
(5)	Total CO2 production	25.57	mtpa
(6)	Heating value of LNG	22,450.00	Btu/lb
(7)	Heating value of LNG	53.054	GJ/t
(8)	Total heat content of 7.6 mtpa of LNG	403.21	mGJ/yr
(9)	Total heat content of 7.6 mtpa of LNG	403,209.18	TJ/yr
(10)	Heating value of coal	28	MJ/kg
(11)	Heating value of coal	28.00	GJ/t
(12)	Quantity of coal to yield energy equal to that of LNG	14.40	mtpa
(13)	Carbon content of coal,85% by weight	85	%
(14)	CO2 produced from combustion of coal in commercial use	44.88	mtpa
(15)	Net CO2 saving from combustion	19.31	mtpa

Notes: (4) = (1)x(3)x44/(12x100)
(5) = (4)+(2)
(7) = (6)x1055x2240/(10^9)
(8) = (7) x(1)
(9) = (13) x 1000
(11) = (10)x1055x2240/(10^9)
(12) = (8)/(11)
(14) = (12)x(13)x44/(12x100)
(15) = (14)-(5)

Table A10.2: Calculation of Other Pollutants

Item	NOx	SO2	Particulates
Data, emission in kg per TJ of energy produced			
LNG	43	0.3	2
Coal	359	731	1,333
Estimated emissions under the Project, tpa			
LNG	17,338	121	806
Coal	144,752	294,746	537,478
Net Reduction, tpa	127,414	294,625	536,671

Notes:

1 Btu	=	1,055	joules
1 metric tonnes	=	2,240	lb
1 giga joule (GJ)	=	10^12	J
1 tera joule (TJ)	=	1,000.0	GJ
Sulfur content of coal	=	4	%

Table A10.3: Economic Value of Environmental Benefits

Item		Unit
Data		
SO2 trading price	200	$/ton in early 2004
	700	$/ton recently
	400	$/ton used in the calculation
CO2 trading price	11.89	$/ton Price in Feb. 2005
NOX	1,500	$/ton in 2001, less than $2,000/ton in 2004
Particulate	784	$/ton, avoidable cost, 1997 price
Benefits		
SO2	117.85	m$
NOx	191.12	m$
CO2	229.61	m$
Particulates	420.75	m$
Total	**959.33**	**m$**
NPV at 8% discount,20 years	10,378.17	m$

Data Sources

Emission of pollutants:	*WEC Survey of Energy Resources 2001-Natural Gas*
Heating value of coal:	*www.railpage.org.au/articles/coal.html*
Heating value of LNG:	
CO2 trading price	*IETA-International Emissions Trading Association, March 2005*
SO2 trading price	*HoustonChronicle.com, March 28, 2005*
Nox trading price	*The Case for Coal, How I See It, Richard Sandor, Environmental Finance, March 2001*
Particulate removal cost	*Captive Power Generation-Air Pollution Impacts due to Increased Capacity Utilization* *Sudhir C. Rajan and Antoneete D'Sa, Energy for Sustained Development, Vol.IV, No.1* *June 2000* The figure used is the lowest figure advanced technology coal plant estimated for India.

EXAMPLE OF RELEVANT CONTRACT ENVIRONMENTAL CLAUSES

A. Environment

1. General

1. The contractor shall be fully committed to the implementation of extensive and innovative environmental protection throughout the contract.

2. The contractor shall comply with the approved ANDAL (environmental and social impact study), RKL (environmental and social management plan), and the RPL (environmental and social monitoring plan) requirements. The approved ANDAL, RKL, RPL are statutory documents.

3. Additionally, the Contractor shall comply with the Tangguh LNG health, safety and environmental policy and with the Tangguh LNG project criteria for environmental performance (CEP).

a. Environmental Management System

4. The contractor shall develop a comprehensive environmental management system (EMS) for company review and approval. The purpose of this EMS is to provide a formal set of procedures and policies that define how an organization will manage its potential impacts on the natural environment and on the health and welfare of the people who depend on it. It defines the methodology to assess, catalogue, quantify and mitigate facility environmental impacts - not simply activity-by-activity, but throughout the entire worksite and organization.

b. General

5. The EMS shall be consistent with the requirements of

(i) approved ANDAL, RKL, RPL requirements,
(ii) applicable Indonesian Regulations,
(iii) criteria for Environmental Performance (CEP), and
(iv) ISO 14001.

6. The contractor shall have an environmental management system that conforms to ISO 14001. Control mechanisms shall be in place to ensure the contractor and subcontractors comply with the Contractor's EMS.

7. The contractor shall support the company during EPC work in their establishment of procedures and practices aimed at ensuring the LNG plant can be ISO 14001-certified by the operator within 1 year after taking over.

c. Contractor Environmental Management System (EMS)

8. The contractor shall prepare for company approval an environmental management system that addresses the

(i) air quality management plan;
(ii) water management plan;
(iii) proposed solid waste landfill location (Refer to 1.8.3);
(iv) waste management plan covering

(a) hazardous,
(b) nonhazardous,
(c) combustible,
(d) noncombustible, and
(e) organic;

(v) spill prevention and control plan;
(vi) environmental health management plan showing

(a) hazard communication,
(b) chemical and physical agents,
(c) public health, and
(d) material handling

(vii) land conservation plan covering

(a) erosion sedimentation and storm water,
(b) cut and fill operations,
(c) establishment of an on-site nursery,
(d) temporary drainage systems,
(e) coastal area protection,
(f) inland location,
(g) dust control, and
(h) dredging and cuttings disposal;

(viii) night lighting management plan (insect minimization issue);
(ix) flora and fauna protection plan in compliance with Indonesian regulation and Convention on International Trade in Endangered Species (CITES);
(x) noise Mitigation Plan to achieve Indonesian noise standard and company requirement;
(xi) mobilization and demobilization;
(xii) maintenance activities;
(xiii) environmental inspections, auditing, reporting, and corrective action of non-compliance issues; and
(xiv) environmental awareness training plan.

LOCATIONS AND DATES OF PUBLIC CONSULTANTS

No.	Location of the Consultation	Date of the Consultation (2000)	Villages Covered In the Consultation	Number of Persons Attending the Consultation
National and Provincial Government				
1.	Jayapura	May 27	Province Level	125 persons
2.	Pertamina Head Office in Jakarta	May 29	National Level	66 persons
Kabupaten				
3.	Manokwari Kabupaten City	June 10	Covers all of the villages in this Kabupaten	Several hundred
4.	Sorong Kabupaten City	July 3	Covers all of the villages in this Kabupaten	Approximately 100
5.	Fak-fak Kabupaten City	July 5	Covers all of the villages in this Kabupaten	59 persons
Kecamatan and Villages on the North Shore of Berau/Bintuni Bay				
6.	Bintuni Town in the Bintuni Barat Kelurahan, Manokwari Kabupaten	July 19	a. Bintuni Timur kelurahan Bintuni Barat b. Kelurahan	96 persons
7.	Manimeri Village in Bintuni Kecamatan, Manokwari Kab.	July 21	a. Argo Sigemeray Village b. Banjar Ausoy Village c. Korano Jaya Village d. Naraitama Village e. Bumi Saniari Village f. Tuasai Village g. Manimeri Village	142 persons
8.	Inawatan Town in Inanwatan Kecamatan, Sorong Kabupaten	July 22	a. Sibae Village b. Wadoi Village c. Mate Village	69 persons
9.	Aranday Town in Aranday Kecamatan, Manokwari	July 29	a. Tomu/Ekam Villages b. Aranday Village c. Manunggal Karya Village d. Kecap Village e. Hamlet of (Dusun/Kampung) Baru Village f. Sebyar Rejosari Village	112 persons
10.	Weriagar/Mogotira Village in Arranday Kecamatan, Manokwari Kab.	August 1	a. Weriagar/Mogotira Village b. Taroy Village c. Kalitami Village	128 persons
11.	Tarof Village in Inanwatan Kecamatan, Sorong Kabupaten	August 2	a. Tarof Village b. Negeri Besar Village c. Siwatori Village	86 persons
Kecamatan and Villages on the South Shore of Berau/Bintuni Bay				
12.	Babo Town in Babo Kecamatan, Manokwari Kab.	July 19	Irarutu III Village	56 persons

No.	Location of the Consultation	Date of the Consultation (2000)	Villages Covered In the Consultation	Number of Persons Attending the Consultation
13.	Tanah Merah Village in Babo Kecamatan, Manokwari Kab.	July 20	Tanah Merah Village	43 persons
14.	Tofoi Village in Babo Kecamatan, Manokwari Kab.	July 21	Tofoi Village	75 persons
15.	SP 2 in Babo Kecamatan, Manokwari Kab.	July 22	SP 2 (Trans)	58 persons
16.	SP 1 in Babo Kecamatan, Manokwari Kab.	July 22	SP 1 (Trans)	70 persons
17.	Saengga Hamlet in Simuri (Saengga) Village, Babo Kecamatan, Manokwari Kab.	July 23	Simuri (Saengga) Village	43 persons
18.	Aroba Village in Babo Kecamatan, Manokwari Kab.	July 24	Aroba Village	34 persons
19.	Warganusa I Village in Babo Kecamatan, Manokwari Kab.	July 26	a. Warganusa I Village b. Warganusa II Village	58 persons
20.	Sidomakmur Village in Babo Kecamatan, Manokwari Kab.	July 27	Sidomakmur Village	77 persons
21.	Kokas Town in Kecamatan Kokas, Kabupaten Fak-fak	July 28	a. Kokas Kelurahan b. Hamlet of Baru Village c. Sisir Village d. Sekar Village	55 persons
22.	Arguni Village in Kecamatan Kokas, Kabupaten Fak-fak	July 29	a. Arguni Village b. Fior Village c. Andamata Village d. Forir Village	107 persons
23.	Goras Village in Kecamatan Kokas, Kabupaten Fak-fak	July 30	Goras Village	73 persons
24.	Otoweri Hamlet in Toweri Village, Kokas Kecamatan, Fak-fak Kabupaten	July 31	Towori Village composed of Otoweri Hamlet and Tomage Hamlet	59 persons
25.	SP 1 Transmigration Project in Bomberay Area, Kokas Kecamatan, Fak-fak Kabupaten	July 30	a. Onim Sari Village b. Mbima Jaya Village c. Kundei Indah Village d. Bomberay VII Village e. Warisa Mulya Village f. Bomberay V Village g. Mekarsari SP IV Village	181 persons
Total				
Twenty-five Presentations			Jakarta Jayapura 3 Kabupaten 5 Kecamatan 52 Villages	In the village and Kecamatan presentations there were 1,622 persons who registered

Source: Tangguh Project, 2001, *Term of Reference (TOR) for Tangguh Integrated AMDAL Study*