FINAL REPORT

031-47

CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES MANAGEMENT

Shell Prospecting and Development (Peru) B.V.

Environmental Impact Assessment of the Pagoreni/San Martin East Exploratory Wells

August 1997

ERM Peru S.A.
Juan Fanning 219, Miraflores, Lima 18
Teléfono (511) 242 0620
Facsímile (511) 241 1128
Email jblima@mail.tambo.com.

ERM

FINAL REPORT

Shell Prospecting and Development (Peru) B.V.

Environmental Impact Assessment of the Pagoreni/San Martin East Exploratory Wells

August 1997

Reference 4200.23

For and on behalf of
Environmental Resources Management

Approved by: K MURPHY

Signed: K.T Murphy

Position: TECHNICAL DIRECTOR

Date: 15/8/97

This report has been prepared by Environmental Resources Management the trading name of Environmental Resources Management Limited, with all reasonable skill, care and diligence within the terms of the Contract with the client, incorporating our General Terms and Conditions of Business and taking account of the resources devoted to it by agreement with the client.

We disclaim any responsibility to the client and others in respect of any matters outside the scope of the above.

This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies on the report at their own risk.

In line with our company environmental policy we purchase paper for our documents only from ISO 14001 certified or EMAS verified manufacturers. This includes paper with the Nordic Environmental Label.

CONTENTS

EXECUTIVE SUMMARY

1	INTRODUCTION	1-1
1.1	DEVELOPMENT OF CAMISEA HYDROCARBON RESERVES	1-1
1.2	PROGRAMMES AND ACTIVITIES SUBJECT TO THIS ENVIRONMENTAL IMPACT ASSESSMENT	1-3
1.3	THIS ENVIRONMENTAL STATEMENT	1-6
1.4	EIA APPROACH AND METHODOLOGY	1-4
1.5	PURPOSE OF THE ENVIRONMENTAL STATEMENT AND ASSOCIATED REPORTS	1-5
1.6	STRUCTURE OF THE ENVIRONMENTAL STATEMENT	1-6
1.7	ENVIRONMENTAL MANAGEMENT PLAN	1-7
1.8	CONTRIBUTORS TO THE EIA AND ACKNOWLEDGEMENTS	1-8
2	LEGISLATIVE AND INSTITUTIONAL FRAMEWORK FOR EIA	2-1
2.1	INTRODUCTION	2-1
2.2	ENVIRONMENTAL PROTECTION WITHIN THE HYDROCARBONS ACTIVITY	2-1
2.3	GENERAL RULES FOR ENVIRONMENTAL PROTECTION	2-3
2.4	APPLICABLE INTERNATIONAL REGULATIONS	2-5
2.5	LEGISLATION RELATED TO INDIGENOUS PEOPLES	2-6
2.6	EIA PREPARATION AND CONTENTS	2-8
2.7	EIAS APPROVAL PROCESS	2-8
2.8	CONTROLLING AGENCY	2-9
2.9	KEY INSTITUTIONS	2-9
3	PROJECT DESCRIPTION	3-1
3.1	THE 1998 PAGORENI/SAN MARTIN EAST EXPLORATION DRILLING CAMPAIGN	3-1
3.2	SITE SELECTION	3-2
3.3	LOGISTICS OVERVIEW	3-3
3.4	THE LOGISTICS CENTRE AT NUEVO MUNDO	3-4
3.5	SCHEDULE	3-5
3.6	WELLSITES PREPARATION: CLEARANCE AND CONSTRUCTION	3-6
3.7	WELLSITES: DRILLING AND TESTING	3-12
3.8	DEMOBILISATION UPON SUSPENSION OF DRILLING ACTIVITIES	3-19
3.9	DECOMMISSIONING UPON ABANDONMENT	3-20

4	STAKEHOLDER PARTICIPATION PROGRAMME	4-1
4.1	INTRODUCTION	4-1
4.2	KEY OBJECTIVES	4-1
4.3	SPDP'S CAMISEA STAKEHOLDER PARTICIPATION PROGRAMME	4-1
4.4	STAKEHOLDER PARTICIPATION AS PART OF THE EIA PROCESS	4-3
4.5	THE PAGORENI/SAN MARTIN EAST STAKEHOLDER PARTICIPATION	
4.6	PROGRAMME	33
4.7	OUTCOME OF THE PAGORENI/SAN MARTIN EAST STAKEHOLDER	
4.8	PARTICIPATION PROGRAMME	4-6
5	EXISTING ENVIRONMENTAL CONDITIONS	5-1
5.1	INTRODUCTION	5-1
5.2	METHODOLOGY	5-1
5.3	GENERAL SETTING OF THE STUDY AREA	5-2
5.4	CLIMATE, METEOROLOGY AND AIR QUALITY	5-4
5.5	GEOLOGY	5-11
5.6	SOILS, VEGETATION AND LAND USE POTENTIAL	5-13
5.7	HYDROLOGY, SURFACE WATERS AND GROUNDWATER	5-27
5.8	VEGETATION AND FLORA	5-37
5.9	FAUNA	5-41
5.10	PROTECTED AREAS	5-50
5.11	SOCIO-CULTURAL CHARACTERISTICS	5-50
5.12	ARCHAEOLOGY AND CULTURAL HERITAGE	5-66
5.13	COMMUNITY RESOURCES AND INFRASTRUCTURE	5-69
5.14	AMBIENT NOISE ENVIRONMENT	5-74
6	ASSESSMENT AND MITIGATION OF IMPACTS	6-1
6.1	ASSESSMENT OF IMPACTS	6-1
6.2	IMPACTS ON THE NATURAL ENVIRONMENT - DRILLING	6-5
6.3	SOCIO-CULTURAL IMPACTS	6-32
7	CONCLUSIONS	7-1

List of Appendices

Appendix A	SPDP's HSE Policy
Appendix B	Key Legislation and Institutions (B1 - B2)
Appendix C	Briefing Papers 7 and 8
Appendix D	Field Survey Diary
Appendix E	Vegetation and Soils Classification and Land Use Potential (E1 - E4)
Appendix F	Water Quality Data (F1 - F4)
Appendix G	Evaluation Methods for Mammals, Herpetofauna and Arthropods (G1 - G2)
Appendix H	Noise Study
Appendix I	Methodology for the Archaeological Survey (I1 - I2)
Appendix J	Participatory Maps
Appendix K	Photo Log

Units

mm	millimetre
m	metre
km	kilometre
km2	kilometre squared
mg	milligramme
t	tonne
MT	Million Tonnes
l	litre
lb	pound (weight)
Bbl	Barrels
%	percent
°	degrees
oC	degrees Centigrade
yr	year
yr-1	per year
ha	hectare
ha-1	per hectare
s	second
s-1	per second
dB	decibels
TDS	Total Dissolved Solids
DO	Dissolved Oxygen
TPH	Total Petroleum Hydrocarbon

Companies

ERM	ERM Peru S.A.
SPDP	Shell Prospecting and Development (Peru) B.V.
SEPP	Shell Exploradora y Productora del Peru B.V.
SIEP	Shell International Exploration and Production

Peruvian Government Organisations

DGAA	Director General Of Environmental Affairs
DGH	Director General of Hydrocarbons
INRENA	Instituto Nacional de Recursos Naturales

Community Representative Organisations

AIDESEP	Inter-Ethnic Association of the Peruvian Amazon
CEDIA	Centro de Investigación Amazónica
CECONAMA	Centre for the Native Machiguenga Communities
COICA	Inter-Ethnic Confederation of the Amazon Basin
COMARU	Council for the Machiguenga People of the River Urubamba
CONAM	National Council for the Environment
CONAP	Confederation of the Peruvian Amazon Nationalities

FECONAYY	Federation for the Native Yines Communities of Yamiria

International Organisations

IFC	International Finance Corporation
WHO	World Health Organisation
IUCN	World Conservation Union
FAO	Food and Agricultural Organisation
US EPA	US Environmental Protection Agency
API	American Petroleum Institute

Other

PEIA	Preliminary Environmental Impact Assessment
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GPS	Global Positioning System
GIS	Geographical Information System
TM	Thematic Mapper
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
NGO	Non-Governmental Organisation
JBA	Joint Business Agreement
FFDP	Full Field Development Programme

Executive Summary

EXECUTIVE SUMMARY

INTRODUCTION

Background

In May 1996, a joint business consortium comprising Shell Prospecting and Development (Peru) BV (SPDP) and Mobil Exploration and Production Peru Inc. signed Licence Agreements with Perupetro SA to undertake appraisal drilling activities and to study options for the future development of the Camisea gas and natural gas liquids reserves. SPDP is the operator of the concession.

Under the terms of the Licence Agreement, SPDP will drill three appraisal wells in 1997 to provide further information on the Camisea reserves; depending on the outcome of this programme a fourth appraisal well may be drilled in 1998. The data obtained from the Appraisal Drilling campaign will be used to improve the definition of the gas fields and to supply technical information for the design of the future production facilities. The Licence Agreement provides a period of two years to study options for the future commercial development of the reserves. Full development and production of the fields (hereafter referred to as the Full Field Development Programme, FFDP) is not expected before the year 2002.

The Licence Agreement also makes provision for the joint venture consortium to explore for further hydrocarbon reserves in Blocks 88A and 88B and to study options for future development of the Camisea natural gas and natural gas liquids reserves.

In March 1997 the Shell/Mobil joint venture consortium entered into a Licence Agreement with Perupetro SA to undertake a hydrocarbons exploration programme in Block 75. Block 75 covers an area of 7 900 km² bordering Blocks 88A and 88B in the south and the Manu National Park in the east. The original delineation of Block 75 was larger as it included part of the Manu National Park. However, at the request of SPDP, the Manu area has been excluded and the size of the block reduced accordingly. SPDP will not enter the Manu National Park.

Under the terms of the Block 75 Licence Agreement, SPDP will undertake a phased exploration programme. During the first phase of this programme, SPDP will re-evaluate (requiring extensive computer analysis) some 300 km seismic data acquired during the 1980's exploratory campaign. The Licence Agreement further calls for drilling of one exploration well in Block 75 by March 1999.

Location of the Camisea Gas Fields

Camisea is situated within the concession area known as Block 75. The May 1996 Licence Agreement is for Camisea Block 88B, which lies within Block 75 allocated to SPDP for purposes of hydrocarbons appraisal and development. Block 88B is located approximately 500 km due east of Lima across the Andes in the Ucayali River (a major tributary of the Amazon) Basin in the department of Cuzco. The region is known as the Lower Urubamba; the Urubamba River flows into the Ucayali River (see Figure 1).

The Exploratory Drilling Campaign

Appraisal drilling is currently being undertaken for three (possibly four) appraisal wells in the San Martin and Cashiriari fields within Block 88B. This appraisal drilling campaign has been the subject of previous rigorous environmental impact assessment.

Following completion of the appraisal drilling campaign, SPDP proposes to embark upon an exploratory drilling campaign comprising development of exploration wells as follows:

- *two (or three) exploratory wells from two locations within the Pagoreni structure (PR-A, PR-D1 and PR-D2) which straddles Block 75 and Block 88B;*
- *one exploratory well within the San Martin field (SME-A), towards its eastern boundary (the San Martin East structure) located within Block 88B.*

Potential locations for these exploration wells are indicated in Figure 1.

It is anticipated that the exploration wells will provide an improved understanding of the subsurface geology of neighbouring areas which have been identified as also having potential to contain hydrocarbons. Confirmation and quantification of this potential addition in reserves will enable the design of the Camisea FFDP to be optimised thereby maximising potential recovery of these reserves.

Implementation of the exploration drilling programme will require continued utilisation of the existing logistics centre at Nuevo Mundo for the transfer or workers, equipment, materials and supplies to and from the proposed wellsites. A fundamental aspect of the project will be the continued use of helicopters to transport all personnel and equipment between the drilling sites and the Logistics Centre; there will be no construction of access roads.

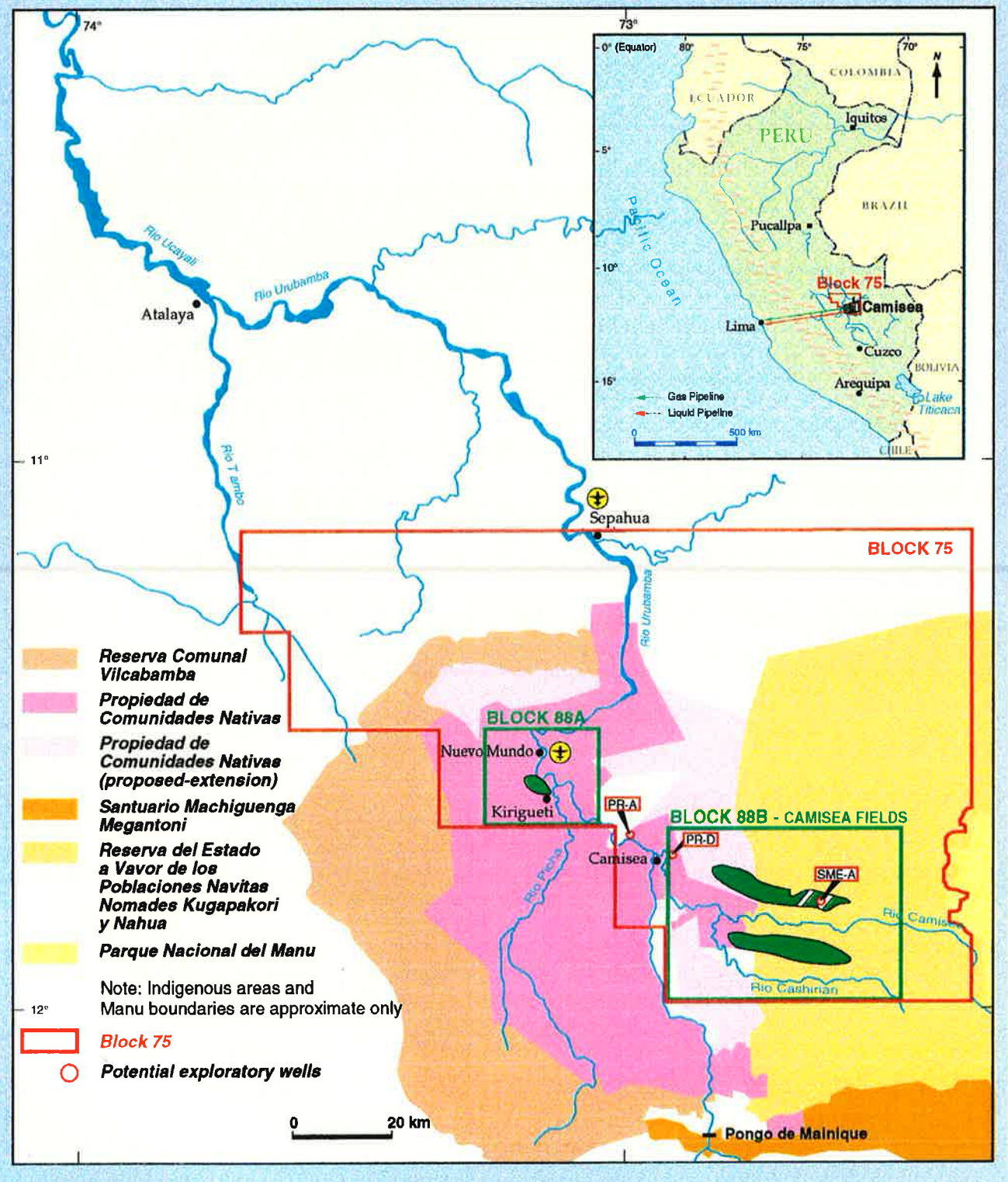
THIS REPORT

In accordance with Peruvian legislation, developers are obliged to subject all their proposed activities to prior environmental impact assessment (EIA) so as to ensure that adequate provision for environmental protection can be incorporated into the planning, design, execution and decommissioning of the project.

This Report, the Executive Summary to the EIA, has been prepared by ERM Peru SA (ERM). It provides the key findings of an independent EIA of the proposed exploratory drilling campaign, including relevant aspects of associated logistical activities.

It is important to recognise that, until the results of the current appraisal and proposed exploratory drilling campaigns are evaluated, it is not possible for SPDP to fully develop the design concept of the future FFDP. This in turn determines that this EIA is only able to evaluate the potential environmental implications of the exploratory drilling campaign. Potential environmental impacts associated with each

Figure 1
Approximate location of the exploratory wells



subsequent stage of the Camisea gas fields development project, and the measures for their avoidance and control, will be subjected to separate EIAs.

SPDP has committed that the focus of each separate EIA will be responsive to the (evolving) issues of concern associated with that stage of the FFDP, and the level of detail at which each assessment is undertaken will be commensurate with the level of environmental risk presented.

This EIA should therefore be seen as a further step in an extended programme of consultation, research and analysis leading to sustainable development of the Camisea gas fields.

SCHEDULE

The exploratory drilling campaign will run over a period of about 18 months, incorporating the following milestones:

- *July 1997: Deployment of a 10-person topographic survey team to survey Pagoreni location (conducted with prior agreement from the Shivangoreni community).*
- *September 1997: Mobilisation of civil engineering equipment by air mainly from the Cashiriari-C location, materials and fuel from the Nuevo Mundo logistic base.*
- *September to December 1997: Preparation of the selected Pagoreni location whereby surfacing of the area will be undertaken by applying a double layer of plastic and one layer of geotextile followed by the actual surface of steel plating. Steel plating will be flown in 10 ton loads.*
- *October 1998: Mobilisation of drilling rig and associated equipment and fuel to the Pagoreni wellsite. Fuel, chemicals and tubulars mainly from the Nuevo Mundo Logistics Centre; the rig and associated equipment will be flown in 10 ton loads.*
- *October to December 1998: Drilling and possibly testing of the Pagoreni well.; transport of drilling rig and associated equipment and materials to the Nuevo Mundo Logistic Centre or to a follow up exploration or appraisal wellsite.*
- *December 1998 to February 1999: Refurbishment and temporary reinstatement of the Pagoreni wellsite.*

This outline schedule is tentative only, since actual timing will be dependent on the outcome of the current appraisal drilling campaign and the actual number of exploration wells drilled will be dependent on the findings of the first exploration well. It is for this reason that the schedule presented above discusses site construction and drilling of one exploration well only.

LOGISTICS ARRANGEMENTS

Although drilling of up to four exploration wells is the prime function of the project, it is the supporting logistical activity that will continue to be most apparent to the local communities. Nuevo Mundo will be the operational focus of the logistics support programme for the exploratory drilling campaign (as it currently is for the appraisal drilling campaign).

The bulk of equipment and materials will be delivered via the Amazon, transferred to barges at Iquitos and thence to Pucallpa; a smaller amount of equipment will be delivered to Pucallpa by road from Lima. From Pucallpa onward to Atalaya and Nuevo Mundo transport, will occur by barge. Personnel and equipment will be flown directly to Nuevo Mundo.

SPDP extended Nuevo Mundo airstrip and set up the Logistics Centre there as part of the current Appraisal Drilling Campaign. The facility is now fully operational and contains all the necessary provisions for:

- *housing workforce;*
- *storing (safely) equipment and supplies;*
- *managing solid wastes;*
- *treating and disposing of sanitary effluents.*

SPDP does not intend to mobilise new workforce and equipment to the area. Rather, the construction crew, and subsequently the drilling crew, will carry on from completing the last appraisal drilling campaign site, to commence work on the first exploration well site.

Throughout the exploratory drilling campaign, Nuevo Mundo will be the main centre of activity from where Shell will operate river transport, fixed wing and helicopter flights.

Since Nuevo Mundo supports a community of about 200 people, all SPDP personnel will be required to continue to observe strict procedures (developed in consultation with the community leaders) aimed at controlling interactions between the workforce and community.

WASTE MANAGEMENT

Introduction

SPDP has developed two waste management plans to deal with wastes at it's Logistics Centre and wellsites; the `Logistics Waste Management Plan` and the `Wellsite Waste Management Plan` respectively. The Logistics Centre manages not only the waste generated on the site, but also any waste materials that are removed from the wellsites. The principal components contained within both Plans are as follows.

Management of Solid and Liquid Wastes

- *non-hazardous combustibles are combusted in on-site (wellsite and Logistics Centre) package incineration plants (incinerator ash from the wellsites will be mixed with drill cuttings and buried on site);*

- *other non-hazardous waste, including cans, bottles, industrial materials, are separated at source, compacted in an industrial compactor and temporarily stored for recycling in Lima;*

- *sewage is treated on-site (Logistics Centre and wellsites) in packaged biological treatment and hypochlorite disinfection units;*

- *all spent lubricating oils or difficult waste materials (arising from the wellsites as well as the Logistics Centre itself) are kept at the Logistics Centre in securely sealed containers housed within a covered, bunded area with an impervious floor, until removal from the site for disposal at an approved disposal location (such as a cement kiln) in Lima*

- *all empty drums will be returned to the suppliers or shipped to an approved drum recycling centre (SPDP are currently storing these drums at the Logistics Centre pending arrangements with a responsible contractor to re-use these drums in an environmentally responsible manner);*

- *any drilling fluid additives and field chemicals unused at termination of the drilling campaign will be returned to the suppliers;*

- *radioactive materials used in open hole formation evaluation will be brought to location and removed from location by the wireline logging contractor;*

- *rig wash and potentially contaminated surface run-off from the drill pad will be routed via an internal drain system to the skimmer tank and then on to the wellsite waste water treatment facility for cleaning through flocculation and aeration prior to use as mud make up water or surface disposal within IFC/World Bank guidelines and Peruvian legislation.*

Management of Drill Cuttings, Muds and Fluids

During upcoming drilling of the Cashiriari-3 appraisal well, SPDP proposes to conduct trials to determine the applicability of annular injection technology for the exploration wells. Using this technology, treated waste waters, slurrified cuttings, or both may be injected down the casing annulus to a minimum depth of 900 m into a permeable, non-potable water-bearing zone overlying the reservoir section. If successful, this will minimise the requirements to bury cuttings and discharge treated waters, thereby providing further enhancement in integrity of mitigation measures incorporated into project design. It is emphasised, however, that viability of annular injection is contingent upon the characteristics of the local geology and existence of a suitable isolated formation for receiving injected waste materials. If it is found that reinjection cannot take place at the exploration wellsites then as a minimum standard, the exploratory drilling campaign will adopt an identical approach to management regime currently employed.

The key features of the waste management programme are outlined in the Wellsite Waste Management Plan and summarised above. As regards drilling wastes specifically, the principal components of the plan are as follows.

- *Only freshwater-based low-toxicity biodegradable drilling fluids will be used and these will be contained in steel tanks on location. Selection of chemical additives (such as potassium chloride, for example) is contingent on the ability to properly dispose of treated fluids within the specifications dictated by Peruvian legislation. All fluids are contained in a closed loop system, with liquids being recycled within*

the system or treated prior to discharge. The fluids treatment system also provides further processing for domestic liquid wastes from the camp packaged bio-treatment unit and for any potentially contaminated fluids caught in the drainage system surrounding the rig.

- *It is estimated that 1 000 m³ of formation cuttings and 500 m³ of solids from spent drilling fluid will be generated during the drilling of a well. A further 1 000 m³ of drilling and completion fluids and run-off rainwater and domestic camp effluent will be produced. The water phase from the de-watered drilling fluid will be handled by the waste water treatment facility, together with the treated water which flows from the packaged sewage treatment plant and the water from the oil separator tank which collects rain and wash water from the dirty drain around the rig equipment. The pH will be adjusted flocculation chemicals added to segregate the solids. After aeration this water will be either used for mud make up, rig wash water or disposed fulfilling IFC/World Bank guidelines and Peruvian legislation. Compliance with these norms will be determined by means of both onsite and offsite testing facilities.*

- *Material in the cuttings burial pit will be maintained well below the surface level which will be achieved via adequate design and sizing of the pit and constructing a cover over the pit and cuttings transport augers to prevent uncontrolled rainwater infiltration. The drilled cuttings and solid waste will be neutralised, treated with lime and buried in the sealed pit.*

EXISTING ENVIRONMENTAL CONDITIONS

Introduction

A Study Area has been defined for the EIA which encompasses the three proposed wellsites.

Baseline data for the Study Area have been acquired through a wide ranging and comprehensive approach which has included:

- *desk studies and literature which built on the work previously conducted by ERM for the previous EIA;*
- *studies commissioned by SPDP, such as the survey of baseline health conditions in the Lower Urubamba;*
- *analysis of available remote sensing data;*
- *a ground field survey of two weeks duration by a team consisting mainly of Peruvian experts;*
- *consultations and interviews with key stakeholders.*

Mapping for the EIA has been produced from aerial photography and ground-truthed by aerial and field survey.

General Setting of the Study Area

Physical Setting

The proposed development of up to four exploration wells at Camisea will take place in a region of Peru that is potentially rich in biological diversity and cultural importance. The project is located in the Urubamba River valley of the Ucayali watershed, between the northern spurs of the Vilcabamba Mountains to the west and the Urubamba Mountains to the east. The Urubamba Mountains lose altitude northwards, and constitute the Fitzcarrald Divide between the Ucayali and Madre de Dios/Purus watersheds. The Camisea River drains the Urubamba Mountains into the Urubamba River. The wider area is primarily low and high rainforest with the land rising to over 3,000 m.

To the south the land rises towards the highlands around Cuzco, intersected by the gorges of the Urubamba river. The river flows past Cuzco and the Inca city of Macchu Picchu before descending through many rapids to the lowlands. The last major rapids, at Pongo de Manique, are approximately 100 km upstream from Nuevo Mundo. Pongo de Manique forms the gateway between the lower and upper Urubamba regions and is recognised as a spiritual landmark by the Machiguenga people.

Ecological Setting

Due to its varied topography and its location at the southern limits of the equatorial region, the Study Area and its surrounds presents a variety of biogeographical and ecological zones. The change in altitude allows for lowland rainforest (below 500 m), highland rainforest (500-1 000 m) and montane cloudforest (`yungas') above 1 000 m. In addition, the transition between tropical and subtropical climates (ie a more marked dry season in the southern parts) and associated vegetation provinces occurs at this latitude, providing for various transitional zones in ecological character.

The tropical rainforest is the dominant biogeographical province in the Study Area, as the climate is humid to very humid with very high rainfall (approximately 3 000 mm yr^{-1}). Rainforests are dependent on this level of rainfall for their high productivity and biodiversity. Paradoxically, however, surface waters and soils tend to be nutrient poor, as the very high biological production rate ensures that there is continual cycling of nutrients through the biomass with very little stored in soil. As a result, rainforests are ecologically fragile and tolerate only minimal loss of nutrients through leaching or, more importantly, soil loss to the outside environment.

The highest diversity of terrestrial plant and animal life in the world is recorded in rainforests. The highest count of mammal species in the world was recorded at the Madre de Dios locality of Balta on the Purus River. This is some 100 km away from the Study Area. At Tambopata Reserve in southern Madre de Dios (some 400 km south east of Camisea), 92 species of mammals, 570 species of birds (a world record) and 71 species of amphibians were recorded over an area of 5.5 km^2. One survey along the Manu river, 100-150 km east of the Study Area, revealed 14 unrecorded amphibian species. It has been estimated that several dozen bird species remain to be described in the Peruvian Amazon. Fish diversity is equally high: 736 species have been recorded in the Peruvian Amazon. Studies of insects and other invertebrates

illustrate the enormous variety of life; in a single tree in Tambopata, 500 species of beetle and 80 species of ant were found, 80% of which were previously unrecorded.

SPDP has commissioned the Smithsonian Institute to undertake a biodiversity assessment of the Camisea region. While the study is still underway, results to-date indicate that the floral diversity of the Camisea region approaches that of the Manu National Park.

Socio-Cultural Setting

The Study Area, and wider area, contains a number of local community settlements. These are populated almost exclusively by indigenous peoples - the Machiguenga. The main settlements in the Study Area are:

- *Camisea;*
- *Segakiato;*
- *Cashiriari (nearest settlement to San Martin East well);*
- *Shivangoreni (nearest settlement to Pagoreni wells);*
- *Nuevo Mundo.*

Other important settlements nearby are Montetoni to the east of the proposed San Martin East location and Kirigueti to the southwest of Nuevo Mundo.

The settlements are exclusively located alongside rivers. Residents practise subsistence agriculture on the forest fringe. Forest and river resources are exploited in a sustainable manner. Most of the communities have some form of primary schooling but limited secondary schooling. Medical and other facilities are somewhat limited.

A baseline health study to assess the current health status and health development needs of the communities in the Camisea area was commissioned by SPDP in 1996. In summary, there was found to be little difference between the general health condition of Camisea's communities compared to that of nearly control communities. Sanitation, nutrition, endemic disease and parasites were found to be key factors in influencing community health.

The communities are strongly linked with each other, and others well outside the Study Area, through family ties and shared culture. The Machiguenga can trace their occupation of the Urubamba and wider area for some 5 000 years into the past. Their culture and way of life has changed relatively little in the last 1 000 years or so, and has survived relatively intact despite contacts with Inca, Spanish colonialism and more recent 'western' influences; of which the latter has introduced familiarity with such matters as radio communication, motorised canoes and links (mainly through community practised forestry) to the cash economy.

The Wellsites

General

The three potential wellsite locations are set in `Great Hilly' grading to `Great Mountainous' landscapes with elevations in the range 430-560 m. All three sites contain shallow acidic soils with low organic matter content and have streams and/or rivers close by. River water sampling undertaken during ERM's field survey indicated that water quality conditions are excellent, with all measured parameters meeting international drinking water standards. Some more specific characteristics of each site are discussed below.

San Martin East

This site is located approximately 20 km east of Cashiriari community. It contains two main vegetation and landscape units:

- *paca tree forest dominated by wild bamboo, situated in moderately dissected high hills with slopes ranging between 12 and 50%;*
- *paca tree forest in moderate to strongly dissected hills with slopes exceeding 75% in places.*

Observations of mammals, herpetofauna and arthropod species indicated a reasonable diversity but overall productivity at this site showed adverse effects from bamboo dominance.

Pagoreni A

This site is in forest on moderately dissected lower hills. The forest type is classed as 'non-disturbed primary forest'. A variety of tree species was recorded including palms. Tree diversity generally varied with soil conditions, thinning somewhat on hill crests. Studies of mammals, herpetofauna and arthropods showed reasonably diverse populations.

Pagoreni D

This site is situated in structurally high hills with steep to extremely steep slopes (50-75%). Vegetation was classed as primary forest with a variety of tree species and some palms. Forest density and species bio-diversity were similar to Pagoreni A.

Other Baseline Characteristics

Data on air quality, water quality and noise were collected during the field survey; the air quality sampling is part of a long-term ongoing programme. Results are summarised below.

- *Atmospheric pollutant concentrations were measured in several communities and at the sites of existing drilling and logistics operations. At all sites, and for all pollutants measured, levels were very low.*

- *Surface water samples from a number of streams and rivers were collected and analysed. All results demonstrated uncontaminated conditions. Sediments, in some places, contained detectable petroleum hydrocarbons but not at levels which indicate contamination or pollution problems.*

- *Noise measurements made at various locations, including the communities, demonstrated the area to have a very 'quiet' ambient noise baseline. Night-time levels, due to forest fauna, often exceeded day-time levels in the communities. The most apparent noisy features were:*

  - *SPDP helicopters;*
  - *SPDP river vessels, especially the hovercraft;*
  - *local communities' motorised canoes.*

ASSESSMENT OF IMPACTS AND MITIGATION

Methodology for Assessment of Impacts

For each category of environmental receptor (such as water resources, ambient air quality etc) the potential impacts of activities planned under the exploratory drilling campaign have been identified. In each case due cognisance has been taken of mitigation measures inherent in SPDP's design of the exploratory drilling programme. These potential impacts have been assessed and, where appropriate, additional mitigation measures have been proposed. Potential residual impacts have been classified according to their likely level of significance. Finally, where further action is deemed necessary (such as training, monitoring etc) this has been identified. An Environmental Management Plan (EMP) has been compiled to incorporate all mitigation measures and further actions proposed.

Criteria for identifying the significance of impacts include compliance with national legislation, guidelines and standards; issues of known concern to Government, non-government organisations (NGOs) or members of the public; likelihood of affecting socio-economic conditions, public health or amenity; and risk of any long-term damage to ecological systems or natural assets of national, regional or local value.

Potential impacts associated with the exploratory drilling campaign have, where practicable, been classified according to the following regime:

- *type, ie positive or negative.*

- *potential significance of environmental impact, according to the following qualitative scale: significant, moderate, or insignificant.*

- *nature: depending on circumstances it may be appropriate to distinguish between those impacts which are local or regional, of short or extended duration, direct or indirect.*

Impacts are presented under the following groupings:

- *impacts on the natural environment arising out of the exploratory drilling activities;*

- *socio-cultural impacts arising out of exploratory drilling and logistics support activities.*

Impacts on Natural Environment

Geophysical Impacts

Geophysical impacts, including soil impacts, will be caused by:

- *landtake at each wellsite needed for construction of associated facilities;*
- *cut-and-fill operations to level and develop each wellsite;*
- *laying of a semi-flexible pipe to abstract water from a nearby stream at each wellsite;*
- *potential spillages and uncontrolled discharges from each wellsite.*

Potential geophysical impacts anticipated are:

- *increased risk of land slippage/slumping and accelerated soil erosion;*
- *interruption of subsoil and overland drainage patterns;*
- *alteration of soil quality by loss of topsoil and overburden;*
- *contamination of soils arising from spillages and contaminated discharges.*

However, all the potential geophysical impacts can be mitigated by good design and construction practice. Key aspects of mitigation will include:

- *site selection to minimise the extent of earthworks and amount of cut and fill required;*

- *protection and stabilisation of bare soil surfaces, especially slopes and storage mounds, using physical and bioengineering techniques;*

- *installation of run-off drains to both mitigate erosion of soils and to minimise wider offside changes to drainage patterns;*

- *protection of soil from contamination.*

Nevertheless, despite best construction practice and fit-for-purpose design there will be a residual risk of potential landslides (such a risk exists without a wellsite present). Unforeseen circumstances such as extremely high rainfall, could cause a landslide or an excessive amount of soil erosion. Run-off surface drainage systems will need to be carefully designed and made site-specific, taking full cognisance of site topography. SPDP now has clearer ideas on managing these impacts based on experience at the appraisal well sites. The risk of adverse effects is now correspondingly lower.

Aquatic Impacts

Surface and groundwater impacts could, in the absence of appropriate design and mitigation, potentially be caused by the following.

- *Earthworks and deforestation at each wellsite may result in changes to drainage characteristics.*

- *Water discharges may arise from the following sources:*
  - *treated effluent (sewage, kitchen and industrial waste);*
  - *drilling cuttings and spent drilling fluids;*
  - *(potentially) contaminated stormwater drainage from the rig pad and rigwash;*
  - *(potentially) high sediment loads in runoff from unpaved wellsite areas;*
  - *any produced water and liquid hydrocarbon fractions collected in the test separator during well testing.*

- *Potential spills of fuel, lubricants or chemicals and leaks from engines (ie chainsaws, power generators) may occur.*

- *Waste handling and disposal, particularly spent lubricants and chemicals, may give rise to accidental releases.*

However, there will be no direct discharges from any of the wellsites to watercourses so the scope for impacts to surface water quality and aquatic life is limited. Water will be abstracted from the nearest suitable watercourse to each wellsite (see description of wellsites above). Watercourses will be selected so that the rate of abstraction will not have a significant effect on dry weather flows. The abstraction pumps will be located within impervious bunds and contingencies will be put in place in the event of any diesel spills.

Indirect effects to water quality will be minor at most. Earthmoving operations will inevitably mobilise soils and in wet weather these will be transmitted down slope towards watercourses. However, as the nearest watercourses are more than 300 m away and the majority of mobilised material will be intercepted by the forest floor vegetation (acting as a natural filter), any adverse indirect effect is likely to be insignificant. As each wellsite becomes established then run-off and drainage controls will further mitigate effects.

Throughout site activities there is the potential for accidental spillages of fuel, lubricants and chemicals to infiltrate watercourses. However, SPDP will ensure that on-site inventories of these materials (both fresh and used) are kept to a minimum, and bunds around the fuel storage area and cuttings pit together with roofing over these storage areas, render the likelihood of contaminated drainage or overflow from a major spill unlikely. Overall, with proper implementation of the mitigation measures to which SPDP is committed, the impacts on surface water quality at all three potential wellsite locations is likely to be insignificant.

Groundwaters will similarly be protected against contamination by using impervious sheeting to underline all storage areas (used for fuels, lubricants and chemicals) and the cuttings pit. Sewage effluent will be treated in a packaged biological treatment plant and then discharged via the water treatment system to the forest floor; it may contain a small level of microbial contamination (<400 coliforms per 100 ml). However, as none of the watercourses are within 300 m of a well site and the fact that the intermediate forest floor will have a dispersion effect, it is not anticipated that the integrity of these watercourses will be threatened.

On completion of drilling, all potentially contaminating materials will be removed from the wellsite. The cuttings pit will be dewatered involving flocculation and pH control which effectively removes suspended solids. Metals will be co-precipitated with the particles. Any extensive hydrocarbon contamination will be skimmed off. The supernatant will be routed to the wastewater treatment system. At the conclusion of this process a relatively clean wastewater will be produced which will be suitable for release (after it has been tested) to the surrounding forest soils.

Figure 2 summarises the water treatment process for the drillsite. The following points are worth noting.

- *There will only be a pit for cleaned cuttings. Mud and drilling fluids will be recycled and spent material will be solidified and disposed off in the cuttings pit.*

- *All potentially contaminated waters will be treated to a recognised standard (IFC/World Bank guidelines) prior to controlled release to the adjacent forest soils.*

- *The overall system offers the ability to recycle and reuse treated water for some functions, thereby reducing abstraction impacts.*

Air Quality Impacts

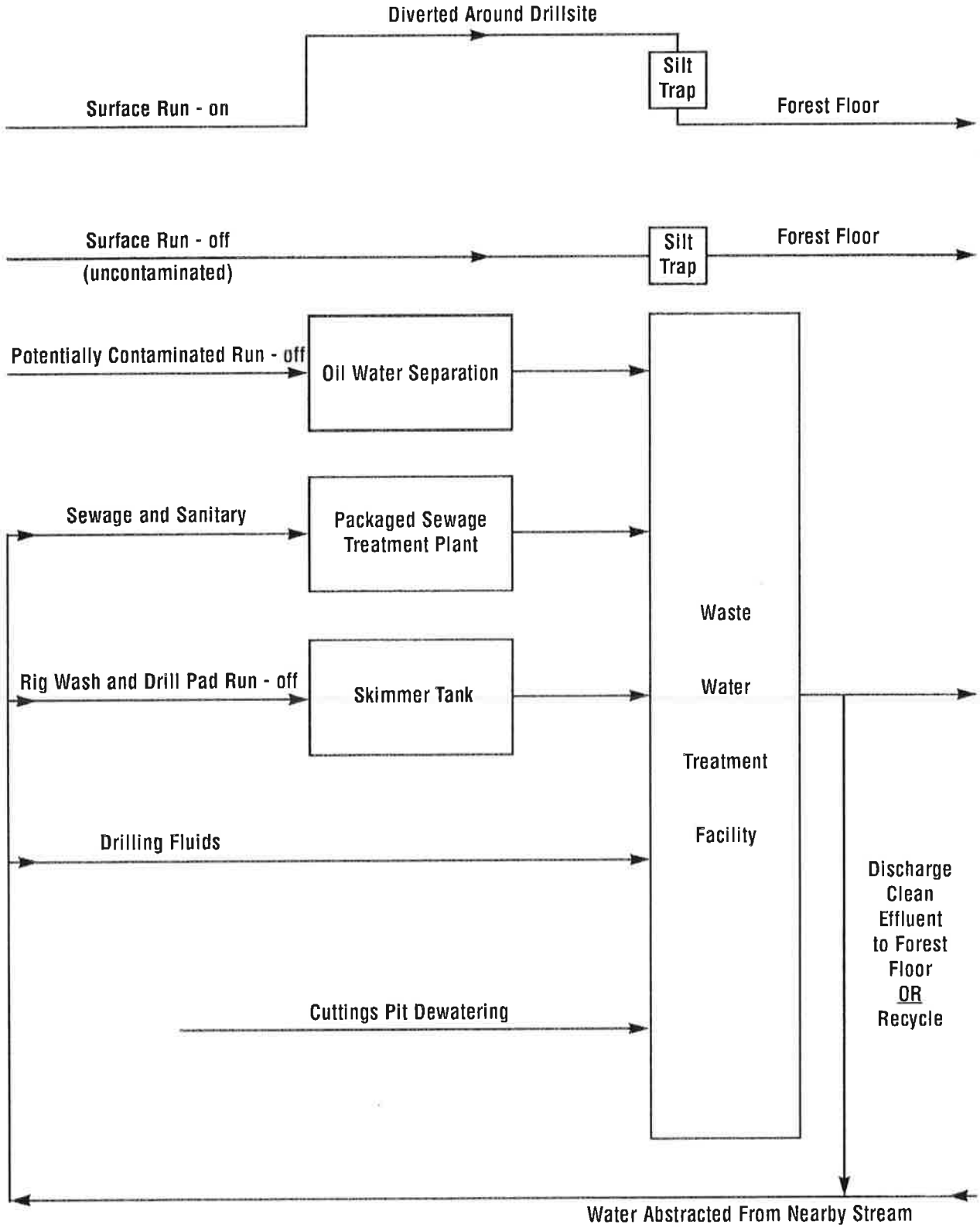
Sources of air emissions at the wellsites will be as follows:

- *dust from earthworks;*
- *exhaust from diesel powered generators;*
- *exhaust from mechanical equipment (excavator, chainsaws);*
- *emission from flaring during any well testing;*
- *emissions from helicopters.*

Ambient air quality effects are normally assessed in relation to their potential to cause:

- *health deterioration and nuisance in local communities;*
- *health deterioration amongst on-site workers;*
- *damage to vegetation.*

During the exploratory drilling campaign there will be low level exhaust emissions from all machines (eg generators). In addition, emissions associated with flaring during any well testing, while more extensive, will be of a maximum duration of 3 days and hence the resultant impacts will be temporary and localised. As a result there will be no significant effects to air quality in the context of human health or nuisance. Similarly, effects on wildlife and flora will also be insignificant. It will be important to mitigate against dust generation since not only is it a form of soil erosion, but may also lead to degradation of habitats fringing wellsites. Measures such as covering stockpiles of soil with plastic sheeting and keeping powdered drilling materials in sealed containers will minimise dust generation.


Diverted Around Drillsite
Silt Trap
Surface Run - on
Forest Floor
Surface Run - off
(uncontaminated)
Silt Trap
Forest Floor
Potentially Contaminated Run - off
Oil Water Separation
Sewage and Sanitary
Packaged Sewage Treatment Plant
Rig Wash and Drill Pad Run - off
Skimmer Tank
Waste Water Treatment Facility
Drilling Fluids
Discharge Clean Effluent to Forest Floor OR Recycle
Cuttings Pit Dewatering
Water Abstracted From Nearby Stream

The fact that existing meteorological data are inadequate to perform dispersion modelling studies is considered immaterial, given the small scale and temporary nature of drilling activities. However, such meteorological data are now being obtained through a programme of data collection at Nuevo Mundo, which includes measuring and recording:

- *hourly wind speeds and directions;*
- *atmospheric stability analysis;*
- *rainfall;*
- *wet and dry bulk air temperatures and relative humidity;*
- *cloud cover and insolation.*

Impacts to Habitats and Flora

Impacts to flora will, or may potentially, be caused by:

- *landtake at each wellsite (up to 4 ha per site during wellsite construction, reduced to 2 ha per site thereafter);*
- *laying of the semi-flexible water supply hose and piping at each wellsite to the nearest stream;*
- *discharges of treated effluents to the forest environment;*
- *potential spillages of drilling fluid additives or fuels;*
- *potential scorching or forest fires resulting from flaring operations during well testing.*

Besides the activities listed above, there are a number of potential impacts to other media which, if realised, would give rise to the following secondary impacts:

- *land slippage and slumping arising out of cut and fill activities to prepare the wellsites;*
- *erosion, siltation and water stagnation arising from run-on and run-off and hydrological change at each wellsite;*
- *deterioration in ambient air quality arising out of emissions from on-site equipment.*

Wellsite design incorporates the following relevant measures.

- *Each wellsite will be managed as a remote wellsite (a so-called `off-shore island') with no access other than by helicopter.*

- *At the wellsites, the extent of vegetation clearance will be minimised by marking out the site boundary prior to commencement of clearance operations.*

- *Helicopter approaches cleared for safety reasons will be kept to a minimum, ie a narrow (50 m wide) approach cut to breast height.*

- *To the maximum extent practicable, flexible hose will be used for water abstraction from the nearest stream at each wellsite: the hose to be lain through the undergrowth and between trees without any need for felling or understorey clearance.*

- *Site-specific run-off and a number of erosion control measures will be installed so as to minimise soil erosion and siltation and prevent water stagnation.*

- *Site drainage and treated sewage and other effluents will be routed via above ground flexible hoses so as not to cause erosion to locations where discharge will not result in water stagnation.*

- *Topsoil removed wherever possible during site clearance and stockpiled at edge of the wellsite for subsequent reinstatement purposes.*

Consequently, measures have been incorporated into project design to minimise the extent of forest clearance so that landtake, which is the main residual impact, will involve 4 hectares or less of complete vegetation clearance at each wellsite location. Impacts will, at worst, be moderate and localised at the two potential Pagoreni sites, and insignificant at San Martin East. In summary:

- *the potential wellsite locations do contain some important tree species, particularly the Pagoreni A and D locations;*

- *the poor soils and domination by bamboo in the vicinity of the San Martin East wellsite gives rise to low density of individuals per species;*

- *habitats at all the wellsites, although fragile, show the ability to regenerate/recover as is evidenced by the recovery since the late 1980's at Armihuari and San Martin-1 wellsites.*

- *the wellsites are small `islands' in otherwise homogenous habitats; they do not form ecological corridors.*

Once the locations of San Martin East and Pagoreni A and D have been surveyed and marked out, SPDP will invite representatives from the local communities to liaise with a tropical forester to identify and assess the species that exist at each site. Opportunities will be provided for the communities to recover useful species such as palm.

Impacts to Fauna

Impacts to fauna could potentially be caused by:

- *landtake at each wellsite;*
- *noise disturbance, related to wellsite clearance, wellhead construction, drilling and any testing;*
- *on-site personnel movements involved in wellsite activities;*
- *illumination from night-time lighting and glare as a result of flaring during any well testing activities;*
- *helicopter movements conveying personnel and equipment to the site;*
- *waste management (storage/disposal);*
- *off-site movements of personnel, hunting, trapping or taming.*

The activities listed above could lead to some of the following:

- *loss, damage or disturbance to habitats;*

- *disruption of food chain as a result of loss of floral species;*
- *disturbance by human movement;*
- *poisoning, resulting from ingestion of toxic materials, plastic bags, etc;*
- *dependence, as a result of consuming food waste (or being fed).*

The exploratory drilling campaign design will incorporate the following relevant measures.

- *Each wellsite will be managed as a remote wellsite (`off-shore island') with no access other than by helicopter.*

- *The extent of clearance of vegetation at the wellsites will be minimised by staying within defined boundaries.*

- *Noisy equipment will be well maintained and acoustic shielding will be installed where practicable.*

- *No hunting or fishing will be allowed by SPDP or contractor staff.*

- *All wastes will be contained at the wellsites and transported to Nuevo Mundo for appropriate disposal. Wastewater will be fully treated prior to discharge.*

Residual impacts to fauna will relate to landtake and disturbance. The protected species of fauna are all judged to be sufficiently mobile as to avoid direct physical harm during tree felling and bush clearing, with the possible exception of birds' eggs and fledglings. At most, a small group of localised individuals would be affected. This together with the small landtake area per wellsite, means that landtake impacts to fauna will be insignificant.

Disturbance impacts will result from various noise sources and human movement. The latter can be strictly controlled and an element of the former will be localised to the wellsites and immediately surrounding areas. Helicopter movements will extend the zone of impacts along their flightpaths and a distance either side. Strict control of helicopter flightpaths will act to limit the zone of impact. Nevertheless there is a degree of uncertainty in how different species of fauna will react to varying levels of disturbance. Some species may simply suspend feeding/foraging activity during helicopter overflights, others may leave the area entirely. Studies on other animal groups have shown that many species can become acclimatised to noise and (less so) visual disturbance once it is apparent there is no associated physical threat. It is reasonable to state that disturbance of forest fauna by helicopter movements will be kept to a practical minimum if regular, constant and well-defined flightpaths are kept to.

To address the uncertainty over fauna disturbance, SPDP commissioned the Smithsonian Institution (with Peruvian experts) to undertake a bio-diversity study in the vicinity of the current appraisal wellsites with a view to gaining a better understanding of such impacts and, if practical, reducing them through further mitigating action. The results of this work are expected in due course.

Socio-Cultural Impacts

Introduction

In discussing potential socio-cultural impacts, it is difficult to isolate those potential impacts associated with the proposed exploratory drilling campaign from the ongoing appraisal drilling campaign and from those of the ultimate FFDP. It is therefore necessary to consider issues which might at this stage result in moderate or insignificant impacts, but which require careful mitigation and controls to be put in place prior to, or during, exploratory drilling to prevent significant socio-cultural impacts during any future full field development.

Potential impacts which may occur as a direct, or indirect, result of project activities are as follows:

- *direct loss of economic resources (timber, other forest products, food etc);*
- *landtake of productive lands (agriculture, pasture, hunting and fishing areas);*
- *contamination of drinking water supplies;*
- *human health impacts;*
- *loss or damage to archaeological sites;*
- *increase in employment and income generation;*
- *provision of health and education services.*

Socio-cultural Impacts

The local communities will be exposed to various types of impact some of which can be regarded as direct (eg landtake, disturbance) and some of which may lead to profound changes in socio-cultural characteristics (eg increase in income generation). However, SPDP has designed the exploratory drilling campaign in such a way as to minimise the impact on the local communities.

- *Each wellsite will be managed as a remote operation and access will be strictly controlled.*

- *All on-site operations will be stringently controlled and managed by SPDP management and staff.*

- *Access roads will not be constructed, thereby avoiding so-called 'boom-town' effects.*

Never-the-less, there will be some direct impacts such as landtake, loss of forestry resource and accidental damage, all of which can readily be 'quantified' and compensated. Other impacts such as noise and general disturbance effects will be managed as previously described, whereas potential adverse effects on drinking water quality or flora will be avoided by strictly applied mitigation measures.

Health Impacts

A key concern is the potential impact on human health through diseases communicated from the workforce to the local community. This potential will be mitigated by a continued programme of health screening, preventative medicine and

monitoring of population together with strict controls on incoming personnel and visitors through SPDP's 'Health Passport' system. There will be close coordination with missionaries and doctors and contingent plans to respond to any medical emergency will be developed.

Health issues are made more complex by the fact that the local communities make clear links between the perceived environmental quality and their own health. Despite the fact that the majority of the poor health condition in the area is attributable to nutritional status, sanitation and the prevalence of endemic diseases and parasites, the perception is that illness is something that strikes from outside not just the body but also the immediate community. Thus if there is a perception that SPDP is polluting the atmosphere or the rivers then this will be perceived as a direct threat to the individual's and community's health above and beyond the usual (and more real) threats. This in turn can lead to a general level of anxiety, which the communities also effectively regard as an illness. In perceiving such threats to health, distinctions are not made over the level of 'pollution' causing it. Small changes to river turbidity or minor emissions of exhaust gases from a handful of vehicles can be perceived as health threats.

Although SPDP has put in place all the necessary measures to protect surface and groundwater supplies and despite air quality impacts being negligible, the means of adequately demonstrating these matters to the local community will need to be sought. Simple monitoring of indicators, whilst necessary, will not be enough. Explanation through consultation will be performed to allay community fears. At present the local communities see changes to their environment and perceive some of them as threats to their health. SPDP will implement a programme, combined with monitoring, to explain the true consequences of what are generally minor changes. The programme will educate the communities in such matters as the levels at which the pollutants are known to cause adverse effects and the corresponding levels that urban communities tolerate.

Land Use Impacts

There are four potential landuse impacts to be considered:

- *loss of potential (ie as yet undeveloped or underdeveloped) agricultural land;*
- *loss of areas suitable for logging;*
- *loss of hunting areas and/or displacement of species of economic importance for the communities;*
- *loss of areas used for cultural purposes (ie areas used for collecting medical plants, sacred areas).*

There will be no direct land use impacts since the wellsites are remote from the local communities and relatively inaccessible. Nevertheless they have potential land use value and may contain resources which are useful to the communities in the long term and therefore an appropriate level of compensation will be agreed with the communities prior to any work.

Impacts to Local Resources and Infrastructure

Wellsite preparation and drilling operations could conceivably affect the following infrastructure:

- *water supply system;*
- *existing trails.*

Potential aquatic impacts are discussed above and are shown to be insignificant. Residual impacts to other local resources and infrastructure will also be insignificant.

The main residual impacts are likely to stem from three areas:

- *general disturbance, especially from noisy activities;*
- *changes to existing economic activity through SPDP's local presence;*
- *changes to the existing culture due to SPDP's local presence.*

Disturbance Impacts

Drillsite noise during construction and drilling itself is sufficiently manageable and far away from communities as to be unlikely to cause impact or nuisance. Of greater concern is noise due to helicopter and river craft movements, both of which are inevitable. On the rivers, the hovercraft has been a significant cause of noise during the appraisal drilling campaign and the 'scaring away of fish' has been attributed to it; it is SPDP's intention not to use hovercraft during the exploratory drilling campaign. The effects of river traffic are in part mitigated by the fact that noise from them is a passing phenomenon to a stationary observer, quite rapidly diminishing with distance and the screening effects of river bends and intervening vegetation. The overall zone of influence is also limited. Helicopters are another matter. They comprise a louder noise source; their use is spread over a wider geographic area; and their noise influence affects an even wider area. Helicopters flying over communities or even near to them are a regular source of noise disturbance and causes disruption to village life. This is unsurprising once it is appreciated how quiet these villages are: average noise levels in the communities show them to be noisier at night (due to the influence of forest life) than during the day - a direct inversion of the normal experience in urban and even rural areas. Helicopters have also been cited as the main cause of 'scaring away game', with the result that villagers have to hunt for longer and further away (although this could equally be attributable to population growth and over-exploitation). However, it also has to be recognised that the helicopters provide a significantly positive function - their use negates the need for a road and isolates the drillsite workforce from the communities. Nevertheless, impacts will need to be managed firmly. In the course of this EIA noise levels have been quantified and avoidance distances (based on widely accepted noise impact criteria and modelling) will be developed further in consultation with the affected communities so that clearly defined flight paths (supported by navigational beacons) are set out that go as far as possible to meet the needs of both the communities and SPDP. These will then be published to the communities and all helicopter contractors/pilots and strictly adhered to.

Changes to Economic Activity

The changes to the existing economic climate are being managed to some extent by:

- *maximising opportunities for the involvement of locals in skilled and semi-skilled work coupled with training where appropriate;*
- *giving preference to the most affected local communities by recruiting Machiguenga;*
- *encouraging over time the purchase of local produce, so as to avoid inflation and/or unsustainable harvesting of resources.*

These measures will continue.

It is important to note that even the positive aspects of SPDP's presence, such as local employment, can have negative impacts, such as income disparities. It is reasonable to state that greater benefits will accrue to the communities through the provision of communal facilities (education, health etc) rather than monetary gain to a limited number of individuals.

Changes to Existing Culture

Changes in cultural characteristics may be profound and subtle and are very difficult to predict in terms of their significance. SPDP's presence will not be the only factor of change in the area; religious missions are also present and active. It is worth noting that there have been no noticeable cultural changes resulting from SPDP's previous presence in the Camisea region. However SPDP's presence this time is substantially less 'temporary' than previously and the potential for initiating significant cultural change is likely to be much greater.

For this reason, SPDP will not only apply the strictest of measures to manage interactions with the local communities, together with a programme of ongoing consultations, but will also initiate a programme of monitoring the results of the interactions that do occur. This monitoring will not only include matters such as health, complaints of construction nuisance etc, it will also keep track of indicators of more profound socio-cultural change, including, but not limited to:

- *prices of local produce;*
- *income and income disparities;*
- *demographic change;*
- *increasing agricultural and domestic workloads for women.*

Understanding these changes and formulating means, in association with the local communities, for dealing with them is a key activity initiated during the current appraisal drilling campaign in leading through the proposed exploratory drilling campaign into the potential Full Field Development Programme.

Furthermore the FFDP will bring some benefits to the local communities and the region as a whole. A major component of SPDP's community affairs strategy is aimed at determining ways of harmonising the current project activities (and ultimately the FFDP) with the provision of overall benefit (ie increasing 'social and

human capital') to the local people of the Region. SPDP will continue its on-going dialogue with the communities, seeking to develop the means and protocols by which this can be achieved.

Chapter 1

Introduction

1 INTRODUCTION

1.1 DEVELOPMENT OF CAMISEA HYDROCARBON RESERVES

1.1.1 Historical Perspective to Current Proposals

Between 1981 and 1987, *Shell Exploradora y Productora del Peru BV (SEPP)* discovered two major gas/condensate accumulations in the Camisea area of the Ucayali River Basin, some 500 km to the east of Lima. The two fields, San Martin and Cashiriari, are located within Block 88B which is adjacent to Block 75 of Peru's Andean Concession. However, no agreement regarding field development was reached with the Peruvian government at the time of these discoveries. Exploratory operations were terminated and SEPP was liquidated in 1988.

In March 1994, *Shell Prospecting and Development (Peru) BV (SPDP)* and *Perupetro SA* signed an agreement to undertake further discussions relating to potential development of the Camisea fields.

In May 1995, SPDP submitted to Perupetro SA a feasibility report which presented SPDP's proposed strategy for full appraisal and subsequent development of the Camisea fields. The feasibility study identified the need to undertake focused early exploratory and appraisal drilling campaigns to more fully delineate the physical extent of the Camisea fields' reservoirs and to provide vital data on their potential productive capacity. It is anticipated that this information will confirm the feasibility of developing the Camisea fields and facilitate design of an appropriate full field development programme that will produce hydrocarbons (both natural gas and natural gas liquids [1]) and transfer them to the markets via export facilities on the Peru coastline.

SPDP meanwhile concluded a joint business agreement with *Mobil Exploration and Production Peru (Inc) (Mobil)* regarding joint execution of exploration and development activities in Blocks 88A and 88B and Block 75. Under this agreement, SPDP holds a 57.5% interest and Mobil holds the remaining 42.5%. SPDP is the designated operator under the agreement.

1.1.2 *The Blocks 88A and 88B Licence Agreement*

In May 1996, the Shell/Mobil joint venture consortium entered into a Licence Agreement with Perupetro SA to undertake an appraisal drilling campaign in Block 88B. (Block 88A encompasses the area surrounding Nuevo Mundo which is the location selected for the logistics and supply operations base providing support to the appraisal drilling campaign.) The Licence Agreement also makes provision for the joint venture consortium to explore for further hydrocarbon reserves in Blocks 88A and 88B and to study options for future development of the Camisea natural gas and natural gas liquids reserves.

(1) Natural gas liquids (NGLs) is the terms used to describe the liquid hydrocarbon fractions that coexist naturally in the reservoir with natural gas. NGLs are also widely (but less accurately) referred to as `condensate`.

The Blocks 88A and 88B Licence Agreement provides a period of two years to study options for the future commercial development of the reserves. Full development and production of the fields (hereafter referred to as a the *Full Field Development Programme, FFDP*) is not expected before the year 2002 and will cost almost US$3 billion.

Under the terms of the Blocks 88A and 88B Licence Agreement the Block 88B appraisal drilling campaign will entail drilling three (possibly four) appraisal wells during the course of 1997/98 to provide essential further information on the subsurface reservoirs. Results obtained from drilling of the first three appraisal wells will determine whether drilling of a fourth well is required. The data obtained from the appraisal drilling campaign will be used to improve current understanding and definition of the Block 88B gas fields and to supply technical information for the design of the future production facilities (ie FFDP).

In February 1996 SPDP commissioned *ERM Peru SA* to undertake an environmental impact assessment (EIA) of the proposed appraisal drilling campaign and associated logistics and supply operations. The EIA was filed with the Directorate General of Hydrocarbons (DGH), Ministry of Energy and Mines in July 1996. SPDP presented its findings at a public hearing in Lima in August and approval (with provisions) to proceed with the appraisal drilling campaign was granted by the authorities on 26 August 1996.

Preparatory field work commenced in September 1996. Drilling commenced in March 1997 and is currently anticipated to be completed by May 1998. Copies of the EIA are available from SPDP's offices in Lima.

1.1.3 The Block 75 Licence Agreement

In March 1997 the Shell/Mobil joint venture consortium entered into a Licence Agreement with Perupetro SA to undertake a hydrocarbons exploration programme in Block 75. Block 75 covers an area of 7 900 km^2 bordering Blocks 88A and 88B in the south and the Manu National Park in the east. The original delineation of Block 75 was larger because it was extended towards North of Camisea as well as including part of the Manu National Park. However, at the request of SPDP, the Manu area has been excluded and the size of the block reduced accordingly. SPDP will not enter the Manu National Park.

Under the terms of the Block 75 Licence Agreement, SPDP will undertake a phased exploration programme. During the first phase of this programme, SPDP will re-evaluate (requiring extensive computer analysis) some 300 km seismic data acquired during the 1980's exploratory campaign referred to in *Section 1.1.1*. The Licence Agreement further calls for drilling of one exploration well in Block 75 by March 1999.

1.2 PROGRAMMES AND ACTIVITIES SUBJECT TO THIS ENVIRONMENTAL IMPACT ASSESSMENT

1.2.1 *The Pagoreni and San Martin East Exploratory Drilling Campaign*

As mentioned in *Section 1.1.2* above, drilling is currently being undertaken for three (possibly four) appraisal wells in the San Martin and Cashirari fields within Block 88B. This appraisal drilling campaign has been the subject of rigorous environmental impact assessment.

Following completion of the appraisal drilling campaign, SPDP proposes to embark upon an exploratory drilling campaign comprising development of exploration wells as follows:

- up to three exploration wells (PR-A, PR-D1 and PR-D2) from two locations within the Pagoreni structure which straddles Block 75 and Block 88B;
- one exploration well (SME-A) within the San Martin field, towards its eastern boundary (the San Martin East structure) located within Block 88B.

Potential locations for these exploration wells are indicated in *Figure 1.1*. While the location of the San Martin East (SME-A) wellsite is fixed, there are currently two surface sites (PR-A and PR-D) under consideration for location of (up to three of) the Pagoreni wells.

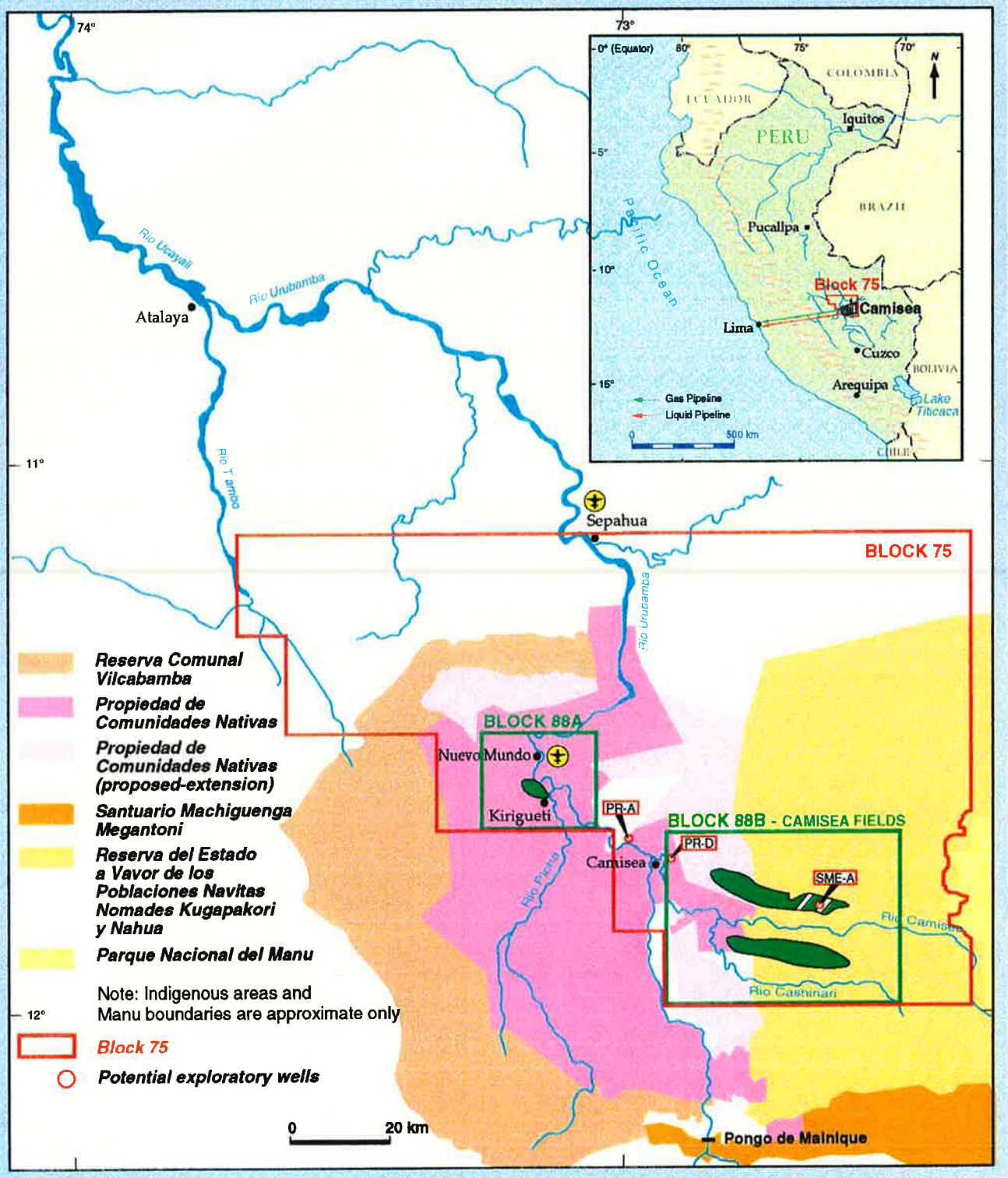
It is anticipated that the exploration wells will provide an improved understanding of the subsurface geology of neighbouring areas which have been identified as also having potential to contain hydrocarbons. Confirmation and quantification of this potential addition in reserves will enable the design of the Camisea FFDP to be optimised, thereby maximising potential recovery of these reserves.

Implementation of the exploration drilling programme will require continued utilisation of the existing logistics centre at Nuevo Mundo for the transfer or workers, equipment, materials and supplies to and from the proposed wellsites.

It is anticipated that construction of the first exploration wellsite will take place in September 1997 and drilling will commence by December 1998 (immediately after completion of the current Block 88B appraisal drilling campaign).

It is the activities associated with development of these exploration wells that are the subject of this EIA. Since the location of the Pagoreni wellsite is currently not fixed, all three potential Pagoreni exploratory wells within Block 88B and Block 75 are considered in the EIA. Should any further wellsite locations or additional wells be considered, they will be the subject of a separate EIA and authorisation process.

Figure 1.1
Approximate location of the exploratory wells



1.2.2 *The Pagoreni Exploratory Drilling Programme*

Licence Obligations

The first well, Pagoreni (D-1), is planned to be drilled from a surface location in Block 88B to a subsurface location in Block 75. The drilling of the well will fulfil the drilling commitments for the current phase of the Block 75 Licence Agreement (ie completion of one exploration well by March 1999).

Well Objectives

The Pagoreni structure is a large anticline northwest of the San Martin Field. The exploration well which will explore the potential contents of the structure will be drilled from a central surface location on the field to a location on the western edge of the structure within Block 75. The well will explore the gas-bearing potential of the Cretaceous and Permian sandstone reservoirs that are gas-bearing in the adjacent San Martin and Cashirairi Fields, namely the Vivian, Chonta, Nia Kaatsirinkari, Noipatsite and Ene Reservoirs. In addition, the well may assess the hydrocarbon potential of the older Carboniferous limestones and sandstones of the Copacabana and Tarma Groups. A successful first exploration well at Pagoreni will need one or two follow up appraisal wells (Pagoreni-D2/Pagoreni-A) to establish the commerciality of the discovery and enable such a discovery to be included within the planning of the Camisea FFDP.

Locations Options

The following five surface locations had initially been identified from the Pagoreni structure as *potential* wellsites for the exploratory drilling programme:

- Pagoreni-A: 720584m E 8708682m N;
- Pagoreni-B: 730821m E 8703667m N;
- Pagoreni-C1: 726550m E 8706375m N;
- Pagoreni-C2: 726550m E 8704800m N;
- Pagoreni-D1/D2: 728950m E 8705200m N.

The selection of the short listed locations for the exploration wellsites at Pagoreni has been based on meeting the following criteria:

- the well should be sited where it is likely to yield the optimum data on the characteristics and extent of the hydrocarbon resource;
- the well should be sited so that the potential environmental and social impacts can be minimised;
- a wellsite should be selected that offers the maximum opportunity for it to be used as a cluster drilling location during appraisal and future development.

Evaluating each of these criteria against the five potential surface locations referenced above yields the following assessment.

- *Pagoreni-A*: This site is not ideally suited to yield the required technical data about the nature and extent of the hydrocarbon resource, but should not be discounted at this early stage. This site can be considered a secondary choice.

- *Pagoreni-B*: This site is considered unsuitable as a future cluster drilling location. Although it is considered likely to be suitable for providing information on characteristics of the hydrocarbon resource it will not provide information concerning the extent of the resource. Furthermore, it can be reached by directionally drilling from the Pagoreni-D location.

- *Pagoreni-C1* and C2: Both these sites are considered to be too close to the host community at Shivangoreni and both locations are unsuitable for future cluster drilling activities. This was confirmed during consultations taken as part of the EIA field survey.

- *Pagoreni-D*: This site meets all the above criteria and is the preferred location for the Pagoreni structure at this stage. Two wells may be drilled from this location, one to reach the original Pagoreni-B location (referred to as Pagoreni-D1) and the other for the Pagoreni-D location itself (referred to as Pagoreni-D2).

The preferred location of Pagoreni-D (PR-D1 and PR-D2) meets all the criteria with Pagoreni-A being included in the programme for possible future development. The scope of work for the first well on Pagoreni (PR-D1) will include drilling and sampling of the well and, in the event that hydrocarbons are encountered, testing will be conducted.

SPDP will commence work by detailing a topographic survey team to the area to determine the precise location and optimum orientation of the site. Contingent upon the approval of this EIA by the DGH, SPDP will proceed to construction. Environmental considerations identified in this EIA will be a key factor in the design, construction and operation of the site.

1.2.3 *The San Martin East Exploratory Drilling Programme*

Licence Obligations

The drilling of the three (possibly four) appraisal wells in 1997 in Block 88B fulfils all SPDP's current contractual drilling commitments of the Blocks 88A and 88B Licence Agreement. Development of the San Martin East exploration well in Block 88B represents an addition to these commitments. It will be planned on the basis of the results obtained from the current appraisal drilling campaign.

Well Objectives

It is envisaged that the San Martin East well will be drilled to a target depth within the Copacabana Group, enabling the well to fully evaluate the gas-bearing potential of the structure. It is anticipated that the well will acquire wireline logs and possibly cores (if hydrocarbon bearing reservoirs are found). Production testing may also be required if the structure is gas-bearing, to allow representative samples of the reservoir fluid (gas) to be obtained for analysis and evaluation.

Location Options

A single target site, located within the San Martin reservoir has been identified as a potential exploration drilling wellsite location. The current surface location is directly above this point and may be adjusted within some limits to accommodate surface topography, safety, community and environmental concerns. The proposed San Martin East (SME-A) wellsite location (757969m E 869102m N) fulfils all the criteria set out in *Section 1.2.2*. It will hopefully also provide information regarding the eastward extent of the San Martin reservoir, which will in turn further assist in optimisation of the Camisea FFDP. The location at San Martin East will be prepared after the results of the forthcoming San Martin-3 appraisal well has been drilled (part of the current appraisal drilling campaign).

1.3 THIS ENVIRONMENTAL STATEMENT

In accordance with Peruvian legislation developers are obliged to subject all their proposed activities to prior environmental impact assessment (EIA) so as to ensure that adequate provision for environmental protection can be incorporated into the design and execution of the project. SPDP has publicly stated its commitment to making the Camisea project a sustainable one, based on openness, cooperation and consultation with a wide range of stakeholders, particularly the local communities of the Lower Urubamba region. An extensive consultation process with local, national and international stakeholders is underway, and is aimed at promoting dialogue, partnership and cooperation during all stages of the proposed project. This consultation process will form a key part in evaluating the options for the future full scale development and production of the Camisea reserves.

This Report, hereafter referred to as the ***Environmental Statement***, has been prepared by ERM Peru SA (ERM) and presents the results of an independent environmental impact assessment of the proposed 1998 Pagoreni and San Martin East exploratory drilling campaign and relevant aspects of the associated logistics support programme which has been summarised in *Section 1.2* and which is described in *Chapter 3*. As such it is the second EIA completed under SPDP's staged programme leading to full development of the Camisea fields. The first EIA covered issues associated with the Block 88B appraisal drilling campaign summarised in *Section 1.1.2* and approved in August 1996.

It is important to recognise that, until the results of SPDP's current appraisal drilling campaign are evaluated, it is not possible to develop the design concept of the FFDP. This in turn determines that this EIA is only able to evaluate the potential environmental implications of the exploratory drilling campaign currently under consideration. Potential environmental impacts associated with each other stage of the Camisea gas fields development project, and the measures for their avoidance and control, have been (and will continue to be) subjected to separate environmental impact assessment, the detail of which will be commensurate with the level of environmental risk presented. This EIA should therefore be seen as one intermediate step in an extended programme of consultation, research and analysis leading to sustainable development of the Camisea gas fields.

1.4 *EIA APPROACH AND METHODOLOGY*

ERM's approach and methodology in executing this EIA has been developed and shaped in light of the following main factors.

- *Complying with national legislation and international environmental standards*: This EIA meets all the requirements of Peruvian legislation (1) and guidance. It has also been developed in accordance with international EIA Standards such as those of the World Bank (2) (3) and related guidelines such as those of the E&P Forum (4) (the Oil Industry International Exploration and Production Forum). A description of the methodology used is presented in *Chapter 6*.

- *Recognising SPDP's step-wise programme*: This EIA has been developed recognising that the exploratory drilling campaign is one intermediate stage of an integrated gas field development programme that SPDP is proposing to undertake in Camisea. Each successive stage of the programme will be preceded by thorough environmental impact assessment; just as each successive stage of the gas field development programme needs to dovetail with preceding and succeeding stages, so each corresponding EIA needs to form part of an integrated EIA process. This EIA is the second stage in that process (the first EIA having addressed issues associated with the current appraisal drilling campaign).

- *Developing a sound baseline methodology*: In order to gain a clearer and more detailed picture of baseline environmental conditions of the well sites, full use was made of the fact that there were six potential study sites in the area (as identified in *Sections 1.2.2/1.2.3*), all of which have been included during baseline data collection.

- *Ensuring the EIA is developed through an iterative process*: This EIA has been developed by maintaining a high degree of transparency which has been

(1) Republic of Peru, Ministry of Energy and Mines, *Guidelines for the Preparation of Environmental Impact Studies*, Volume IV.

(2) World Bank *Procedures for Environmental Impact Assessment* Operational Directive 4.01 (1991)

(3) World Bank *Procedures for Projects Impacting Indigenous Peoples*. Operational Directive 4.40 (1991)

(4) E&P Forum, Oil Industry Operating Guidelines in Tropical Rainforests, Report 2.49/17.

achieved through continued dialogue with SPDP and consultation with key stakeholders.

- *Identifying the right team*: This EIA has been produced using a team of experts to assess baseline conditions and evaluate potential environmental and social impacts for what is a very sensitive area and a development that is likely to draw the attention of the international arena.

- *Maximising use of local knowledge*: Throughout this EIA process local expertise, skill and knowledge has been used to assist the field team during baseline data collection and the ongoing consultation programme.

- *Complying with the Shell Group's corporate policy*: This EIA has taken into full account and complied with Shell Group corporate policy and especially the following documents:

  - SPDP's Health, Safety and Environmental Policy (see *Appendix A*);
  - Shell International Exploration and Production (SIEP) Environmental Assessment Guidelines;
  - SIEP's Social Impact Assessment Guidelines.

1.5 PURPOSE OF THE ENVIRONMENTAL STATEMENT AND ASSOCIATED REPORTS

The Terms of Reference of the Consultants' work is as follows.

- To conduct a comprehensive EIA of the 1998 Pagoreni and San Martin East exploratory drilling campaign proposed by SPDP in Blocks 88A and 88B and Block 75 of the Camisea region involving the following components:

  - collection and review of information pertaining to existing environmental conditions in the areas of Camisea potentially affected by the proposed exploratory drilling campaign (including relevant aspects of the associated logistics programme which will support the drilling campaign) through consultation with relevant parties and experts, supported by field and aerial photography surveys;

  - evaluation of all potentially significant adverse environmental and socio-economic impacts and hazards associated with the exploratory drilling campaign;

  - identification and planning of measures to prevent, mitigate or compensate potential adverse impacts.

- To consult closely with SPDP in developing a comprehensive Environmental Management Plan (EMP) for the exploratory drilling campaign which:

  - identifies and describes appropriate measures to prevent, mitigate or compensate for all potential adverse impacts identified in the EIA, including environmental monitoring;

- provides focused plans for the implementation of these measures, (including requirements for contractors) during well construction, drilling, testing and decommissioning, as well as during operation of the logistics support facilities underpinning the exploratory drilling campaign;

- presents an abandonment plan describing the measures needed to restore the well site(s) should exploratory drilling activities be unsuccessful;

- provides an outline Emergency Response Plan.

1.6 *STRUCTURE OF THE ENVIRONMENTAL STATEMENT*

The remainder of this Environmental Statement is structured as follows.

- *Chapter 2* provides a concise summary of the project planning and environmental protection legislative instruments and requirements that are of direct relevance to the proposed exploratory drilling campaign, pertinent aspects of the EIA process in Peru and the key organisations responsible for environmental and indigenous affairs.

- *Chapter 3* describes the proposed project activities in detail.

- *Chapter 4* summarises the results of consultation undertaken thus far.

- *Chapter 5* describes the current physical, environmental, socio-economic and institutional baseline conditions of the area within Blocks 88A and 88B and Block 75 potentially affected by the proposed exploratory drilling campaign.

- *Chapter 6* sets out the approach and methodology used in this EIA, provides an assessment and evaluation of the significant environmental impacts and presents the most appropriate mitigation measures required to prevent, minimise or compensate the identified significant impacts, and also sets out the role of SPDP's environmental management system in the mitigative process.

- *Chapter 7* presents the key issues and conclusions of the EIA.

This Environmental Statement is supported by the following set of appendices:

- *Appendix A:* SPDP's HSE Policy;
- *Appendix B:* Key Legislation and Roles and Functions of Key Institutions that are involved in Environmental Management in Peru;
- *Appendix C:* Briefing Papers 7 & 8;
- *Appendix D:* Field Survey Diary;
- *Appendix E:* Vegetation and Soils, Classification and Land Use Potential;
- *Appendix F:* Water Quality Data;

- *Appendix G:* Evaluation Methods for Mammals, Herpetofauna and Arthropods;
- *Appendix H:* Noise Survey Data and Assessment;
- *Appendix I*: Archaeology;
- *Appendix J*: Participatory Maps;
- *Appendix K*: Photographs.

1.7 ENVIRONMENTAL MANAGEMENT PLAN

This *Environmental Statement* is further supported by a 'stand-alone' *Environmental Management Plan* which sets out the following components:

- Role of SPDP and SPDP's Contractors;
- Environmental Mitigation and Monitoring Plan;
- Contingency Plan for Environmental Incidents and Emergencies;
- Abandonment Plan.

1.8 CONTRIBUTORS TO THE EIA AND ACKNOWLEDGEMENTS

ERM acknowledges the expertise provided by the following organisations and individuals during the EIA process.

Sub-Contractors

- *Livia Varas Holstein* and her team for all translation services;
- *CSM Peru* for provision of logistical support to ERM's field survey team;
- *Water Management Consultants (Peru) SA* for reviewing hydrological baseline data for the proposed well area;
- *Environmental Laboratories Peru SA(Envirolab)* for analytical services and field sampling support
- *Centro Mallqui,* The Bioanthropology Foundation Peru, for provision of Lucia Medina de la Cruz, archaeologist.
- *Forestsoil SA* for providing Carlos Huatuco, to the field survey team and for production of forestry, landuse, physiographic and soils maps.

Sub-Consultants

- *Martha Rodriguez Achung (Sociologist)* expertise during the field survey, assessment of potential sociological impacts and provision of recommendations for their mitigation.

- *Gladys Lopez (Forestry and Mapping)*, expertise during the field survey, assessment of potential impacts on flora and soils, and production of an Abandonment Plan.

- *Ms Anida R Yupari Aguado (lawyer)* for updating the legislative and institutional framework section of the Environmental Statement.

- *Jose Santisteban Castillo (entomology specialist)* expertise during the field survey and rapid assessment coordinator.

- *Guillermo Tello Velasquez (Amphibian specialist)* expertise during the field survey.

- *Ross Mitchell (forestry expert)*, review of the Restoration Plan.

Local Communities and Organisations

- ERM would like to thank the following communities who showed the field team great hospitality during their baseline data collection activities:

    - Nuevo Mundo;
    - Shivangoreni;
    - Camisea.

SPDP

- *Mr Tom Kelly*, Technical Operations Manager of SPDP, approval of project design and mitigation measures.

- *Mr Murray Jones*, SPDP's Health, Safety and Environment Manager, review of the EIA.

- *Mr Stephen Macklin*, SPDP EIA Coordinator - The Hague, review of EIA.

- *Mr Miguel Ruiz-Larrea*, SPDP's Environmental Advisor, review of the EIA and EMP.

- *Mr Craig Schenk*, Drilling Manager, review of project design and mitigation measures.

- *Mr Alonso Zarzar*, SPDP Community Liaison Advisor.

- *Victor Grande Grande, Martha Rojas and Alejandro Alvarez*, SPDP Community Liaison Officers.

ERM Staff

- *Dr Kevin Murphy*, Technical Director of ERM, managed the overall EIA programme.

- *Jorge Briceño*, ERM Peru SA Resident Project Manager and Field Survey Team Leader.

- *Sachin Kapila*, ERM Peru SA Resident Project Coordinator and contributor to the EIA.

- *Diego Shoobridge*, ERM Consultant and contributor to the EIA.

- *Don MacIntyre*, Director of ERM, reviewed the EIA for consistency and conformance to international EIA standard.

Chapter 2

Legislative and Institutional Framework for EIA

2 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK FOR EIA

2.1 INTRODUCTION

Protection of the environment and recognition of indigenous peoples' land rights has in recent years occupied an ever increasing profile in Peru's political agenda, as indicated by provisions in the *1993 Peruvian Constitution* and promulgation of the *1990 Environmental and Natural Resources Code Nº 611*. Recognition of the need for sustainable development and the balanced exploitation of natural resources is reflected in provisions introduced into industry-specific legislature aimed at facilitating balanced economic growth within Peru's primary industrial sectors such as the petroleum industry. In this context, the legal requirement to undertake an environmental impact assessment (EIA) prior to commencing any substantial activity in the hydrocarbons sector constitutes a basic preventative action tool to protect the environment. The importance of environmental protection and native communities' rights is also reflected in Peru's evolving institutional framework.

This Chapter of the Environmental Impact Assessment describes only that legislation, regulatory enactment and institutional administrative issues which are of direct relevance to SPDP's proposed 1998 Pagoreni/San Martin East exploratory drilling campaign. The following aspects are addressed in sequence:

- regulations for environmental protection within Peru's petroleum sector;
- general (ie not petroleum sector specific) provisions for protection of Peru's environment;
- applicable international conventions, agreements and treaties for environmental protection;
- legislation related to indigenous peoples (both Peruvian and international provisions);
- EIA preparation, evaluation and approval process.

2.2 ENVIRONMENTAL PROTECTION WITHIN THE HYDROCARBONS ACTIVITY

This section lists Peruvian national legislation with provisions for environmental protection specifically targeted at hydrocarbons activity. A summary table is provided in *Appendix B1*.

2.2.1 *Law No 26221, dated August 19, 1993: National Oil Law*

This provision governs all hydrocarbons activities within the national territory and basically establishes that Government promotes development of these activities on the basis of free competition within this economic sector with the aim of promoting national development and welfare of the population. Pertinent articles of this Law provide as follows:

- *Article 34* stipulates that the exploitation and economic recovery of hydrocarbons reserves shall be in accordance with generally accepted technical and economical principles currently in use by the international hydrocarbons industry without prejudice to the environmental protection rules that apply in Peru.

- *Article 87* states that local or foreign individuals or corporations carrying out hydrocarbons activities must comply with the national provisions for environmental protection. In the event of non-compliance with these rules, the controlling agency shall impose the relevant penalties with the possibility for the Ministry of Energy and Mines to terminate the Agreement.

2.2.2 *Supreme Decree No 046-93-EM dated November 10, 1993: Regulations for Environmental Protection to Hydrocarbons Activities*

This provision establishes rules with which individuals and corporations developing hydrocarbons activities or which undertake or take part in project implementation, works execution and installations operation related to hydrocarbons activities within the national territory must comply.

The Regulation controls the conditions to which these activities are subject to with the aim of avoiding creation of negative environmental or social impact. To this effect, corporations operating in the hydrocarbons sector are responsible for emissions, discharges, spillages and waste arisings produced as a result of the processes carried out under their control. Corporations are obliged to avoid the use of substances or concentrations of substances which may have adverse effects on the environment.

This Regulation was amended ***by Supreme Decree N° 09-95-EM dated May 12, 1995*** thereby establishing that any EIA related to projects intended to be developed in protected natural areas, shall have the opinion of the responsible institution for such areas, ie *Instituto Nacional de Recursos Naturales (INRENA),* before it is approved.

2.2.3 *Supreme Decree N° 055-93-EM dated November 17, 1993: Regulations for Exploration and Extraction of Hydrocarbons*

This Regulation establishes the rules related to technical aspects of exploration/extraction activities and operation of installations. It is applicable to corporations having entered into hydrocarbons exploration or extraction agreements. Corporations are also responsible for ensuring that their contractors comply with the provisions of the Regulation.

Chapter IV, Section V of this Regulation deals with environmental protection, emphasising the requirement to submit an EIA prior to commencement of the geophysical survey. Corporations are also obliged to carry out regular inspections and to implement control measures according to the relevant Environmental Management Plan. It also sets out measures to protect surface waters, cattle-raising regions, wetlands, fauna, archaeological sites and buildings. It additionally provides regulations for abandonment and

remediation, base camp management, waste management and the responsibility of operating corporations to inform the authorities in the event of accidents.

2.3 *General Rules for Environmental Protection*

This section lists Peruvian legislation with a general (ie not specific to any industrial sector) environmental protection focus.

2.3.1 *Decree Law N° 613 dated September 7, 1990: The Environmental and Natural Resources Code.*

This Code was introduced to create an overall, interdisciplinary legislative framework, focusing on general environmental issues. Although it has experienced a number of amendments and reductions, it has the virtue of having established for the first time a *National Environmental Policy*. The stated aim of the Policy is protection of the environment and preservation of natural resources thereby facilitating development of Peru's citizens and, by way of implication, an adequate quality of life.

The Code promotes the concept of ecological education starting from the basic levels of the education system, in order to attain effective implementation of environmental policy. It also identifies as basic principles the following concepts for achieving environmental protection: citizenship participation; polluter pays principle; and the principle of prevention.

Chapter XIII of this Code concerns Energy Resources. However some of its articles were revoked and superseded by the subsequent rules regarding investment promotion for the agrarian and hydrocarbons sectors.

2.3.2 *Decree Law N° 17505 dated March 18, 1969: The Sanitary Code.*

It is currently anticipated that this regulation will be revoked if proposed new Health Laws are enacted. It provides that health is the main component of welfare and is therefore an essential element for mankind's development and the nation's progress. Therefore, health is a legal right which may not be waived.

Section Four, Second Book of the Sanitary Code includes provisions related to environmental sanitation. To this effect, *Article 143* establishes that environmental sanitation shall include control of sanitation, air, noise, waters, lands and wastes. *Article 164* addresses the need for employers to promote the health of their employees.

2.3.3 *Decree Law N° 17752 dated July 27, 1969: Waters Law*

This Law, which it is also anticipated will shortly be superseded (there is a Draft of a new Water Law currently before Congress), prohibits spilling or discharging any solid, liquid or gaseous waste that may contaminate waters, cause harm or threaten human health, or damage flora and fauna, or impair its utilisation for other uses. Such discharges are only permitted when

suitable pre-treatment occurs to render it harmless, or if there is satisfactory evidence that the natural environment is capable of assimilating the contamination.

2.3.4 *Decree Law N° 21147 dated May 13, 1975: Forestry and Wildlife Fauna Law.*

This Decree regulates the preservation of forests and wildlife resources and establishes relevant legislation regarding their use for manufacturing and commercialisation purposes. It additionally appoints the Ministry of Agriculture as the appropriate authority to regulate and control the conservation of forestry and wildlife resources.

This Decree has been ruled by the following Supreme Decrees: *N° 158-77-AG Regulation of Wildlife Flora and Fauna Conservation; N° 159-77-AG Regulation of Forest Law´s Forestry Planning; N° 160-77-AG Regulation of Preservation Units* and *N° 161-77-AG Regulation of Forest Extraction and Transformation.*

2.3.5 ***Decree Law N° 757 dated November 8, 1991: Private Investment Growth Framework Law.***

This Decree Law introduced meaningful changes to the Environmental and Natural Resources Code.

To that effect, *Section VI* of this Decree Law sets out rules to ensure juridical safety to investors through the establishment of clear rules for environmental protection. Articles of Section VI include items related to: the appropriate authorities in environmental matters, the compulsoriness to submit EIA for activities exceeding tolerable levels or standards regarding pollution or environmental damage, and measures to be adopted in the event of serious or imminent danger to the environment. It also introduces the formality for the establishment of Protected Natural Areas.

2.3.6 ***Law N° 26786 dated May 12, 1997: Works and Activities Environmental Impact Assessment Law.***

This recently enacted Law amends some articles from *Decree Law N° 757* and establishes the role of the *Environmental National Council (CONAM)* created by law *N° 26410*, with regard to approval of activities creating risks for the environment, cumulative environmental impact, permissible maximum limits, requirements for EIA and Environmental Management Programmes preparation, EIA approval and supervision and other related rules.

2.3.7 ***Law to be shortly enacted: Proposed Law N° 2596, Organic Law for Natural Resources Development.***

This proposed Law, already approved by the Congress´ full meeting, but not yet enacted by the Executive, aims to promote and regulate sustainable development of natural resources, thereby creating an appropriate framework for investment promotion and seeking a dynamic balance between human development and resource exploitation. *Article 4 (i)* of this proposed Law specifically categorises hydrocarbons as a natural resource.

2.4 APPLICABLE INTERNATIONAL REGULATIONS

There are no international Treaties, Covenants or Agreements specifically applicable to hydrocarbons activities in tropical rainforests. There are, however, a number of international regulations containing provisions aimed at protecting different components of the environment. Many of these international regulations are part of the national law by virtue of their ratification in Peru.

- *Covenant for the Protection of Flora, Fauna and Natural Scenic Beauty of the Countries of America, Washington, 1940.* Approved in Peru by virtue of *Supreme Resolution N° 983* dated December 31, 1941; effective on 01 May, 1942.

- *Covenant for the Protection of Cultural and Natural Heritage of the World. Paris, 1972.* Approved in Peru by virtue of *Legislative Resolution N° 23349* dated December 21, 1981, ratified on February 5, 1982; effective on 24 May, 1982.

- *Covenant on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Washington, 1973.* Approved in Peru by virtue of *Decree Law N° 21080* dated January 21, 1975, ratified on 12 June, 1975; effective on 25 September, 1975.

- *Agreement for the Conservation of Flora and Fauna of the Amazon Regions of Peru and Brazil*, signed in 1979.

- *Agreement for the Conservation of Flora and Fauna of the Amazon Regions of Peru and Colombia*, signed in 1979.

- *Treaty of Amazon Cooperation, Brasilia, 1978.* Approved in Peru by virtue of *Decree Law N° 22660* dated 27 August, 1979, ratified on 31 August, 1979; effective on 02 August, 1980.

- *Covenant on Wetlands of International Importance, especially as Waterfowl Habitat, Ramsar 1971.* Approved in Peru by virtue of *Legislative Resolution N° 25353* dated November 23, 1991, ratified on 12 December, 1991; effective on 30 July, 1992.

- *Covenant on Biological Diversity, Rio de Janeiro, 1993.* Approved in Peru by virtue of *Legislative Resolution N° 26181* dated 30 April, 1993, ratified on 24 May, 1993; effective on 07 September, 1995.

- *United Nations' Framework Covenant on Climate Change, New York, 1992.* Approved in Peru by virtue of *Legislative Resolution N° 26185* dated 10 May, 1993, ratified on May 24, 1993.

- *Covenant on Archaeological, Historical and Artistic Cultural Heritage of Countries of America (San Salvador Covenant), Chile 1976.* Approved in Peru by virtue of *Decree Law N° 22682* dated September 18, 1979, ratified on 26 September, 1979; effective on 22 January, 1980.

- *International Agreement on Tropical Timberland, Geneva, 1994.* Approved in Peru by virtue of *Legislative Resolution N° 26115* dated 04 August, 1995, ratified on 03 September, 1995.

2.5 LEGISLATION RELATED TO INDIGENOUS PEOPLES

This section lists both Peruvian laws and international covenants which address the rights of indigenous peoples.

2.5.1 *Peruvian Constitution of 1993*

The Peruvian Constitution establishes the basic rules applicable to native communities. The Constitution establishes a liberal ownership regime, whereby the native communities have decision rights on the use of their lands.

2.5.2 *Civil Code of 1984.*

This legal Code establishes organisational criteria for the native communities settlements and sets out legal requirements for their formal existence.

2.5.3 *Decree Law N° 22175, dated May 9, 1978, The Law of Native Communities and Agrarian Development for the Forest Edge Regions. Ruled by Supreme Decree N° 003-79-AA dated January 25, 1979.*

Certain provisions of this Decree have been superceded by the 1993 Peruvian Constitution. Nevertheless, it is still applicable for those provisions that do not oppose provisions contained in the Constitution. One of the basic points established by this rule is found in *Article 10* related to the native communities' land delineation, stating that this delineation applies when native communities acquire sedentary characteristics or when they resort to seasonal migrations within a determined geographical area.

It also establishes that the Government must grant land title documents to native communities for those parts of their territory corresponding to lands with cropping and cattle-breeding capabilities and an Agreement for Assignment of Land Use must be provided for lands with forest capabilities.

2.5.4 *Ministerial Resolution N° 00046-90-AG/DGRAAR, dated February 14, 1990: Creation of the Government Reserve in favour of Kugapakori and Nahua Ethnical Groups.*

This temporary land reserve was established with the aim of protecting the native groups' rights on lands they occupy. Passing of the Resolution also guarantees their right to utilise the natural resources within the Reserve area.

2.5.5 *Law N° 26505 dated July 17, 1995: Private Investment Law for the Development of Economic Activities in National Territory and Rural and Native Communities' Lands. Ruled by Supreme Decree N° 011-97-AG dated 12 June, 1997.*

This Law aims at promoting private investment for the development of economic activities within Peruvian lands and those pertaining to native and rural communities. It is therefore established that any real estate to which an agrarian use is given, shall be considered as community land. Amongst others, it applies to lands for agricultural use, for shepherding, lands with forest and fauna capabilities, idle lands, also river banks and river beds.

Another important provision of this Law is that any use, leasing or any other action on community lands located in the highlands or the jungle, requires a General Meeting Agreement together with the vote of approval of not less than two thirds of all the members of the community.

On the other hand, *Article 7* of this Law provides rules for use of land subject to mining or hydrocarbons activities, firstly requiring that the parties concerned (landowners and the developer) must come to an agreement. In the event of not coming to an agreement, a provision for easement may be requested before the Ministry of Energy and Mines. *Article 7* has been specifically ruled by *Supreme Decree N° 017-96-AG* dated October 18, 1996 providing the procedure to be followed in order to request easement and also the formal requirement that the previous agreement conclusion shall follow in order to use lands for the development of mining or hydrocarbons activities.

2.5.6 ***International Provisions: Covenant N° 169 on The International Labour Organisation's (ILO) Indigenous and Tribal Peoples, dated July 27, 1989.***

Covenant N° 169 has been approved by the Constitutional Democratic Congress on December 2, 1993, by virtue of *Legislative Resolution N° 26253*, ratified by the Executive on January 17, 1994 and filed with the ILO on February 2, 1994. *Articles 2, 3 4* and *5* call on governments to adopt coordinated and systematic actions oriented towards protection of the indigenous peoples' rights, fully respecting their identity. Such actions must be directed towards providing natives with the same rights and opportunities as national legislation grants to society in general, provided that their social and cultural identity, costumes, traditions and institutions are respected. These actions must be executed with the active participation of the native peoples.

Articles 6 and *7* set out the principle that Governments must consult with indigenous peoples every time legislative or administrative measures are taken which may affect them.

Article 15.2 of the Covenant, establishes obligations for governments to comply with in regard to the exploitation of natural resources within the territory of indigenous peoples.

2.6 EIA PREPARATION AND CONTENTS

In accordance with *Article 10* of the *Regulation for Environmental Protection for Hydrocarbons Activities Supreme Decree N° 046-93-EM* corporations are obliged to submit an *Environmental Impact Assessment (EIA)* or *a Preliminary Impact Assessment Study (EIAP)* before commencing any hydrocarbons activity, ie before commencement of initial works for exploration drilling. (In this regard, SPDP has voluntarily elected to commission a comprehensive and detailed EIA in support of their application to undertake an exploration drilling campaign in Pagoreni/San Martin East in 1998.)

2.7 EIAS APPROVAL PROCESS

- In accordance with *Regulation on Environmental Protection for Hydrocarbons Activities, Supreme Decree N° 046-93-EM,* modified *by Supreme Decree N° 09-95-EM,* the EIAs are approved by the *Hydrocarbons General Bureau (DGH)* of the Ministry of Energy and Mines, counting on previous evaluation and opinion from the *General Bureau of Environmental Affairs (DGAA)* of the said Ministry. In the event of surveys developed in protected natural areas the opinion of the appropriate authority must also be taken into account, ie the *National Institute for National Resources (INRENA).* The EIA Approach Process is illustrated in *Figure 2.1.*

- The proponent of the project shall submit three copies of the EIA.

- DGH has a term of 45 calendar days to issue its Resolution. DGH may determine in the following three outputs: accepting the project, rejecting it or conditionally accepting it.

- If the resolution has a disapproval orientation, the project proponent may resubmit a revised EIA and request its approval.

- If the approval is conditional, the project proponent shall accept in writing the conditions set forth by DGH or submit a revised EIA and request its approval.

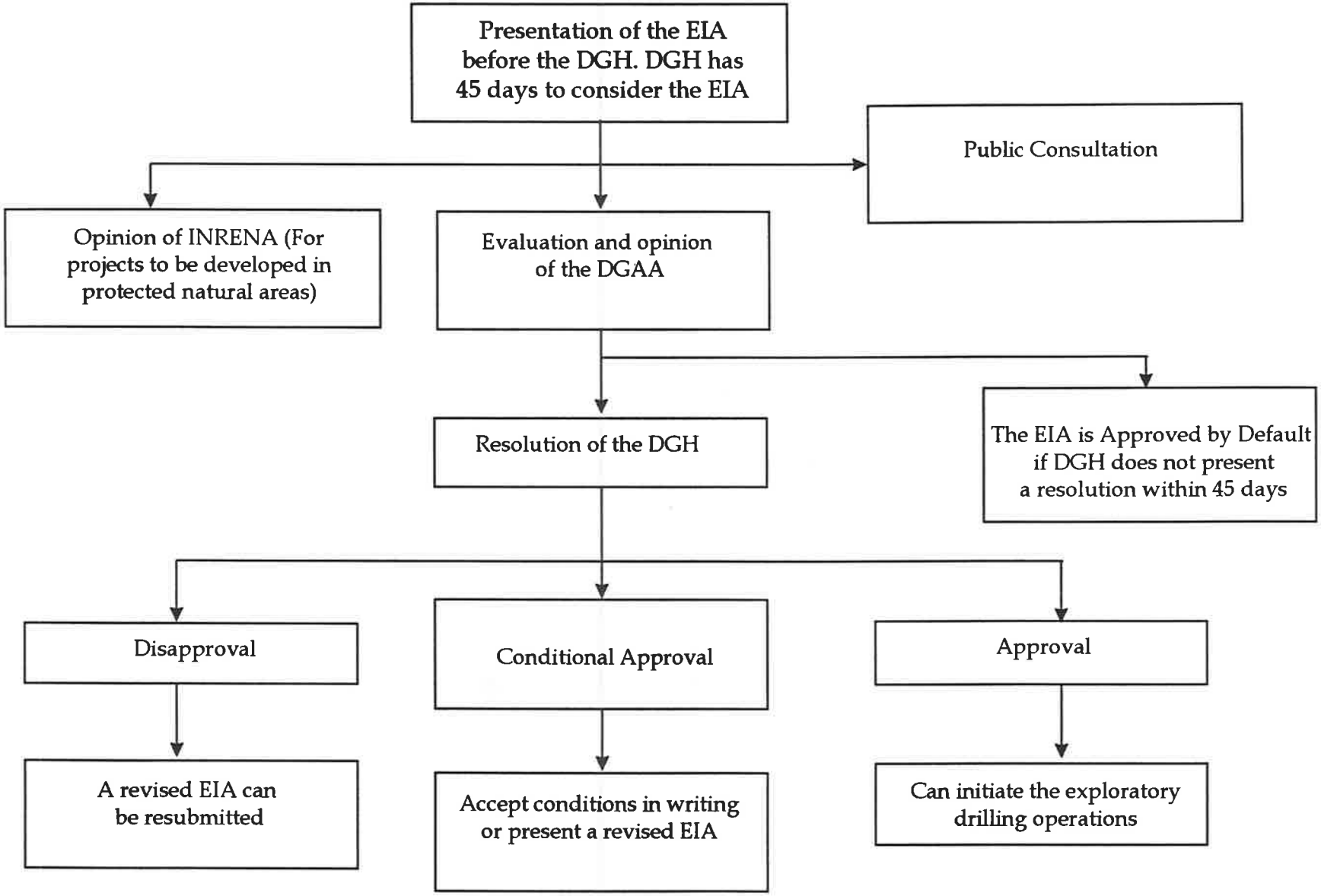
- Within the aforesaid term during which DGH is determining the EIA, interested individuals and corporations have the opportunity to review the EIA in the offices of DGAA and submit their opinions to DGH.

2.7.1 *Public Hearing in the EIA Approval Process*

Under *Ministry Resolution N° 335-96-EM/56 dated July 25, 1996,* the *Citizenship Participation Regulation* was approved. This initiates a public hearing procedure which forms part of the EIA approval process.

- Following submission of the EIA to the DGH, the latter will appoint place, day and time for the EIA public hearing in Open Court.

Figure 2.1 Scheme of the Approval Process for the Exploratory Drilling Operations EIA



- The project proponent is required to submit at least 30 copies of the executive summary of the EIA to the DGH for their further distribution to the registered participants.

- The public hearing shall be carried out under DGH and DGAA officials' direction.

- Prior to the conclusion of proceedings, the President of the Board will invite the registered participants to submit their questions or submissions in writing. These will be considered as part of the EIA evaluation process.

2.8 *CONTROLLING AGENCY*

Under *Law N° 26734* dated December 27, 1996, *Investment on Energy Supervising Organisation (OSINERG)* was created, ruled *by Supreme Decree N° 005-97-EM* dated April 17 this year.

OSINERG is an institution constituted for regulating activities carried out in the energy and hydrocarbons industrial sectors. It has a juridical authority of Internal Public Law and has functional, technical, administrative, economic and financial self-government and operates with the Ministry of Energy and Mines.

OSINERG's function is to control, nationwide, compliance with legal and technical provisions related to activities in the energy and hydrocarbons industrial sectors, including compliance with legal and technical rules related to environmental conservation and protection.

2.9 *KEY INSTITUTIONS*

A list of key institutions that are associated with hydrocarbon activities, environmental management, protection of human rights and native community organisations is presented in *Appendix B2*.

Chapter 3

Project Description

3 PROJECT DESCRIPTION

3.1 THE 1998 PAGORENI/SAN MARTIN EAST EXPLORATION DRILLING CAMPAIGN

3.1.1 *Overview: The Role of Exploration Drilling*

All accumulations of oil or gas are found within sub-surface sedimentary basins, however not all sedimentary rocks contain reserves of hydrocarbons or reserves that can be commercially exploited. The presence of hydrocarbons in commercial quantities is predicated upon the following:

- a source rock, rich in organic carbon;
- sufficient heat over millions of years to convert the organic carbon into hydrocarbons;
- migration pathways to enable the hydrocarbons to migrate upwards from the source rock.

Migrating hydrocarbons can accumulate where:

- there is a suitable reservoir rock, such as limestone or sandstone which must be sufficiently porous to store the hydrocarbons;

- there is an effective seal of impermeable rock, such as clay, shale or salt, above and against the reservoir, thereby forming a closed sub-surface structure and preventing further migration (and hence loss) of the hydrocarbons.

A further requirement for commercial exploitation of the hydrocarbons is that the source rock must be sufficiently permeable to allow the hydrocarbons to be released at a sufficiently fast rate to enable their economic recovery.

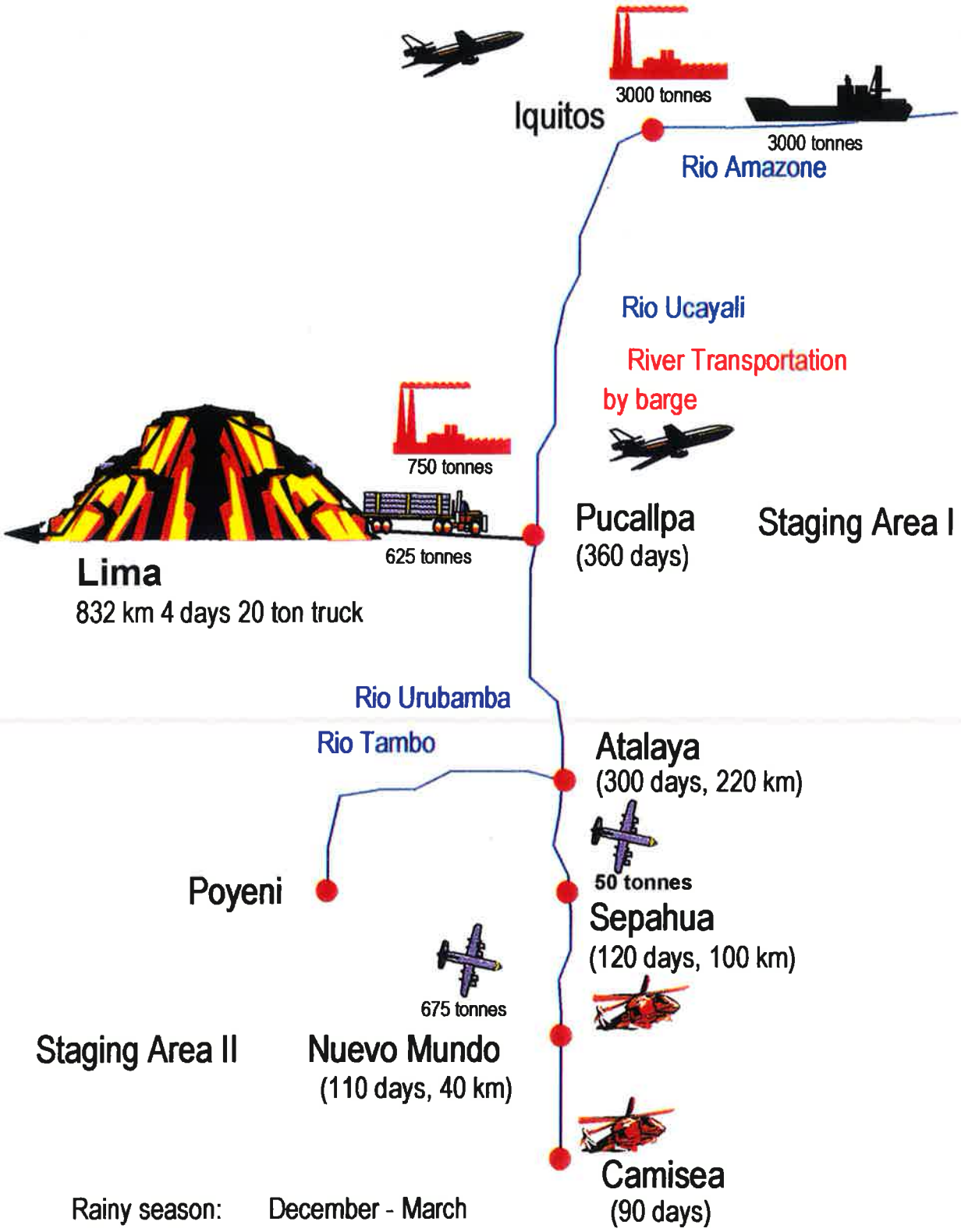
Once a seismic campaign has been undertaken and potential closed sub-surface structures have been identified on the seismic maps, then (one or more) exploration wells need to be drilled to establish whether the sub-surface structure does contain either oil or gas.

3.1.2 *SPDP's Proposed Exploration Drilling Campaign*

As indicated previously in *Chapter 1*, Shell carried out a very extensive seismic campaign during the eighties in which 2 883 km of 2D seismic was shot in the Lower Urubamba area; various potential structures were identified during that seismic campaign. By reprocessing the data previously accumulated, now using more powerful computers, more accurate predictions can be made on the locations of potential oil and gas accumulations.

The remainder of this Chapter describes the principal components of the proposed 1998 San Martin East and Pagoreni exploratory drilling campaign and the associated logistics programme to support it.

Figure 3.1 *Logistical Arrangements*



3.2 SITE SELECTION

The selected location of the Pagoreni and San Martin East exploratory wells and the rationale for selecting these particular sites has been presented in *Section 1.2* of this Environmental Statement.

3.3 LOGISTICS OVERVIEW

3.3.1 *Introduction*

The aspects of the project which will be most visible to local communities are the arrangements for moving personnel and materials to and from the wellsites. The overriding principal adopted by SPDP in the design of logistical arrangements has been to maximise the use of river and helicopter transport in order to reduce to the absolute minimum the requirement for construction disturbance and landtake on the ground.

Project personnel will be based in self-contained camps (ie either at the wellsite or at the Logistics Centre at Nuevo Mundo, see *Section 3.4*) and any interface with local communities will be strictly on the basis, terms and conditions agreed with the communities.

3.3.2 *Operating Philosophy*

Figure 3.1 provides an overview of logistical arrangements for the shipment of personnel, materials and resources. For the exploratory drilling campaign (as for the 1996/7 appraisal drilling campaign), it is envisaged that 80% of the project equipment will enter via the Amazon river system by ocean-going vessel and be transferred to river barges at Iquitos; vessel movements and haulage will depend on the river depth and season. Approximately 10% of project equipment will enter the Port of Callao or the airport of Lima and will be transported by road to the staging area at Pucallpa. The road distance between Lima and Pucallpa is approximately 830 km taking 4 days by 20 t truck. All haulage contractors will be required to meet SPDP's corporate safety standards in their operations. From Pucallpa it will be transported by river barge to the Logistics Centre located at Nuevo Mundo. A further 10% of project equipment will be transported directly by air to the Nuevo Mundo Logistics Centre. A brief description of the main logistics sites are given in the following sections.

3.3.3 *Logistics Centres Located Outside of the Project Area*

Iquitos

Iquitos, located 80 km downstream of the confluence of the Ucayali and Marañon Rivers, will continue to provide a transit and customs entry point for cargo and equipment required for the exploratory drilling campaign. Materials and equipment will then be transferred from ocean-going vessels to river barges of approximately 400 t capacity. Key drilling components will be assembled here (and at Pucallpa - see below). These components will include, tubulars, oil field chemicals and fuel.

Pucallpa

Pucallpa will continue to serve as the main collection and storage centre for cargo arriving from Lima. Facilities will be available at Pucallpa to transfer cargo to river barges with less draft and to store machinery and materials awaiting higher rainy season river flows.

Atalaya

River navigability is possible for 300 days of the year along the Ucayali River to Atalaya. From Atalaya upstream to Camisea, navigable days reduce from 120 days (Atalaya to Sepahua), 110 days (Sepahua to Nuevo Mundo) down to 90 days (Nuevo Mundo to Camisea). Maximum flows are experienced during the rainy season from December to March.

3.3.4 *Logistics Centres Located within the Project Area*

Temporary Holding Area

To facilitate the transport of chemicals, pipe and casing, a temporary holding area (mooring only) for barges may be needed close to Camisea (Peruanita or Las Malvinas) from which equipment may be taken directly to the wellsite. Barges would tie-up only for offloading by helicopter (utilising a cable or sling for hoisting material from barges) and would then return down river to pick up the next load. Although the use of a permanent staging area closer to Camisea appears operationally attractive, this is not being considered due to associated potential negative impacts on the nearby community, the necessity of duplicate manning of logistic facilities and creation of a sense of permanence.

Logistics Centre at Nuevo Mundo

The operational focus of the logistics support programme will be the Logistics Centre located at Nuevo Mundo. This centre has acted as the principal supply and transhipment centre for the current appraisal drilling campaign and will continue to serve in this capacity for the proposed exploratory drilling campaign (and the subsequent FFDP). Nuevo Mundo airstrip was extended to 1,800 m in length by SPDP in 1996 and is constructed from compacted gravel. A description of the airstrip and the various support facilities available at the Logistics Centre is given in *Section 3.4* below.

3.4 *THE LOGISTICS CENTRE AT NUEVO MUNDO*

3.4.1 *General*

As a result of works undertaken to support the current appraisal drilling campaign, facilities are now installed at Nuevo Mundo to receive shipments by river and by air. This involves the use of the airstrip, together with provision of a helipad, a river landing area for barges and hovercraft, storage areas for equipment and fuel, a small work camp and logistics office, a crane

for material handling, a communications centre and accommodation facilities. Other facilities are an electricity generating station, a packaged camp incineration unit, sanitary landfill, surface water drainage system and packaged sewage treatment plants. Throughout the exploratory drilling campaign the Logistics Centre will continue to be the main centre of activity from where SPDP will operate river transport and fixed wing and helicopter flights.

Storage of Fuels and Chemicals

Diesel and jet fuel are being stored in 1 000m^3 bolted steel tanks which are placed in a bunded and impermeably lined area, sized to contain at least 110 % of the total tank capacity. Furthermore there is a roofed storage facility which can accommodate up to eight 90m^3 fuel bladders. These bladders are placed in individual storage compartments with impervious floor and which are bunded to contain at least 110% of the volume of the bladder. Interconnecting pipework has have been specified to international standards with isolation valving arrangements reflecting petroleum industry codes of practice. Containment and clean-up contingency equipment, adequate to handle the largest foreseeable fuel spill, is kept on-site for use in the event of accidental spillage in the river or within the Logistics Centre.

3.4.2 *Waste Management*

The approach adopted for management of waste arisings at the Nuevo Mundo Logistics Centre throughout the exploratory drilling campaign will continue to follow the practices now in place for the current appraisal drilling campaign. These are as follows:

- non-hazardous combustibles are combusted in an on-site package incineration plant;
- other non-hazardous waste, including incineration ash, cans, bottles, industrial materials, are separated at source, compacted in an industrial compactor and temporarily stored for recycling in Lima;
- sewage is treated on-site in packaged biological treatment and hypochlorite disinfection units to meet IFC/World Bank guideline discharge values and discharged to the Urubamba River downstream of the local Nuevo Mundo native community;
- all spent lubricating oils or difficult waste materials (arising from the wellsites as well as the Logistics Centre itself) are kept in securely sealed containers housed within a covered, bunded area with an impervious floor, until removal from the site for disposal at an approved disposal location (such as a cement kiln) in Lima;

- all empty drums will be returned to the suppliers or shipped to an approved drum recycling centre (SPDP are currently storing these drums on-site pending arrangements with a responsible contractor to re-use these drums in an environmentally responsible manner;

- any field chemicals unused at termination of the drilling campaign will be returned to the suppliers.

The Logistics Centre manages not only the waste generated on the site, but also any waste materials that are removed from the wellsites (see *Section 3.6.8*). SPDP has developed criteria for determining whether particular non-hazardous wastes are suitable for incineration or landfill.

3.4.3 *Community Safety*

Nuevo Mundo currently supports a population of approximately 200 people located on the northern bank of the river. All SPDP personnel are required to observe a strict code of conduct to minimise impacts on the local community. Procedures have been developed in consultation with the community leaders to ensure that they are both appropriate and effective. SPDP workers are required to confine their movements to within the clearly demarcated boundaries of the Logistics Centre and associated work areas unless accompanied by SPDP's Community Liaison Officer. These procedures are strictly enforced.

Additionally, all fixed wing and helicopter flights are prohibited from directly overflying the local communities and habitations, both to eliminate safety risks and reduce noise impact, with the potential exception of emergencies.

All these measures and procedures for safeguarding the wellbeing of the Nuevo Mundo community will be retained throughout the duration of the proposed exploratory drilling campaign.

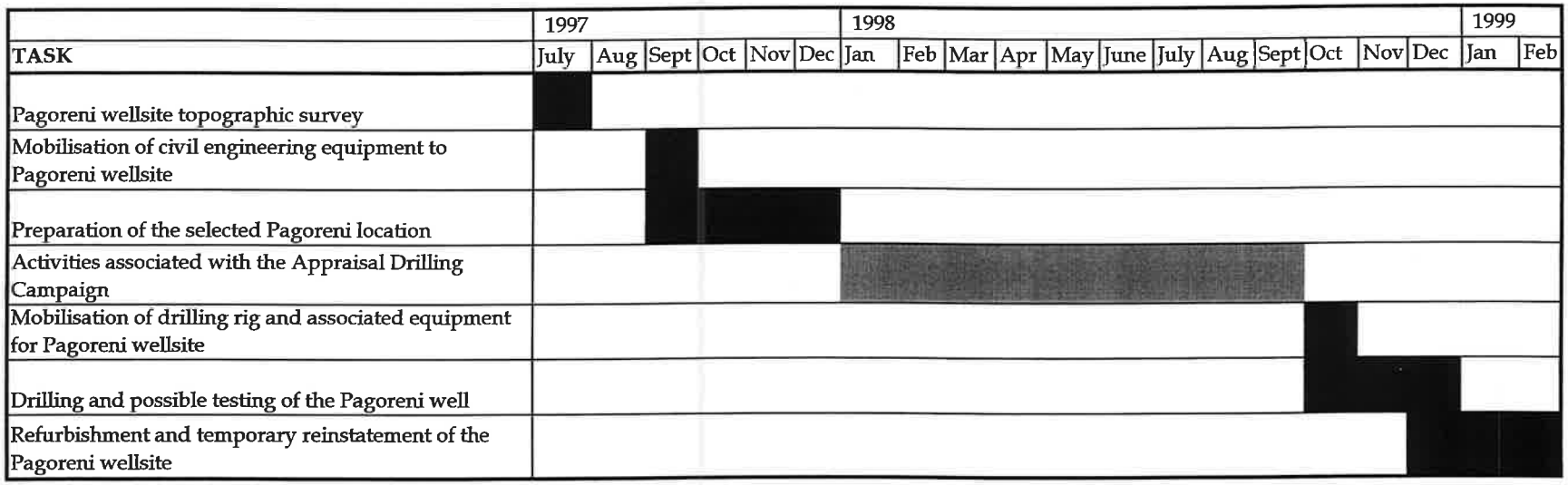
3.5 *SCHEDULE*

The total preparation and drilling period will be approximately 16 months commencing in July 1997 with pre-project mobilisation for topographic survey of the Pagoreni location (with prior agreement of the Shivangoreni community), followed by construction of the agreed and approved wellsite and terminating with drilling and possibly testing of the exploration well in December 1998. The key features of the drilling schedule are presented in *Figure 3.2* and discussed below.

- *July 1997*: Deployment of a 10-person topographic survey team to survey Pagoreni location (with prior agreement of the Shivangoreni community).

- *September 1997*: (Following approval of this EIA) Mobilisation of civil engineering equipment by air mainly from the Cashiriari-C location, together with materials and fuel from the Nuevo Mundo logistic base.

Figure 3.2 Project Schedule



- *September to December 1997*: Preparation of the selected Pagoreni location whereby surfacing of the area will be undertaken by applying a double layer of plastic and one layer of geotextile followed by the actual surface of steel plating. Steel plating will be flown in 10 ton loads.

- *October 1998*: Mobilisation of drilling rig and associated equipment and fuel to the Pagoreni wellsite. Fuel, chemicals and tubulars will mainly be brought in from the Nuevo Mundo Logistics Centre; the rig and associated equipment will be flown in 10 ton loads.

- *October 1998 to December 1998*: Drilling and possibly testing of the Pagoreni well; transport of drilling rig and associated equipment and materials to the Nuevo Mundo Logistic Centre or to a follow up exploration or appraisal wellsite.

- *December 1998 to February 1999*: Refurbishment and temporary reinstatement of the Pagoreni wellsite.

This outline schedule is tentative only since timing is dependent on the outcome of the current appraisal drilling campaign and the number of exploratory wells is dependent on the findings of the first exploration well. It is for this reason that the schedule presented above discusses construction and drilling of one exploration well only.

3.6 WELLSITES PREPARATION: CLEARANCE AND CONSTRUCTION

3.6.1 *Overview*

Each wellsite will require the following facilities:

- helipad;
- workers camp with power generator and package sewage treatment plant;
- rig foundation and cellar;
- space reserved for drill rig equipment and working area;
- dirty water and oil separator pit (skimmer tank) for site drainage;
- mud treatment and drilled solids removal package, including storage tanks;
- waste water treatment area and equipment;
- equipment and materials laydown area;
- fuel storage area;
- cuttings pit;
- vertical seismic profile pit;
- space reserved for ground flare and test separator;
- flare pit.

Figure 3.3 provides the proposed layout of the Cashiriari-C wellsite; it is anticipated that the new exploratory wellsites will be based on a similar layout. It should be noted however, that the final configuration and layout of wellsites will be determined by the topography of each wellsite following completion of the topographic survey.

3.6.2 *Access and Transport*

Transport of personnel and equipment to and from the exploration wellsites will be by helicopter. No roads or other ground access will be employed. Adoption of this policy has minimised the extent of forest clearance required, but has also determined the maximum loads of equipment that can be deployed at the wellsites and hence has influenced the drilling technology that is to be employed at the wellsites (see *Section 3.7*).

3.6.3 *Site Clearance*

A clearance crew will be dropped in as close as possible to the proposed wellsite locations and clear some survey lines over the area around the locations and clear an area for a helipad. A topographic survey crew will thereafter survey the proposed wellsite locations and provide the topographic map which will be used to establish the precise location and orientation of each wellsite. The site boundaries will be marked out by a clearance crew and a representative of the local communities will be requested to identify any plants of value to the communities which should either be saved once cut or, if practicable, left *in situ*. Land clearance for site construction at each wellsite will be kept to the absolute minimum practicable (less than 4 ha), in order to safely accommodate the facilities outlined in *Section 3.6.1*. The final working area will be less than 2 ha, after reclamation of surrounding area disturbed during the construction process. Clearance of vegetation will initially be achieved by a two-person team with chainsaws and machetes. As the cleared area becomes progressively larger more men and equipment will be lifted in. Cut timber and vegetation will be maintained at the edge of wellsites as a seed bank to assist in re-vegetation, where this does not constitute a fire risk.

A temporary construction camp to house approximately 70 workers will be established and provided with septic sewage treatment, waste containment, kitchen, generator, workshop, and fuel storage area.

Eventually earth moving equipment will be brought in and the site levelled, graded and compacted. Where possible topsoil will be cleared and stored for later reinstatement purposes (see *Section 3.8.4*) by stockpiling it along a boundary of the wellsite. While every effort will be made to longline (1) equipment on to site, helicopters need a safe flight-path approach to the wellsites when they are landing and this is usually achieved by clearing vegetation, typically an area 50 m in width and 200 m in length, depending on terrain conditions, in the vicinity of the approach path. However, it is unnecessary to completely clear down to bare soil along the flight path for either passenger transport or freight transport helicopters; vegetation will be cut to chest height for the helicopter approaches (and anywhere else where full clearance is not essential). This will allow speedier regeneration and will leave the forest understorey relatively intact.

(1) Longline is the technique whereby the helicopter hovers over the site, utilising a cable or sling for hoisting material, equipment or personnel up or down. Longline reduces the necessity for extensive forest clearance for helicopter landings and can also reduce the number of flights necessary, due to the ability to use larger helicopters.

3.6.4 *Site Preparation and Installation of Wellsite Facilities*

Site Preparation

As the site is graded and levelled, site berms, culverts, drains and drainage treatment facilities will be provided to control run-on and run-off and enable the wellsite to be operational throughout the year (including any interim period between wellsite construction and commencement of drilling activities) in all weather conditions (see *Section 3.6.7*).

The surface of the site (except for the location of the cuttings and flare pit as outlined below) will then be covered with steel plates, concrete slabs, wood or other suitable prefabricated surfacing so as to provide sufficient compressive strength to enable all construction and drilling operations to be executed safely and with minimum impact on the environment.

Boundaries will be marked with colour ribbons and construction crews will receive training and continuous supervision to ensure that landtake is contained within the 4 ha (later reduced to 2 ha working area) footprint.

Erosion control techniques, such as bamboo walls, terraces, and siltation traps, will be installed to minimise the impact of heavy rains. This will be assisted by revegetation around the borders of the site to assist in recovery as well as run-off control. The outlets of discharge pipes leading from the drains located along the wellsite perimeter will be fitted with diffusers to minimise erosion as part of the run-off control system.

Installation of Facilities

Within the cleared footprint, portacabins and a packaged sewage treatment plant will be set up on-site. A bunded lubricants and chemicals storage area will be installed. A 30 m x 15 m x 15 mm thick reinforced concrete drilling pad will be built.

A 20 m x 40 m area, 4 m deep cuttings pit will be constructed. This pit will be lined with impervious plastic material (backed by the impervious clay soil prevalent at all the proposed exploratory wellsites) so as to provide a protection layer to protect soil and groundwater from potential contamination. The cuttings pit will have a cover erected over it. A raised clay bund may surround the pit to provide a 0.5 m contingency freeboard.

Each drill site will require a continuous water supply of at least 400 litres per minute; a pumpset and partly flexible hose pipeline will deliver water from the nearest suitable stream to the wellsite water storage tanks. The pipeline will be run above ground and some hand cut forest clearance, needed for a footpath to access the pump, will be required. The pump will be either electric driven (if the source is close to the location) or diesel driven, (if the source is far away from the location); if diesel driven, the pump and storage tank will be placed on a platform within a bunded area underlain with an impervious plastic lining. To provide the back-up water storage capacity for water to be used by the drilling rig a 30 m x 30 m area, 2 m deep fresh water pit may be installed on the wellsite. Alternatively a separate tank may be

constructed, or a temporary dam put in the stream, designed to allow safer operations while permitting continued flow of the stream.

A vertical seismic profile pit with dimensions 2 m x 3 m x 2 m will be constructed towards the end of the drilling phase to provide more information regarding the subsurface layers and reservoir formation.

A flare pit with dimensions 30 m x 10 m and 2 m deep may be constructed at the edge of the location to house the liquids flare during well evaluation; A vertical flare and/or box-type flare (see *Section 3.7.3*) will be needed to evaluate natural gas flow rates, should hydrocarbons be encountered.

When the drilling rig becomes available, drilling equipment, supplies and drilling personnel will be mobilised and the drilling rig will be erected.

3.6.5 *Use of Local Resources*

Prior to any forest clearance (see *Section 3.6.3*) a representative of the local communities will be invited to check each site for plants of value. In principle, no trees will be cut for the provision of wood for the foundation of drilling rigs. Instead steel matting and pre-fabricated concrete slabs or 'imported' wood are proposed. Where timber is cut for land clearance, high quality logs will be made available for community use if possible. Any cleared topsoil will be saved for restoration of those areas of the construction site not required for future drilling or associated activities. Gravel and sand may need to be removed from a river bank or gravel bar, at a location, and in a manner, which will not disturb local communities nor result in siltation of waterways, to allow onsite preparation of concrete pad structures.

3.6.6 *Storage of Fuels, Lubricants and Chemicals*

A strict inventory control of all drilling additives to be used will be established and they will be placed in controlled storage. All chemicals, lubricating oils and fuels will be stored in sealed containers and placed within a sheltered area with cement slab floor. Underlaying the cement slabs will be an impervious plastic liner. The entire storage area will be bunded to contain at least 110% of the volume of the largest storage container.

3.6.7 *Surface Drainage*

There will be two surface drainage systems at each site:

- non-contaminated run-off from the majority of the wellsite will be routed via a silt trap and discharge pipeline (fitted with outlet diffuser) to an off-site location where stagnation will not occur so as not to cause off-site erosion;

- potentially contaminated surface run-off from the drill pad will be routed to the dirty water and oil separator tank for treatment in the waste water treatment system where oils will be skimmed off and put in drums for removal from site.

3.6.8 *Waste Management and Effluent Treatment*

The principle governing all wellsite activities is that no contamination off-site will be permitted, and any on-site contamination will be controlled and removed. SPDP has developed a *Wellsite Waste Management Plan*, a copy of which is included as *Appendix F1* of the separately bound *Environmental Management Plant (EMP)*. The principal components of the *Wellsite Waste Management Plan* are as follows.

- As per current practice, established at the appraisal drilling campaign sites, containers will be deployed on-site for `at source' separation and collection of all waste material. A compactor will be employed on the wellsite to compact plastic, glass, cans, and other inert materials. Full waste containers will be transported to the Logistics Centre at Nuevo Mundo for appropriate disposal (either landfill or temporary storage prior to transfer to a suitable waste disposal facility, see *Section 3.5.5*).

- Radioactive materials used in open hole formation evaluation will be brought to location and removed from location by the wireline logging contractor.

- Wood, paper and food scraps from the kitchen waste will be burnt in the on-site incinerator. Incinerator ash will be mixed with drill cuttings and buried on site.

- Hazardous Wastes, as defined in the *Wellsite Waste Management Plan* will be segregated, labelled, manifested, and sent to Nuevo Mundo for ultimate disposal. This includes used chemicals and lubricants, contaminated and waste products and contaminated soil

- Empty drums will be removed from site and taken to the Nuevo Mundo Logistics Centre for temporary storage prior to return to the supplier or transfer to an approved drum recycling centre.

- Sewage will be treated in a package treatment plant to the same standards as those outlined in *Section 3.5.5*. This treated effluent will be discharged to the waste water treatment facility which is also handling the contaminated surface run off as well as the water phase from de-watering the mud as mentioned below.

- Rig wash and potentially contaminated surface run-off from the drill pad will be routed via an internal drain system to the skimmer tank and then on to the waste water treatment facility for cleaning through flocculation and aeration prior to use as mud make up water or dumping within WHO guidelines and Peruvian legislation.

3.6.9 *Community Safety, Disturbance and Workforce Conduct*

As outlined in *Section 3.6.2*, each wellsite will be installed and managed as a 'remote wellsite', ie the only access to the site will be by helicopter and the forest beyond each wellsite boundary will be strictly enforced as out of bounds to all site workers. The only exceptions to this restriction will be

periodic inspections of the drainage and siltation pond systems, the fresh water supply system and pumpset and monitoring of slope stability, soil erosion, forest siltation and water stagnation. The only personnel permitted to visit or make contact with the communities will be SPDP's Community Liaison Officer.

3.6.10 *Noise Disturbance*

Shivangoreni, a community consisting of approximately 270 people is roughly 3 km from the proposed Pagoreni wellsites; there are no communities near the San Martin East location. The proposed exploratory drilling campaign will, by necessity, involve the deployment of machinery and equipment at each wellsite. This will include a power generator, earth moving equipment and a drilling rig. This equipment is inherently noisy, but SPDP plans to minimise the extent of the disturbance by requiring contractors to implement all practicable measures, subject to SPDP's prior-approval and subsequent inspection, to minimise the level of noise disturbance.

Contractors tendering for the wellsite construction and drilling contracts have been required to provide in their tenders an inventory and specification of all equipment (including the age of the equipment). SPDP will require them, under provisions in the contract, to maintain equipment in good working order so as to minimise noise emissions, to implement work practices whereby site workers always switch engines off when no longer required and to discuss with SPDP, prior to commencement of work, how noise disturbance will be minimised.

Helicopter traffic is required to pass around communities, thus reducing associated noise impact during the location construction, drilling, and well testing phases.

3.6.11 *Workforce Numbers*

In July 1997, after receiving community approval, a topographical survey team of some 10 people surveyed the potential wellsite for Pagoreni. In September 1997, civil engineering contractor personnel and equipment, previously employed on construction of the Cashiriari-C location wellsite, will move to Pagoreni and then to San Martin East. During location construction, some 70 people may be on location.

As from October/December 1998, during the rig move and subsequent rig operations, some 60 people may be rotating via the Nuevo Mundo Logistics Centre to Lima on a 4 week on/off schedule and possibly some 20 people rotating via the Logistics Centre to Pucallpa on a 2 week on/off schedule.

3.6.12 *Timing*

On-site duration for each well, including preparation, drilling and testing, will vary from well to well but is anticipated to be less than 100 days. The tentative schedule for execution of drilling activities is presented in *Section 3.5.*

3.7 WELLSITES: DRILLING AND TESTING

3.7.1 *Overview: Choice of Drilling Technology*

Minimisation of environmental damage and the volume of drilling wastes generated has been an important consideration in the selection of drilling technology. Initially SPDP looked in detail at using `slim hole' drilling technology. This method offers certain operational and environmental advantages in that it requires less equipment and resources and generates less waste than conventional drilling (refer to *Table 3.7a*). However, `slim hole' drilled wells are unsuitable for future re-use as production wells due to their small diameter bores. Since production may occur in the future at the exploration wellsites, conventional production wells would need to be drilled in addition to the `slim hole' appraisal wells. The environmental advantages noted above would be lost. After evaluating these factors, and taking due consideration of planned means of managing resource usage and wastes, SPDP is currently keeping open the option to utilise a slim hole rig for exploration wells, but will opt for the more conventional but heli-portable rigs for appraisal and development wells.

Table 3.7a ***Comparison between Slim-Hole and Conventional Drilling Technology***

Slim-Hole Technology	Conventional Technology
• smaller location	• larger location requirement
• less wastes generated	• more waste materials generated
• lower overall materials cost and less logistical support	• more logistical support required
• small well bore, unsuitable as producer	• usable as high rate producers
• lesser capability to drill deep wells	• ability to drill deeper wells
• lesser capacity to drill directional wells	• ability to drill complex direction wells

3.7.2 *Drilling Methodology*

Drilling Equipment

Before describing the typical sequence of drilling operations it is worth briefly describing the key items of equipment that will be used. These are summarised below:

- drill bit;
- drill string, connecting sections of drill pipes and drill collars (the former being lighter and more flexible than the latter);
- kelly, which is situated on the derrick floor and allows the drill string to be rotated;
- (in cases where higher torques are expected, such as when drilling deviated wells) a topdrive may be installed;
- drilling rig;
- swivel, to which the high pressure flexible drilling mud hoses are attached;
- diesel-fuelled electricity generators to supply the necessary power to run the drilling operation and supporting logistics (ie work camp).

Drilling Mud

The drilling mud, which is pumped through the drill string, through the bit and then returns up the annulus between the drill string and the borehole, serves a number of important functions, including:

- the removal of drilled solids (ie cuttings) from the bottom of the hole and their transport to the surface for separation from the mud;
- lubrication and cooling of the drill bit and string;
- deposition of an impermeable cake on the wellbore wall to seal the formations being drilled;
- suspension of drill cuttings in the fluid during the interruption of drilling;
- countering the natural formation pressures and preventing uncontrolled flow of fluid from the formations.

The main components of the drilling muds are a slurry of inert solids suspended in a liquid phase. The liquid phase may be made up either of oil or water. SPDP has not considered using oil-based muds on the basis that they are more toxic and more difficult to dispose of than low-toxicity water-based muds. The main constituents of the water-based muds are bentonite and baryies, both of which are natural minerals.

The role of the mud in pressure control is especially important. If the drill bit penetrates a formation containing oil, gas or water under pressure these fluids are prevented from flowing into the borehole by ensuring that the drilling mud is of sufficient density to counteract the natural formation pressures. The density of the mud can be increased by the addition of barite weighting material. Bentonite is employed to improve the rheological properties (eg viscosity) and enable the drill cuttings to be transported from the hole while drilling and also to be suspended in the fluid while the drill bit is changed.

The drill cuttings, cut by the bit, are removed from the mud by the shale shakers (vibrating screens) and centrifuges and transferred to the mud tank. Once the mud has been `cleaned' it is pumped down the drill string again.

General Drilling Sequence

Once the cellar has been excavated, the drill pad constructed and equipment set in place, drilling can commence. Typically for the first 50 m or so a large diameter bit is used. A length of pipe, the casing, is cemented into the shallow borehole produced to support the walls, which can be weak and porous and can potentially collapse. The first drilling fluid used is quite often water alone. Drilling will then continue for several hundreds of metres. At this depth smaller diameter casing is usually cemented into the hole. This intermediate casing protects the well by sealing potentially weak zones. At this stage low density drilling muds will be used and although it is unlikely that gases or fluids under pressure might be encountered, a blow-out preventer (see *Section 3.7.4*) is typically installed to prevent fluid from the

formation gushing to the surface. Drilling continues using progressively smaller bits and incrementally decreasing casing diameters. Changes in mud composition, and drill bit, are also likely to occur according to the different strata encountered.

The main waste generated during drilling comprises cuttings from the formations being drilled. Typically the cuttings will have mud adhering to them. Waste spent mud is also generated. SPDP's proposals for dealing with these wastes are addressed in *Section 3.7.5*.

3.7.3 *Well Evaluation*

Although the primary purpose of the proposed drilling campaign is for exploration rather than appraisal purposes, SPDP may wish to proceed with full well appraisal. Under such circumstances all the activities described below may be undertaken.

While drilling, cores of rock will be taken from the gas-bearing strata and a number of well logs performed. The objectives of coring and logging are to identify the geology of the penetrated rock, to confirm the previously interpreted geology from the seismic surveys and to locate possible hydrocarbons.

After drilling to the specified final well depth, various logs for hydrocarbon bearing strata will be taken. Such logs can accurately measure the pressure and fluid content of a porous zone. These logs will take approximately 2-3 days. The main objectives of these tests are to determine:

- what is the fluid in the zone and what is its composition (gas, oil or water)?
- will it flow and (if so) at what rate?
- what is the pressure regime of the fluid?

When gas is encountered it is necessary to determine whether the gas composition and reservoir permeability warrants further development of the reservoir. Typically a production test might proceed through the final completion with the permanent production valves (christmas tree) in place or with a temporary production completion in place. In the latter case the following will occur.

- The first stage is to ensure that the weight of the mud column is more than adequate to counteract any formation pressures that could potentially be released.

- A mechanical plug or packer is used to plug off the area of the formation to be tested; tubing is run through the packer.

- The blow-out preventer is kept in place throughout the test.

Gas from the zone being tested is flowed to the surface. It will then pass through a three phase separator, which will separate the formation fluid into:

- gas;
- oil (if present) and condensate;
- water.

A series of metering devices and valves will be used for the estimation of production rates. The gas and associated condensate will then be flared, and the water will be discharged to the wastewater treatment system.
A combination of flaring techniques may be used on the exploration wells. Small volumes of condensate produced during the flow tests will be flared in a conventional water cooled, horizontal burner which is housed in a lined flare pit. Produced gas itself is typically flared in a vertical flare stack of approximately 30m in height, to minimise close proximity radiation and noise. State-of-the-art technology, in the form of an enclosed burner system, is currently also being pursued. This technology allows for flaring with no visible flame, minimal heat radiation, and greatly reduced noise emissions.

On completion of this sequence of events (once it has been performed in a sufficient number of zones to characterise the reservoir) the well is suspended using cement and/or mechanical plugs and the drilling rig, separator and flare systems moved off location.

3.7.4 *Drilling Safety and Well Control*

A high pressure influx of formation fluids (water and/or gas) into the wellbore is commonly known as a `kick'. Well control is aimed at preventing the kick and a possible blow-out. The function of well control can be conveniently sub-divided into two main categories, namely primary well control and secondary well control. These categories are briefly described below.

- *Primary Well Control*: This is the maintenance of sufficient hydrostatic head of fluid in the wellbore to balance the pressure exerted by the fluids in the formation being drilled. This means that the pressure exerted by the density of the drilling fluid (mud) should be greater than the pressure of the formation fluids. It should be noted that balancing formation pressure is a theoretical minimum requirement; good drilling practice dictates that a sufficient excess of hydrostatic head over the formation pressure be maintained at all times to allow for contingencies.

- *Secondary Well Control*: If, for any reason, the effective hydrostatic head in the wellbore should fall below formation pressure, an influx of formation fluids (kick) into the wellbore would occur. If this situation occurs the Blow-out Preventers (BOP's) must be closed to prevent the loss of mud from the well. The purpose of secondary well control is to rectify the situation by closing the well in and circulating the invading fluid out of the well, while at the same time increasing the mud weight to prevent any further influx.

Personnel on rigs are experienced in the above procedures and the key personnel hold certificates to prove competence in well control procedures.

They will be trained and regular drills held to ensure that they will know how to act in such events (1). Furthermore, they will be aware of the safety aspects associated with the drilling operation, through training and experience. Responses to well control scenarios, as well as other wellsite events, are summarised in the *Outline Emergency Response Plan* presented in *Appendix D* of the separately bound *Environmental Management Plan (EMP)*. It must be also be noted that blowouts are rare events during exploratory drilling operations.

3.7.5 *Management of Drill Cuttings, Muds and Other Wastes*

Drilling Waste Management Principles

Waste management principles focus on waste minimisation and recycling. The key features of the waste management programme are outlined in the *Wellsite Waste Management Plan*. The types of waste to be generated during the exploration drilling and well testing campaign will include:

- drill cuttings (2)
- excess or spent drilling muds and completion fluids;
- water from pump lubrication, rigwash and rain water;
- cementing waste;
- discarded consumables;
- domestic waste (solid and sewage);
- water from test separators.

In practice, waste minimisation will be achieved through a number of measures:

- employing the latest technologies currently available (see *Management of Cuttings and Spent Drilling Fluids* below);
- carefully designing the mud handling system so as to maximise recycling of muds and treatment of cuttings;
- provision of treatment facilities so as to maximise recycling of fluids and minimising quantities of effluents;
- contracting and procurement of appropriate equipment so as to minimise breakdowns;
- residue disposal; after drilling completion, solids from de-watered drilling muds and cuttings will be made inert through treatment with lime and buried on site with at least 1 m of cover.

(1) In addition, SPDP already has it's internal Health, Safety and Environment Management System in place for the current appraisal drilling campaign. This will be evaluated prior to commencement of fieldwork to ensure that it is adequate for the exploratory drilling campaign.

(2) Drill cuttings will be selectively collected for analysis.

Drilling Fluids

It is intended to utilise a simple freshwater based gel/polymer drilling fluid system for the upper sections followed by a dispersed freshwater barite-gel system for the higher pressure, deeper sections. These drilling fluids are conventional freshwater-based, non-toxic, biodegradable fluids with inhibitive and encapsulative characteristics. The make-up drilling fluids will be contained in steel tanks on location. As required for control of reactive shales and for density during completions, potassium chloride or potassium acetate may be used. Selection of these additives in contingent on the ability to properly dispose of treated fluids within the specifications dictated by Peruvian legislation.

Management of Cuttings and Spent Drilling Fluids

The drilling rig circulating system employed under the current appraisal drilling campaign is equipped with the latest technology for the separation of drilled cuttings and solids materials from the drilling mud, and this same system will be employed during the exploratory drilling campaign. Equipment utilised consists of shale shakers (vibrating screens), hydrocyclone separation devices, and centrifuges. The entire system is covered and enclosed to prevent ingress of rainwater and contaminants. Unlike conventional systems, there is no open pit for storage of drilling fluids and untreated cuttings - all fluids are contained in a closed loop system, with liquids being recycled into the system or treated prior to discharge. The fluids treatment system also provides further processing for domestic liquid wastes from the camp and any potentially contaminated fluids caught in the drainage system surrounding the rig.

It is estimated that a volume of 1 000 m^3 of formation cuttings and another 500 m^3 of solids from spent drilling fluid will be generated during the drilling of a well. Additionally, approximately 1 000 m^3 of drilling and completion fluids, in addition to runoff rainwater and domestic camp effluent, will be produced.

The water phase from the de-watered drilling fluid (together with the treated water which flows from the packaged sewage treatment plant and the water from the oil separator tank which collects rain and wash water from the dirty drain around the rig equipment) will be handled by the waste water treatment facility. The pH will be adjusted with acetic acid and flocculation chemicals will be added to segregate the solids. After aeration this water will be either used for mud make up, rig wash water or disposed fulfilling IFC/World Bank discharge standards (1) and Peruvian legislation. Compliance with these norms will be determined by means of both onsite and offsite testing facilities.

The level of material in the cuttings burial pit will be maintained well below the surface level. It is currently anticipated that this will be achieved via adequate design and sizing of the pit and constructing a cover over the pit and cuttings transport augers to prevent uncontrolled rainwater infiltration.

(1) These are listed in *Appendix G* to the separately bound *Environmental Management Plan (EMP).*

On completion of the drilling programme, the cuttings and solid waste will be neutralised, treated with lime and buried within the sealed pit.

3.7.6 *Proposed Potential Alternative Regime for Discharge/Disposal of Cuttings, Muds and Other Drilling Wastes: Annular Injection*

Section 3.7.5 presents the regime currently employed by SPDP on the appraisal drilling campaign for management of cuttings, muds and other drilling wastes. As discussed in *Section 3.7.5*, this system is a substantial improvement on conventional drilling fluid circulation systems. Nevertheless, the system does generate spent mud, fluids and cuttings which ultimately require disposal, and the methods for disposal of these materials are presented above. As a minimum standard, the exploratory drilling campaign will adopt an identical approach to the management regime currently employed.

During upcoming drilling of the Cashiriari-3 appraisal well (part of the current appraisal drilling campaign), SPDP proposes to conduct trials to determine the applicability of annular injection technology for the planned exploration drilling campaign. Using this technology, treated waste waters, slurrified cuttings, or both may be injected down the casing annulus to a depth of 900 m at least into a permeable, non-potable water bearing zone overlying the reservoir section. If successful, this will minimise the requirements to bury cuttings and discharge treated waters, thereby providing further enhancement in integrity of mitigation measures incorporated into project design. It is emphasised, however, that viability of annular injection is contingent upon the characteristics of the local geology and existence of a suitable isolated formation for receiving injected waste materials.

3.7.7 *Community Safety and Disturbance*

During drilling and testing, controls will be in placed to minimise noise and light emissions from the wellsites. As it is anticipated that the Shivangoreni community could be disturbed by either glare or noise associated with wellsite activities they will be informed prior to the commencement of any testing at the Pagoreni wellsite. As discussed previously in *Section 3.7.3*, specialised technology is being investigated (such as the recently developed Enclosed Burner System) which will reduce noise and flare glare very significantly during night time well testing operations.

3.7.8 *Workforce Numbers*

The favoured mode of operation will be:

- a drilling contract;
- an integrated services contract to which the well evaluation contract will be assigned;
- a logistics contract to which the helicopter contract will be assigned;
- the civil engineering contract.

SPDP and contract crews will remain in either the Nuevo Mundo Logistics Centre or at the wellsite camp. The wellsite camp will accommodate up to

100 persons maximum, although operating numbers at the wellsite will typically be 80 persons. The Nuevo Mundo Logistics Centre accommodates up to 200 persons.

3.8 DEMOBILISATION UPON SUSPENSION OF DRILLING ACTIVITIES

3.8.1 *Demobilisation Overview*

At the conclusion of the exploration drilling programme at each wellsite, a demobilisation plan will be implemented. This will provide for the orderly withdrawal of all personnel and the removal of all drilling and testing equipment and non-fixed items from the wellsite. The overriding principle will be that in case the well is suspended when economic quantities of hydrocarbons are found, the site should be left in a stable condition with no waste or derelict material remaining, so as not to present any risk to people, or the physical or biological environment. In any other case the site will be cleared and refurbished so that it is restored to permit recovery to as near as possible the local environment.

3.8.2 *Removal of Equipment and Materials*

In the event that economic quantities of hydrocarbons are found, the well will be suspended with a wellhead in place, but all other equipment and materials will be removed from the site.

All empty drums, wastes, used and unused drilling fluids, fuel and lubricants will be removed from the wellsite. Water supply and effluent discharge hoses and associated equipment will be removed and stream flows will be restored.

3.8.3 *Restoration of Cutting Pits*

At the conclusion of well testing at each wellsite, the reservoir of drilling fluids will be dewatered by flocculating the contents and pumping the supernatant liquid into the water treatment tanks. There, the water will be suitably treated (pH control, further flocculation and settlement and aeration) to provide a clarified liquid low in toxic metal content which will be discharged to the forest floor (as discussed in *Section 3.7.5*). The residual slurry will be mixed with lime to form an inert material which will then be mixed with the contents of the cuttings pit. Upon completion of solids/liquids separation, the plastic liner from the cuttings pit will be closed and the pit recovered with native earth.

3.8.4 *Restoration of Wellsites*

Grading will take place to ensure natural runoff and no ponding or erosion. Any remaining topsoils that have been stockpiled during site clearance will be respread over appropriate portions of the site and seeded to promote revegetation. Previously cut timber (branches and small trees) will be retained at the edge of wellsites to assist revegetation of cleared areas. The freshwater pumping stations will be similarly restored. Refer to *Appendix E* in the

separately bound *Environmental Management Plan (EMP)* which outlines a more detailed *Site Restoration Plan*.

3.9 *DECOMMISSIONING UPON ABANDONMENT*

In the event that no economic quantities of hydrocarbons are found, a full abandonment plan will be implemented for the wellsites constructed under the exploratory drilling campaign. In the course of development of this abandonment plan, SPDP would consult with key stakeholders (local communities and government).

The actions outlined in *Section 3.8* would apply to decommissioning upon abandonment as well, but abandonment would be more permanent. The overriding principle being that the environment should, with time, be reinstated to broadly its original condition. Until such time as this is achieved, SPDP would actively manage the reinstatement process.

All concrete or steel installations not being provided directly to others would be removed to at least 1 m below ground level. In the unlikely event that soil were found to be contaminated, measures such as those suggested by the E&P Forum (1) would be taken to remove or treat appropriately all contaminated topsoil to promote its remediation such that it is suitable for regrowing native vegetation.

(1) E&P Forum, *"Decommissioning, Remediation and Reclamation Guidelines for on-shore E&P sites"*, prepared by AGRA, 1996.

Chapter 4

Stakeholder Participation Programme

4 STAKEHOLDER PARTICIPATION PROGRAMME

4.1 INTRODUCTION

Implementation by SPDP of the *SPDP HSE Policy* and *SPDP's Camisea Community Relations Guidelines* has established the principles for implementation of a wide ranging and comprehensive stakeholder participation programme. 'Stakeholder' is the name given to those individuals or groups that are likely to be either directly affected by any part of a proposed project development (such as native communities, farmers, or fishermen) or indirectly affected but are none-the-less important to the overall development and success of the project (such as line ministries, government departments and national and international NGOs, etc). Those groups likely to be directly affected are referred to as *primary* stakeholders, while those likely to be indirectly affected are referred to as *secondary* stakeholders.

4.2 KEY OBJECTIVES

The key objective of stakeholder participation is to maintain dialogue and seek participation of all interested parties. This provides an essential platform for achieving meaningful cooperation and exchange of points of view within relevant decision-making processes, thereby facilitating implementation of projects in an environmentally and socially responsible manner. Stakeholder participation is a two-way flow of information specifically aimed at developing ideas that can help shape project design, resolve conflicts at an early stage, assist in implementing solutions and monitor ongoing activities.

The remainder of this Chapter describes the role of stakeholder participation in the EIA process and how it fits into SPDP's overall Camisea stakeholder participation programme. It also highlights the key phases of the current Pagoreni/San Martin East exploration drilling campaign stakeholder participation programme and presents the outcome of discussions with primary and secondary stakeholders.

4.3 SPDP'S CAMISEA STAKEHOLDER PARTICIPATION PROGRAMME

4.3.1 *Principle of Stakeholder Pariticipation*

SPDP began its overall Camisea stakeholder participation programme in 1994 with the objectives outlined above, in accordance with the following key principles of stakeholder participation:

- developing and maintaining an open and transparent dialogue with all parties who have an interest in, or influence on, progression of the various stages of the Camisea projects (ie from exploration through to development, operation and abandonment);

- providing full and relevant information to the public on current operations, decision making and engineering and design activities and feeding back information received from interested parties into the planning and decision making process;

- being proactive in creating a platform for dialogue which will enable interested parties to gain a fair hearing for their point of view;

- taking a constructive interest in Peruvian societal matters (but not to take any part in party politics);

- looking for means to contribute to the wider interests of Camisea and its region, its people and environment in a sustainable manner, and encouraging partnerships;

- ensuring that all SPDP employees and contractors are kept informed of project developments;

- ensuring that those SPDP officers representing the Camisea project present an open, transparent and consistent response to legitimately interested parties, and present accurate and fair feedback to those involved in decision making within the various stages of the project;

- ensuring that SPDP does not imply or assume any commitment to the project by those individuals or organisations consulted.

Adoption of these principles has led to implementation of the following mechanisms for promoting dialogue with primary and secondary stakeholders.

4.3.2 *Key Mechanisms used for promoting dialogue with Primary Stakeholders*

The key mechanisms used with primary stakeholders has included the following:

- distribution of briefing papers related to overall project development progress;

- distribution of briefing notes which are based on the briefing papers but simplified and translated into Machiguenga;

- community meetings conducted during field surveys as part of the EIA process to provide information face to face, and to seek feedback on any concerns, viewpoints and fears [1] .

(1) During community meetings full use of Participatory Rural Appraisal (PRA) Techniques was made (such as semi-structured interviews and participatory mapping.

4.3.3 *Key Mechanisms used for promoting dialogue with Secondary Stakeholders*

The key mechanisms used with secondary stakeholders has included the following:

- meetings with stakeholders to provide information face-to-face, and to seek feedback on any concerns, viewpoints and fears;
- distribution of a series of briefing papers related to progress of the overall project development (eight released so far; Briefing Papers 7 and 8 are of direct relevant to the proposed exploratory drilling campaign and hence are presented in *Appendix C*);
- feedback provided via correspondence with interested parties;
- information coming out of environmental and social studies (eg the current *Socio-economic Diagnostic Study* being carried out by Region Inka and Cusco-based NGOs in the Lower Urubamba);
- *Scoping Reports* which have been distributed to all stakeholders prior to any EIA field work;
- participating in (or reacting to feedback from) key external discussion groups (eg community meetings or topic specific workshops).

4.3.4 *Results Achieved To-date*

So far almost 200 different Peruvian and internationally based stakeholders (including both primary and secondary stakeholders) have been contacted. Even though the interest levels may vary amongst the groups, new potentially interested groups are often identified during the course of meetings and therefore the list of stakeholders continues to grow.

4.4 *STAKEHOLDER PARTICIPATION AS PART OF THE EIA PROCESS*

Stakeholder participation is an integral component of the EIA process and consequently SPDP has focused on a focused consultation programme within the framework of each EIA it undertakes. This is being undertaken as a distinct yet integrated component of SPDP's overall Camisea stakeholder participation programme outlined in *Section 4.3*. Stakeholder participation as part of the EIA process began in 1996 with the appraisal drilling campaign EIA undertaken by ERM. This included dialogue with primary stakeholders in the region, and secondary stakeholders in Peru, Europe and the USA. Meetings with primary stakeholders were mainly carried out by ERM's team of social anthropologists as part of the EIA field survey. In addition, an ongoing programme of meetings has been arranged by SPDP to continue communication links with the local communities, identify their key concerns and fears, and provide a forum for future dialogue during the post-EIA period.

Following on from the appraisal drilling campaign EIA, SPDP has developed its stakeholder participation strategy for the FFDP EIA. As explained in *Chapter 1*, the scope for the FFDP has yet to be finalised. The EIA process for the 1998 Pagoreni/San Martin East exploratory drilling campaign has therefore been cognisant of the fact that stakeholder participation needs to tie-in with the overall FFDP stakeholder process and that dialogue focusing on the FFDP will commence soon after the present EIA programme has been completed. With this in mind, the EIA team has initiated dialogue on a more generic nature introducing the overall FFDP programme at the same time as the specifics of the present EIA. Care has been taken to highlight that the current EIA is an integral, and not separate, part of this process.

4.5 THE PAGORENI/SAN MARTIN EAST STAKEHOLDER PARTICIPATION PROGRAMME

Within the stakeholder participation and EIA programmes there is a need to provide focus on the present EIA for the 1998 Pagoreni/San Martin East exploration drilling campaign so as to identify key concerns and viewpoints specifically related to this component of the FFDP. The stakeholder participation programme for the 1998 Pagoreni/San Martin East exploration drilling campaign EIA has followed a very similar approach to that used in the previous appraisal drilling campaign EIA, which has been based around four phases:

- *Phase 1*: identification of key stakeholders;
- *Phase 2*: discussion with all key stakeholders;
- *Phase 3*: public access to the outcome of the EIA process;
- *Phase 4*: ongoing consultation during project implementation and operation (ie through the FFDP).

Each of these phases is discussed in more detail below.

4.5.1 *Phase 1: Identification of Key Stakeholders*

As aforementioned, a total of around 200 stakeholders have been identified which are of relevance to the overall FFDP programme. From this list stakeholders were identified based on the criteria that they were either potentially directly affected by the proposed project development (ie the 1998 Pagoreni and San Martin East exploration drilling campaign), had very close links with the project, and/or had indicated a desire to be involved. These included the communities potentially affected by the proposed project, Government Departments, an indigenous umbrella organisation and various NGOs.

4.5.2 *Phase 2: Discussion with Key Stakeholders*

The discussion with the stakeholders identified above has focused around the respective needs of both primary and secondary stakeholders, each of which warranted a different approach.

Primary Stakeholders

The primary stakeholder consultation programme for the 1998 Pagoreni/San Martin East exploration drilling campaign included the following principal activities:

- seeking permission from the community to enter their land prior to any field work (1) ;
- conducting meetings with primary stakeholders as part of the EIA field survey;
- evaluating with each community group how the activities proposed during the exploration drilling campaign may affect them or their specific interests;
- discussing with each community group (men and women) their main areas of concern and how these might be addressed and mitigated;
- seeking permission to undertake the topographic survey of the wellsite;
- negotiating the terms for an agreement with the community.

Secondary Stakeholders

The secondary stakeholder consultation programme for the 1998 Pagoreni/San Martin East exploration drilling campaign included the following main activities:

- providing each stakeholder with a *Scoping Report* which highlighted the main features of the proposed exploration drilling campaign and included a provisional table of contents for this EIA;
- organising meetings with the key secondary stakeholder groups where they were notified of the broad activities, aims and objectives of the proposed exploration drilling campaign;
- evaluating with the secondary stakeholder groups how these activities may affect their specific interests;
- discussing with the secondary stakeholder groups their main areas of concern and how these might be addressed and mitigated.

(1) See the letter of acceptance from the Shivangoreni community presented at the beginning of this Report.

4.5.3 *Phase 3: Public Outcome of the EIA Process*

Interested members of the public are provided with an opportunity to study the outcome of the stakeholder participation programme as documented in the EIA report and other communication mechanisms (such as future briefing papers or scoping reports). This Environmental Statement (along with the separately bound Environmental Management Plan) will be placed in the office of the Director General of Environment Division at the Ministry of Energy and Mines and the SPDP office in Lima, where it will be accessible to any member of the public who wishes to consult it. The primary stakeholders will be informed of the existence of this EIA through the SPDP Community Liaison Officers (CLOs) and copies (and explanation of the results) will be provided to them for their consideration.

4.5.4 *Phase 4: Ongoing Consultation during Project Implementation and Operation*

Even after the EIA programme is completed and the Environmental Statement released, the stakeholder participation programme will continue throughout the lifetime of the FFDP project in order to maintain a high level of continuity and transparency and to enhance the relationships already in place. SPDP acknowledges this consultation process will continue to evolve.

4.6 *OUTCOME OF THE PAGORENI/SAN MARTIN EAST STAKEHOLDER PARTICIPATION PROGRAMME*

The stakeholder participation programme has essentially taken place in two stages, identifying separately the concerns and views of the primary and secondary stakeholders. The programme for primary stakeholders was conducted separately by SPDP (as part of their overall participation programme) and ERM (during the present EIA field survey). The programme for secondary stakeholders was conducted jointly by ERM and SPDP. Each stakeholder group was relatively small so information was exchanged in small `across-the-table` type meetings.

Key concerns and viewpoints raised by the primary stakeholders (both men and women) are presented in *Tables 4.6a, 4.6b* and *4.6c* (1), and a summary of the issues raised during meetings with secondary stakeholders is presented in *Table 4.6d, 4.6e* and *4.6f*(2).

The tables also provide an indication of how feedback from these comments has been integrated into the EIA process by highlighting actions where appropriate.

(1) The comments and opinions provided in *Tables 4.6a, 4.6b* and *4.6c* are representative at the time of the study and reflect the opinions of the interviewees and not the community at large. For this reason individual names have not been included.
(2) *Tables 4.6d, 4.6e* and *4.6f* have been prepared by ERM and are a summary of all comments received. It should be noted that it is not the intention of this Report to link any issue with a particular stakeholder and therefore complete anonymity has been maintained. These stakeholders' comments are presented as directly as possible from the comments received in an attempt to truly reflect the comment without interpretation or judgement.

Table 4.1 Primary Stakeholders - Summary of Key Issues and Actions: Shivangoreni Community

Key Issue		Action / Comment
Men	Women	
Helicopters • Helicopters flying over (sometimes 20 times per day) makes much noise. • There is a risk of accidents from falling of transported cargo. Some pipes fell down last month, although it occurred far away from a populated area. • The noise causes fauna to go away.	• The noise distracts the children when they are attending school.	• Helicopters are instructed not to fly over any communities. • Normal helicopter operations should stay at least 4-6 km away from the communities. • SPDP CLOs will relay any complaints back to SPDP in Lima and if necessary appropriate modifications to flight paths will be made.
Water Pollution • There is still enough fish. Yields have not changed very much in the last year. • There is a risk of water pollution from the Cashiriari-2 site since some of the pipes are connected to Puipuiyoari creek (a tributary of the Cashiriari river). • At present water cannot be used for drinking; it can only be used for taking a bath.	• Camisea river waters are more turbid than ever.	• SPDP will commission a study to research into the socio-economic importance of fish to the native communities. • Discharge levels are controlled to IFC/World Bank Standards and SPDP is committed to meeting these standards. • The discharge point at Cashiriarti-2 was changed from the creek to the forest floor following a request from the Cashiriari community. • SPDP operations will not have added any turbidity to the rivers.
Relations with Shell • The community does not oppose Shell's operations. • The community demands that Shell complies with all rules and regulations set by the government and agreements set by the community. • The community requests more frequent interaction with Shell's CLOs. • The community wish to be permanently informed of Shell's work in progress.	• Shell has to respect the community. • Shell labourers have to be kept away from the communities. • Shell workers have to respect women. • The husbands of the women in the community should work for the company. • When there is a need for labour, Shell should not bring outsiders to work.	• SPDP is committed to abide by all rules and regulations set by the Government and fulfil all agreements set by the communities. • SPDP has already hired one additional CLO and is in the process of hiring one more (five in total) which will allow for more interaction with the communities and information transfer regarding SPDP operations. • SPDP has a policy not to hire outsiders. If labour is required then preference shall be given to personnel from the local communities.
Training • The men would like to be trained in such things as fish breeding, farming, animal husbandry and growing garden vegetables.	• The women would like to be trained through workshops in growing garden vegetables. • Training for the 'young' is a priority as it will help the community for years.	• SPDP is currently co-financing a *Socio-economic Diagnostic Study* in the region (with Region Inca) aimed at identifying such priorities. • SPDP's programme of *Social Capital* will focus on delivering such training programmes.

Table 4.1 Primary Stakeholders - Summary of Key Issues and Actions: Shivangoreni Community

Men	Women	Action/Comment
Infrastructure • There is no sewerage system. • They have a power generator (donated by Shell) but cannot install it due to lack of cables, fuel, light bulbs etc. • They would like to have (as in Nuevo Mundo and Kirigueti) a parabolic antennae to "watch what happens in the outside world".	• The health clinic is short of drugs. • It is necessary to have a doctor available in the community.	• Recommendations from the *Health Baseline Assessment* commissioned by SPDP are currently being implemented through a number of health programmes. • If necessary, SPDP will initiate the supply of more drugs to the clinic. • SPDP has a commitment to provide 'Net Benefit' to the region, ie the provision of sustainable benefit. The provision of a parabolic antennae needs to be considered in light of other competing needs. • SPDP is currently negotiating an agreement with the community to provide solar lighting for the health post and for a multi-purpose building which has been requested by the community.

Source:

Note 1: This information has been collected during meetings conducted by ERM's sociologist expert, Martha Rodriguez, during the field survey for the Pagoreni/San Martin East EIA. The meetings were arranged by the community's themselves and took place on the following dates:

- Shivangoreni: 30 April 1997 - meeting with the community and the Mother's Club and 01 May 1997 (general meeting);
- Camisea: 02 May 1997 - meeting with the community and the Mother's Club;
- Nuevo Mundo: 06 May 1997 - meeting with the community and the Mother's Club.

Note 2: The comments and opinions provided within these tables are those expressed by individuals at the time of the meetings and do not reflect the opinion of the community as a whole.

Table 4.2 Primary Stakeholders - Summary of Key Issues and Actions: Camisea Community

Key Issue		Action
Men	Women	
Helicopters • Some time ago helicopters used to pass daily; at present they fly far away from the community. Sometimes they fly around and the noise can be heard. • The noise has caused some animals to go away, although some of them are already used to the noise.	• Helicopters bring in cargo and can cause accidents to houses since they fly close to populated areas. • When they land they can cause damage to houses. • They make much noise when they fly.	• See previous comment on helicopters.
Water Pollution • There is less fish at the Camisea river because of the pollution that comes from Cashiriari-2. • The impact on fishing is still not known, although by April we should be catching shad and this year there is none.	• The river is dirty with sticks, wood, debris and much sand, and the waters are more turbid. • Garbage is thrown away into the creek near the wellsite making the waters polluted; it passes through the community where kitchen utensils are washed.	• See previous comment on water quality. • SPDP is not and will continue not to discharge any untreated liquid wastes to river courses. All solid wastes are separated at source and handled according to agreed waste management guidelines as contained in SPDP's *Wellsite Waste Management Plan* (copy of which is presented in *Annex F1* of EMP).
Relations with Shell • During the last year since Shell's arrival everything is almost the same. • They hope that Shell's operations will benefit Camisea. • The men had hoped that they would be hired by Shell.		• SPDP is committed to providing 'Net Benefit' to the Region. • SPDP has a policy not to hire outsiders. If labour is required then preference shall be given to personnel from the local communities.
Economy • At present the number of 'merchants' in the area is greater since the population is gaining more income. • Merchants pass along daily, however, locals do not have many products to sell.		• One of the focuses of SPDP's *Social Capital* programme is to provide the skills for the communities to develop their own economic structure so that they can develop better links to a market economy.

Source:

Note 1: This information has been collected during meetings conducted by ERM's sociologist expert, Martha Rodriguez, during the field survey for the Pagoreni/San Martin East EIA. The meetings were arranged by the community's themselves and took place on the following dates:

- Shivangoreni: 30 April 1997 - meeting with the community and the Mother's Club and 01 May 1997 (general meeting);
- Camisea: 02 May 1997 - meeting with the community and the Mother's Club;
- Nuevo Mundo: 06 May 1997 - meeting with the community and the Mother's Club.

Note 2: The comments and opinions provided within these tables are those expressed by individuals at the time of the meetings and do not reflect the opinion of the community as a whole.

Table 4.3 Primary Stakeholders - Summary of Key Issues and Actions: Nuevo Mundo Community

Key Issue		Action
Men	Women	
Helicopters • No accidents have occurred. At present helicopters are transporting cargo which can cause accidents, although they do not pass next to the community. • The helicopters make much noise and they would like to complain to Shell, but have not done so yet.	• The children are now used to the helicopters flying over, but some time ago they were scared of them.	• See previous comment on helicopters.
Water Pollution • It is too early too know the impacts of Shell's operations on fishing.	• The water is very dirty since there are more boats in the river. The women wash their clothes in the Rio Urubamba and the turbid waters makes their clothes dirty.	• SPDP will commission a study to research into the socio-economic importance of fish to the native communities. • SPDP operations would not have added any turbidity to the rivers.
Relations with Shell • The agreements regarding salaries are not being complied with; many discounts are being applied. • They do not trust Shell's staff in charge of community relations because they do not comply with their agreements. They are asking Shell to comply with dates and times of meetings. The community believes that there are more important departments within Shell where agreements can be reached. • The community leaders would like to negotiate directly with Shell directors; by being allowed to enter Shell's headquarters in order to direct their affairs directly with Shell directors. • The contract with Shell can be renewed.		• Salaries are paid by SPDP according to Peruvian law which dictates that certain taxes are paid (eg social security and income tax). This has been discussed with the community on several occasions and will be discussed again during the next visit by the SPDP Community Liaison Adviser. • Some of the deliverables set out in the contract with the community have taken longer to provide than originally envisaged because of difficulties in identifying appropriate contractors. • SPDP empowers it's CLOs to address these issues wherever possible. There is a formal complaints procedure in place. • SPDP empowers it's staff to work out details on behalf of the company. SPDP leaders are pleased to meet for regular updates. • SPDP recognises the possibility of renewing the contract with the community after 3 years. • All agreements to date have been complied with by SPDP. Additional benefits to those in the contract have also been provided (eg primary school building, domestic waste handling, solar power panels etc).

Table 4.3 Primary Stakeholders - Summary of Key Issues and Actions: Nuevo Mundo Community

Men	Women	Actions/Comments
Training • More young people need to be trained.	• The women would like to be trained in poultry breeding and growing garden vegetables.	• SPDP support the idea of skills enhancement and will through its *Social Capital* programme aim to deliver training for women. • SPDP has a scholarship programme for young personnel from the native communities.
Hiring of Manpower • The men have had problems with the contractor companies, in particular COSAPI; salaries are lower than those originally agreed with Shell. • In case of accidents they would like to receive medical attention from Shell. • They would like to have health insurance and social security should anything happen to them to safeguard them and their family. • In case of a worker's death, the rights of their wives are not currently recognised as the women are unable to present the documentation requested.		• See previous comment on salaries. • In case of an accident, all local workers including those hired from native communities would be treated (if necessary) in an IPSS hospital in Lima, and all medical expenses would be covered by social security payments. • Cosapi is paying monthly social security payments for both native and local workers. • All workers when hired elect a beneficiary (wife and/or children and/or nominee). This person must however have a legal identification paper (eg Libreta Electoral, marriage or birth certificate) to qualify.
Economy • There is an improvement in the community's economy, particularly since Shell signed a contract with Nuevo Mundo.	• When the husbands go to work for Shell, the women are left alone to look after things not allowing them to work on the farms. • The women are beginning to experience problems with food supply.	• SPDP CLOs will identify what problems with food supply are being experienced and identify possible solutions.
Infrastructure • Shell has built new premises for the clinic and school.	• The health clinic is short of drugs (especially for children).	• SPDP will investigate the situation and if necessary initiate the supply of more drugs to the clinic, as well as training in establishing a rotating fund for better management.

Source:

Note 1: This information has been collected during meetings conducted by ERM's sociologist expert, Martha Rodriguez, during the field survey for the Pagoreni/San Martin East EIA. The meetings were arranged by the community's themselves and took place on the following dates:

- Shivangoreni: 30 April 1997 - meeting with the community and the Mother's Club and 01 May 1997 (general meeting);
- Camisea: 02 May 1997 - meeting with the community and the Mother's Club;
- Nuevo Mundo: 06 May 1997 - meeting with the community and the Mother's Club.

Note 2: The comments and opinions provided within these tables are those expressed by individuals at the time of the meetings and do not reflect the opinion of the community as a whole.

Table 4.4 Secondary Stakeholders - Summary of Key Issues and Actions: Government Agencies

Key Issue	Action
• The Ministry of Energy and Mines (MEM) technical board is currently reviewing a new initiative to develop new standards for air emission levels for the oil and gas industry. In particular there has been extensive discussion on NOx levels from point sources. The MEM would be very keen to learn of experiences elsewhere in the world in setting up such standards and invites dialogue on this subject.	• SPDP is prepared to arrange a seminar for MEM on setting standards for emission levels, and will research into other appropriate case studies that can be of assistance to MEM.
• The EIA for the Pagoreni/San Martin East Drilling Programme must include an Emergency Response Plan and an Abandonment (or restoration) Plan.	• This EIA will include both plans in the *Environmental Management Plan* (EMP).
• It would be considered acceptable to drill from Block 88 into Block 75 and have this count as an exploration well, as SPDP has a commitment to drill one exploration well before March 1999. A company in northern Peru has drilled into an offshore block from the shore (outside the block) and so Peru has experience of this type of case, subject to full justification. A full case could be seen for the Pagoreni scenario, as directional and remote drilling would be advantageous on environmental and in particular social grounds *vis-à-vis* the proximity to the nearby community.	• None required - information only.
• The EIA is able to request approval for more than one site.	• This EIA requests approval of 3 sites (2 at Pagoreni and 1 at San Martin East).
• All information presented in the EIA is in principle accessible to the public and this open approach is encouraged. This also applies to the auditing procedure.	• This EIA and EMP will be openly available at DGAA offices and at SPDP Lima offices. It will also be distributed to the communities, Federations and other key stakeholders.
• Region Inca is very keen to support, as well as receive support, in any way it can during the EIA process. The Region would be keen to hold a workshop so that the EIA team can select the most suitable candidates (ie technical specialists) from the Region to work on EIA's as apart of an overall skills transfer and capacity building programme.	• ERM is currently developing its team of technical specialists for the FFDP EIAs. Opportunities will be sought to utilise specialists from Region Inca wherever possible. SPDP has supported Region Inca in the regional social baseline diagnostic.

Table 4.4 Secondary Stakeholders - Summary of Key Issues and Actions: Government Agencies

Key Issue	Action
• If SPDP plan to work at all in the Apurimac Reserve Zone (ARZ) they must involve INRENA in all the stages and keep them continually informed of proposed project developments as they have a key role when a natural reserve or an ecologically critical area is involved.	• ERM/SPDP will continue to consult with INRENA should any issues relating to the ARZ arise. SPDP is particularly interested in the further definition of the ARZ into more permanent reserve areas.
• There is no legal restriction to working in the Apurimac Reserve Zone since it has a temporary status, but SPDP must ensure that a exhaustive stakeholder involvement programme is initiated. The Reserve's boundaries are not clearly defined, since the original limits were set in the 1960s.	• There is a plan currently put forward by INRENA to redefine the status of the ARZ; ERM will consult with INRENA to discuss the implications.
• INRENA currently has three projects under review by the Ministry Council in the 'Camisea region'. These are the Vilcabamba ridge, the first communal reserve in Kutivirene and the Megantoni area. These areas have been chosen because they have been identified as very sensitive areas with rich biodiveristy and therefore in need of special management.	• None required - information only.

Table 4.5 Secondary Stakeholders - Summary of Key Issues and Actions: Community Representative Organisations

Key Issue	Action
• Significant advances have been made during this EIA process compared to the Appraisal Drilling Campaign where communities then did not have a real opportunity to participate in an effective manner.	• None required - information only.
• Peruvian legislation has not yet defined the appropriate and necessary procedures for native community involvement in the particiatory or EIA process and therefore it is difficult to gauge whether what SPDP is doing is in accordance with set standards.	• SPDP's commitment is to follow appropriate international standards (eg World Bank *OD 4.20*).
• Consultations with primary stakeholders should not only include those communities that are directly affected by the proposed project (and/or their neighbours), but also extended to include representative organisations, community federations (eg CECONAMA and COMARU), regional organisations and also at the local level. These organisations are responsible for facilitating information exchange and general coordination between the native communities and would therefore, be legitimate stakeholders within the process.	• Consultations is steadily improving through CLOs, community meetings and Federation involvement. It is recognised that additional measures are needed to build capacity.
• The EIA provides an excellent opportunity for skills transfer between technical specialists and selected personnel from the native communities. These personnel should be identified and involved in the EIA field work.	• ERM has and will continue to involve representatives from native communities in EIA fieldwork.

Table 4.5 Secondary Stakeholders - Summary of Key Issues and Actions: Community Representative Organisations

Key Issue	Action
• There is a main concern of the proximity of the Pagoreni wellsites to Shivangoreni community, and in the case of San Martin East, the relative proximity to communities that are in the initial stages of contact. This makes it all the more imporant for local communities to be involved in the EIA process, particularly during design and development of mitigation.	• At *Pagoreni* SPDP has withdrawn it's 'PR-C' well location from the potential list of wellsites following concerns from Shivangoreni relating to the proximity of this site to their community. The favoured `PR-D` location has been chosen with community input. As regards *San Martin East,* SPDP will enforce their guidelines *'Pre-trip Preparation and Response Plan in case of Contact with Isolated Nahua, Kugapakori or Machighuenga Indigenous Peoples'* (copy encloses as *Appendix B* of the EMP.
• There is the urgent need to initiate a programme to promote the area east of SPDP operations (ie eastwards of San Martin East) as an official buffer zone for the Manu National Park. The existing known groups of Montetoni and Serhajli should be granted official land titles and the remainder of the land designated a buffer zone.	• SPDP has stated agreement with the creation of a buffer zone. This may best be guaranteed through the creation of a defined Native Community for Montentoni.
• The creation of an *Indigenous Commission* remains a possibility which is encouraged. However, the 'influence' of outside groups needs to be watched carefully.	• SPDP and the Community Federations have initiated a continuing series of meetings. The establishment of any role for the Indigenous Commision is clearly a decision for the Federations.

Table 4.5 Secondary Stakeholders - Summary of Key Issues and Actions: Community Representative Organisations

Key Issue	Action
• The continued use of Nuevo Mundo as a logistics base is not regarded as acceptable. An intermediate installation (chosen in consultation with the communities) should be sought.	• The use of Nuevo Mundo will be re-evaluated in the EIAs for the subsequent FFDP. Continued use of Nuevo Mundo will depend on the location of the gas/condensate production plant and on SPDP's relations with Nuevo Mundo and other communities.
• Controlling the activities of the Developer's contractors is seen as key to ensuring success of any development programme. This necessitates the need for training programmes on issues such as environmental management.	• This is fully agreed and supported by SPDP.

Table 4.6 Secondary Stakeholders - Summary of Key Issues and Actions: NGOs/Institutions/Universities

Key Issue	Action
• There is potential for the native communities to be exploited during the FFDP with regards to achieving true 'net benefit', equity, and social capital. The preservation of human rights is seen as a key issue.	• SPDP conducts an extensive training programme for its staff and sub-contractors with a view to preserving the rights of native communities. Strict policies and guidelines are in place.
• If SPDP has been experiencing problems at Cashiriari-2 then why did they want to proceed with another drilling programme before having sorted out all the problems - ie has SPDP learnt from previous lessons?	• The problems at Cashiriari-2 originated with a very tight schedule to initiate drilling, slow delivery of supplies due to low river levels, and a very heavy rainy season. Furthermore, SPDP has learnt from previous experiences; San Martin-2 for example has been constructed taking these lessons into account. This process of learning will continue through the project's development.
• If helicopter noise was found to be a cause of complaints from the native communities, would SPDP be willing for example, to modify helicopter flight paths?	• SPDP has modified flight paths in the past and is currently requesting expert advice on the effects of helicopter noise on animal life.
• The effects of sound transmission through water should be included in the noise baseline survey to measure noise levels from various types of river traffic (in particular the hovercraft) so that an evaluation can be made on the potential effects on amphibia, aquatic mammals and reptiles.	• SPDP will commission an underwater noise survey during the FFDP EIA field survey to address these issues.

Table 4.6 Secondary Stakeholders - Summary of Key Issues and Actions: NGOs/Institutions/Universities

Key Issue	Action
• There is an urgent need to initative a programme of studying the importance of fish to the native communities of the area (ie as a food and economic resource). This is needed to understand the potential adverse impacts caused by the hovercrafts or increased boat traffic, or increased pollution as a result of SPDP's activities on the fish and their dependent communities.	SPDP will commission a study to investigate the socio-economic importance of fish to the native communities.
• The disposal of all types of waste (from inerts through to hazardous materials) from 'cradle to grave' is seen as a key issue.	• SPDP has waste mangement guidelines in place which address the disposal of all waste types (Both Rigsite and Nuevo Mundo Waste Management Plans; these are presented as *Appendices F1* and *F2* to the *EMP*).
• The language used in the briefing papers should be made a bit less technical so that it is understandable by all audiences. One answer is to produce a small bulletin in Machiguenga or Piro which could be a summary of the briefing papers.	• SPDP will translate and distribute future Briefing Papers and has also prepared specific communications to the native communities in Spanish and Machiguenga.

Table 4.6 Secondary Stakeholders - Summary of Key Issues and Actions: NGOs/Institutions/Universities

Key Issue	Action
• The research work being currently carried out by Smithsonian Institution (SI) is widely accepted as both necessary and a positive step forward. However, a number of questions focused on whether the technical specialists were using native communities as assistants and more importantly were they being trained?	• The SI studies are a partnership between international experts and Peruvian Universities. Over half the visiting scientists are Peruvian. Specimens are shared with the National Museum according to Peruvian permitting procedures. Native workers are included in all activities both to provide logistical support and for long-term training. The programme will be defined in detailed reports produced by SI.
• It is hoped that other oil companies will adopt similar control measures (such as SPDP's *Health Passport*) to those currently employed by SPDP.	• None required - information only.
• The potential in-migration of workers and other people seeking employment to the region may alter the social structure and dynamics of the native communities (eg the introduction of sexually transmitted or vector-born diseases). This is seen as a real threat even when important measures have been put in place in order to minimize the risk.	• SPDP will not hire workers arriving into the region. If local labour is needed the native communities will be used as first choice.
• The EIA results and any subsequent follow-up studies should be made available at a mini-library at SPDP's Lima offices.	• The EIAs are openly avaliable at SPDP offices in Lima. SPDP will develop a mini-library for appropriate documents to be publically available.

Chapter 5

Existing Environmental Conditions

5 EXISTING ENVIRONMENTAL CONDITIONS

5.1 INTRODUCTION

This Chapter describes the existing physical, biological and socio-economic conditions of the area which could potentially be affected by the exploratory drilling programme.

A study area (hereafter referred to as the 'Study Area') has been defined to include the number of proposed wells (up to four wells from up to three locations) which are proposed to be used as exploratory well sites. This Study Area is specifically covered by mapped information (for example see *Figure 5.1*) and in the text of this Chapter. Whilst logistical activity will extend further north to Nuevo Mundo and to Sepahua and beyond, these areas have not been addressed in any detail in this EIA other than in regard, for example, to noise and socio-cultural aspects. Information on these areas is available in the EIA for the Appraisal Drilling Campaign

5.2 METHODOLOGY

5.2.1 *General*

Baseline data for the Study Area were acquired through a combined and comprehensive approach which included:

- desk studies and literature which built on the previous work conducted for the Appraisal Drilling Campaign EIA and more recent studies commissioned by SPDP, for example: *A Health Baseline Study in the Camisea Area, Lower Urubamba, Peru;*
- mapping digitally produced from aerial photography;
- a ground field survey of two weeks duration which included biodiversity surveys, air, water, sediment and noise sampling and analysis, socio-cultural interviews with the local communities and an archaeology survey;
- consultations and interviews with key stakeholders.

Each of these activities is outlined in more detail below.

5.2.2 *Desk Studies*

The following main desk study activities were carried out by local specialists as part of the baseline data collection phase and were focused by the findings of previous work:

- conducting literature reviews;
- visiting local libraries;
- accessing international data bases;
- consulting experts from relevant key national academic and scientific institutions and NGOs.

5.2.3 *Map Preparation Methods*

Using standard photogrammetric techniques, data were captured digitally from aerial photography of the Camisea area dating from 1962, 1986 and 1990 at scales of 1:60,000, 1:35,000 and 1:80,000 respectively. The resultant map produced has scale of 1:25,000 and captures ground features including rivers streams and settled areas. The resolution achieved and ground detail and accuracy are an improvement on satellite imagery for the area, especially in terms of topographic information.

5.2.4 *Ground Field Survey*

In order to gain first hand knowledge of the study area and verify information collected during the desk study phase, an extensive ground field survey was initiated, together with local consultations. This survey was carried out between 24 April and 14 May 1997 by a team of Peruvian specialists supplemented by an ERM UK noise consultant. In addition an air quality monitoring programme was initiated in April/May 1997 in the study area. A detailed field survey diary and account of methodologies are presented in *Appendix D*.

5.2.5 *Stakeholder Participation*

Consultation with key stakeholders played an integral part in developing a clearer understanding of the socio-cultural issues and environmental context of the study area. The stakeholder participation programme is described in *Chapter 4*.

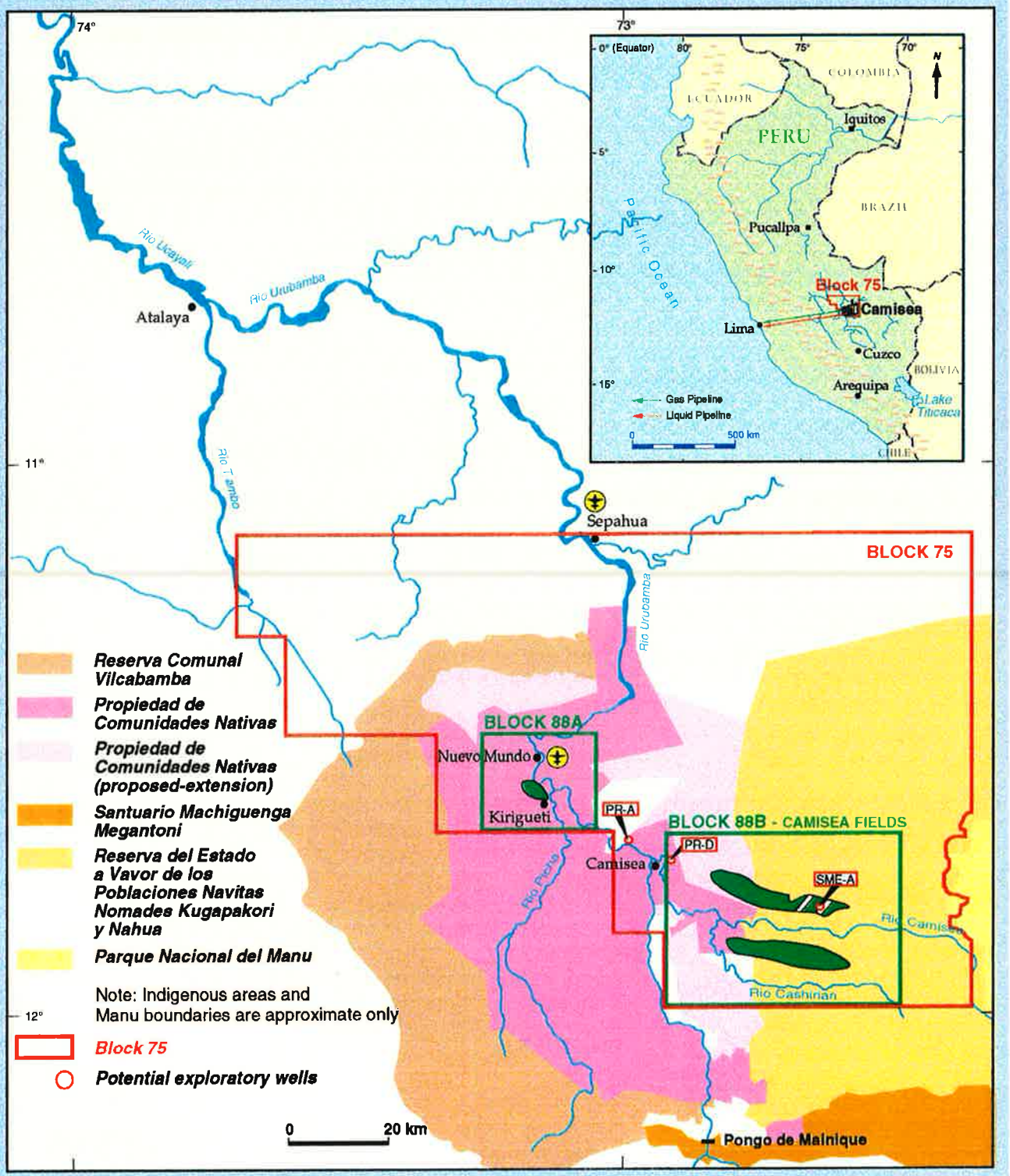
5.3 *General Setting of The Study Area*

5.3.1 *Physical Setting*

The proposed development of three exploratory drilling sites at Camisea will take place in a region of Peru that is potentially rich in biological diversity and cultural importance. The project is located in the Urubamba River valley of the Ucayali watershed, between the northern spurs of the Vilcabamba Mountains to the west and the Urubamba Mountains to the east (see *Figure 5.1*). The Urubamba Mountains lose altitude northwards, and constitute the Fitzcarrald Divide between the Ucayali and Madre de Dios/Purus watersheds. The Camisea River drains the Urubamba Mountains into the Urubamba River. The wider area is primarily low and high rainforest with the land rising to over 4,000 m both east and west of the Urubamba.

To the south the land rises towards the highlands around Cuzco, intersected by the gorges of the Urubamba river. The river flows past Cuzco and the Inca city of Macchu Picchu before descending through many rapids to the lowlands. The last major rapids, at Pongo Mainique, are approximately 100km upstream from Nuevo Mundo.

Figure 5.1
Approximate location of the exploratory wells



5.3.2 *Ecological Setting*

Due to its varied topography and its location at the southern limits of the equatorial region, the Study Area and its surrounds present a variety of biogeographical and ecological zones. The change in altitude allows for lowland rainforest (below 500 m), highland rainforest (500 - 1,000 m) and montane cloudforest ('yungas') above 1,000 m. In addition, the transition between tropical and subtropical climates (ie a more marked dry season in the southern parts) and associated vegetation provinces occurs at this latitude, providing for various transitional zones in ecological character.

The tropical rainforest is the dominant biogeographical province in the Study Area, as the climate is humid to very humid with very high rainfall (approximately 3,000 mm yr^{-1}). Rainforests are dependent on this level of rainfall for their high productivity and biodiversity. Paradoxically, however, surface waters and soils tend to be nutrient poor, as the very high biological production rate ensures that there is continual cycling of nutrients through the biomass with very little stored in soil. As a result, rainforests are ecologically fragile and tolerate only minimal loss of nutrients through leaching or, more importantly, soil loss to the outside environment.

The highest diversity of plant and animal life in the world is recorded in rainforests. The highest count of mammal species in the world occurred at the Madre de Dios locality of Balta on the Purus River (Pulido 1991). This is some 100 km away from the Study Area. At Tambopata Reserve in southern Madre de Dios (some 400 km south east of Camisea), 92 species of mammals, 570 species of birds (a world record) and 71 species of amphibians were recorded over an area of 5.5 km^2 (Pulido 1991). One survey along Río Manu, 100 - 150 km east of the Study Area, revealed 14 previously unrecorded amphibian species. It has been estimated that several dozen bird species remain to be described in the Peruvian Amazon (O'Neill 1985). Fish diversity is equally high: 736 species have been recorded in the Peruvian Amazon. Studies of insects and other invertebrates illustrate the enormous variety of life; in a single tree in Tambopata, 500 species of beetle and 80 species of ant were found, 80% of which were previously unrecorded.

Smithsonian Institution, in collaboration with various Peruvian institutions and experts, has been commissioned to conduct bio-diversity studies in the Camisea region. When the results of these studies are available they will go a considerable way towards defining the nature conservation importance of this part of the Lower Urubamba.

5.3.3 *Socio-Cultural Setting*

The Study Area, and wider area, contain a number of local community settlements. These are populated almost exclusively by indigenous peoples - the Machiguenga. The main settlements are:

- Camisea;
- Segakiato;
- Cashiriari (nearest settlement to proposed San Martin East-A, SME-A, drill site);

- Shivangoreni (nearest settlement to proposed Pagoreni drill sites);
- Nuevo Mundo.

Other important settlements nearby are Montetoni to the east of the proposed SME-A well site and Kirigueti to the south of Nuevo Mundo (see also *Figure 5.11*).

The settlements are exclusively located alongside rivers and practise subsistence agriculture on the forest fringe. Forest and river resources are exploited in a sustainable manner. Most of the communities have some form of primary schooling but limited secondary schooling. Medical and other facilities are quite limited.

The communities are strongly linked with each other and others well outside the Study Area through family ties and shared culture. The Machiguenga can trace their occupation of the Urubamba and wider area for some 5,000 years into the past. Their culture and way of life has changed relatively little in the last 1,000 years or so and has survived relatively intact despite contacts with Inca, Spanish colonialism and more recent 'western' influences; the latter of which has introduced familiarity with such matters as radio communication, motorised canoes and links, through forestry, to the cash economy.

5.4 CLIMATE, METEOROLOGY AND AIR QUALITY

5.4.1 General

The general climate in the Study Area corresponds to a wet tropical rainforest according to Holdridge's bioclimate classification (ONERN, 1988). This type of climate is commonly referred to as tropical rainforest and is typical of a low latitude environment controlled by equatorial tropical air masses such as the intertropical convergence zone. Moist tropical maritime and equatorial air converge, producing troughs which yield heavy rainfall through convectional storms (see *Section 5.4.2*). Uniform temperatures generally prevail through the year.

The Study Area is characterised by two bioclimate regions. The eastern section from the Camisea to the Urubamba river is classified as humid tropical rainforest. The west, from the Cashiriari and upper Camisea, is a transitional, very humid pre-mountainous forest (ONERN, 1988).

Overall, meteorological information for the Study Area is limited. The closest meteorological stations are in Sepahua and in El Sepa. Information from Atalaya and Oviri, stations outside the study area, was used by ONERN (1988) to characterise the precipitation and wind patterns in the upper Urubamba and Study Area. There is a tendency toward an increase in precipitation from the upper to lower Urubamba region as indicated by the rainfall registered at Atalaya during the same period (3,029 mm). During the year, there are two defined patterns of precipitation. A low rain season occurs from May through September with higher precipitation occurring from October through April. In agreement with these patterns, the highest recorded precipitation tends to occur at the end of the year in November and

December when the total registered precipitation can reach 400 mm (El Sepa station).

SPDP has recently set up its own meteorological recording station at Nuevo Mundo. This will, in due course, start generating data which is more specific to the region.

5.4.2 *Rainfall*

General

The Study Area is affected by different scale rainfall-producing mechanisms which range from continental down to microscales. These are discussed in *Box 5.1.*

Box 5.1 *Rainfall Inducing Mechanisms for the Study Area*

Continental and Synoptic Scale

The heating of air and evaporation of moisture for upper Amazonia contribute to basic mechanisms that define the relationship of the dry season, which is short (June through August) to the wet season. The Study Area is too far south to be affected by the Zonal Trough in the Easterlies over the Atlantic, indicated by a lightly bimodal rainfall pattern in northern Amazonia.

Synoptic implies a characteristic length of 1,000 km and, in the Study Area, contains frontal systems of polar or temperate origin that move equatorward close to the Andes. Despite their rarity, Amazonian frontal systems can produce exceptional rainfalls.

Sub-synoptic Scale

This scale has a characteristic length of 500 km and is marked by instability of the upper air indicated by clusters of large cumulo-nimbus clouds. These initiate by the development of convective cells during mid-morning. A selection process ensues, in which the larger ones grow to form clusters or lines, and the smaller ones are suppressed. The formation of a line or cluster depends on the tropospheric flow pattern: in a strong wind field, downdrafts of the original cell operate as mini-frontal zones, raising the ambient humid air and causing new cells, originating from this forced convection, to form an arched line downwind, in a weak wind field, new cells surround the mother-cell as a ring or cluster that continues to grow at the expense of downdrafts.

Line systems produce average rainfall intensities in the order of 10-20 mm h^{-1} for 3-5 hours. Rarely stationary, line squalls tend to move away from measuring stations. During the field survey, most daytime storms appeared to be of the cluster variety. These typically followed an advanced time sequence in which the highest intensities occurred during the first half of their duration, up to one-third of storm rainfall occurring during periods lasting about 1 hour.

Mesoscales and Microscales

The mesoscale grid has a typical length of 100 km. In the tropics its most common feature involves clusters of cumulo-nimbus clouds, which produce intense precipitation for short durations and random distribution. Most often these are submerged by frontal systems, but can also develop as isolated clusters. The largest of these is about 50 to 300 km diameter and may live between 5 and 12 hours with average intensities of 10-30 mm h^{-1} and 24-hour totals between 50 and 150 mm.

Microscale mechanisms involve lengths of 1 km and are made up of small convective cells, 2-4 km in diameter, which form during the morning and precipitate between 1,400 and 1,600 hours. Typical storms are short-lived, lasting 1-2 hours, with average precipitation less than 5 mm.

Rainfall in the Vicinity of the Study Area.

Table 5.1 gives monthly rainfall measured at Pucallpa on the Urubamba River downstream of Sepahua. It shows that about half the annual total of rainfall is received before the onset of the dry season, which is short and provides about 20 % of the annual total. However, levels at Pucallpa appear low and are probably not representative of the Study Area. Maps of mean annual precipitation show it to be about 3,000 mm yr^{-1} in the Study Area. SPDP is now collecting rainfall data at its meteorological monitoring station at Nuevo Mundo.

Table 5.1 *Monthly Rainfall, Pucallpa, Peru*

Month	mm	% of total
January	159	9.60
February	183	11.05
March	195	11.78
April	179	10.81
May	110	6.64
June	87	5.25
July	42	2.54
August	63	3.80
September	118	7.13
October	156	9.42
November	208	12.56
December	156	9.42
Total	**1,656**	**100**

Rainfall Variability

Inter-annual variability of rainfall appears to be largely governed by the El Niño Southern Oscillation (ENSO), itself a key variable in determining the spatial and temporal variability of equatorial sources of latent heat. During a warm phase of the ENSO, continental rainfall lessens as large-scale cells of ascending air, previously located over the climatically warm Amazon Basin, are displaced to the west over a now abnormally warm Pacific. These cells ecome reinforced by strong convective circulation over the eastern Pacific, so that rising air and the rainfall that results from it gives cause to a westward shift of precipitation.

5.4.3 *Winds*

Another important factor that can affect the precipitation in the region is the southerly, easterly, and northeasterly winds that bring large amounts of moisture laden clouds. Precipitation occurs after these clouds collide with the Vilcabamba Ridge which acts as a natural barrier that divides the Urubamba from the Ene and Tambo rivers. This cloud system is a distinctive feature in the Study Area. Clouds tend to be high and dense and more scattered in the drier times of the year. Dense fog can cover extensive areas until mid morning. In general, half of the sky is covered with clouds in an average day and completely covered during any stormy period. Prevailing winds during the year are generally calm (<2.0 ms^{-1}) and predominantly from the southeast, south and east. Of special interest are the southerly winds that can bring cool fronts to the region. These fronts are capable of dropping the local temperatures by 10-15°C. The winds that accompany the fronts can be strong, with maximum speeds up to 14 ms^{-1}. These conditions are more frequent toward the end of the year (ONERN, 1988).

5.4.4 *Temperature*

Temperatures tend to increase slightly from south to north. In the Study Area, temperatures from 23.5°C to 24.5°C have been reported (ONERN 1988). At the El Sepa station, the annual average is 25.2°C. As in other tropical regions, the overall temperatures are relatively constant. Relative humidity in

the Study Area is high (>80%). The overall humidity remains more or less constant throughout the day and during the year.

5.4.5 *Air Quality*

Air quality data have been collected for seven sites in the Camisea region using diffusion tubes - a standard, reliable and robust technique. The sites were selected to represent the typical air quality that is experienced by the local people. Results are summarised in *Table 5.2 to 5.4.*

Table 5.2 ***Sulphur Dioxide Diffusion Tube Analysis***

Sample Number	Start Date	End Date	µg m^{-3}
Batch Number 1			
Shivangoreni	01/05/97	31/05/97	3.5
Camisea	01/05/97	31/05/97	4.1
Armihuari - Satellite Dish	04/05/97	03/06/97	3.5
Armihuari - Shell Office	04/05/97	03/06/97	3.5
San Martin - Satellite Dish	05/05/97	03/06/97	<0.8
Nuevo Mundo Community - Satellite Dish	06/05/97	03/06/97	3.8
Nuevo Mundo - Base Camp(1)	06/05/97	03/06/97	4.3
Batch Number 2			
Shivangoreni	31/05/97	05/07/97	<0.8
Camisea	31/05/97	05/07/97	<0.8
Armihuari - Satellite Dish	03/06/97	14/07/97	4.1
Armihuari - Shell Office	03/06/97	14/07/97	<0.8
San Martin - Satellite Dish(2)	03/06/97	14/07/97	-
Nuevo Mundo Community - Satellite Dish	03/06/97	14/07/97	<0.8
Nuevo Mundo - Base Camp	03/06/97	14/07/97	<0.8

(1) A motor grader throwing black smoke was working close by for a few days.
(2) Tube was found in radio room due to moving camp. Probable end date 23-27 June.

Natural background (1) concentrations of SO_2 are normally below 5 µg m^{-3}. The measured concentrations at all sites are below this value indicating unpolluted air at the sites measured.

(1) World Health Organisation (1987) **Air Quality Guidelines for Europe**, European Series 23, Copenhagen.

Table 5.3 *Nitrogen Dioxide Diffusion Tube Analysis*

Sample Number	Start Date	End Date	µg m^{-3}
Batch Number 1			
Shivangoreni(1)	01/05/97	31/05/97	(0.8)
Camisea	01/05/97	31/05/97	1.0
Armihuari - Satellite Dish	04/05/97	03/06/97	3.8
Armihuari - Shell Office	04/05/97	03/06/97	3.0
San Martin - Satellite Dish	05/05/97	03/06/97	2.0
Nuevo Mundo Community - Satellite Dish	06/05/97	03/06/97	2.4
Nuevo Mundo - Base Camp(2)	06/05/97	03/06/97	1.9
Batch Number 2			
Shivangoreni	31/05/97	05/07/97	0.4
Camisea	31/05/97	05/07/97	0.6
Armihuari - Satellite Dish	03/06/97	14/07/97	2.7
Armihuari - Shell Office	03/06/97	14/07/97	2.4
San Martin - Satellite Dish(3)	03/06/97	14/07/97	-
Nuevo Mundo Community - Satellite Dish	03/06/97	14/07/97	2.3
Nuevo Mundo - Base Camp	03/06/97	14/07/97	2.2

(1) Tube was found turned around (the hole was upside).

(2) A motor grader throwing black smoke was working close by for a few days.

(3) Tube was found in radio room due to moving camp. Probable end date 23-27 June.

Natural sources of oxides of nitrogen contribute at least ten times that of anthropogenic sources. Source such as volcanoes, lightning and bacterial action being the main contributors. Natural background concentrations of NO_2 are therefore related to a sites proximity to these natural processes. The measured concentrations at the seven sites are very low in relation to those found in most inhabited areas and are well below any levels set to protect human health or vegetation.

Table 5.4 BTEX Diffusion Tube Analysis

Sample Number	Start Date	End Date	Benzene ppb	Toluene ppb	Ethyl-benzene ppb	m,p-xylene ppb	o-xylene ppb
Batch Number 1							
1	01/05/97	31/05/97	0.09	<0.06	<0.06	<0.06	<0.06
2	01/05/97	31/05/97	0.20	0.08	<0.06	<0.06	<0.06
3	04/05/97	03/06/97	0.08	0.06	<0.06	<0.06	<0.06
4	04/05/97	03/06/97	0.10	0.18	0.16	0.34	0.46
5	05/05/97	03/06/97	0.13	0.22	0.14	0.31	0.12
6	06/05/97	03/06/97	<0.07	<0.06	<0.06	<0.06	<0.06
7(1)	06/05/97	03/06/97	0.10	0.12	<0.06	<0.06	<0.06
Batch Number 2							
1	31/05/97	05/07/97	0.10	<0.05	<0.05	<0.04	<0.04
2	31/05/97	05/07/97	0.12	0.08	<0.05	<0.04	0.04
3	03/06/97	14/07/97	<0.06	<0.05	0.05	0.05	0.18
4	03/06/97	14/07/97	0.10	0.51	0.89	2.71	1.51
5(2)	03/06/97	14/07/97	-	-	-	-	-
6(3)	03/06/97	14/07/97	0.28	0.13	<0.05	0.06	0.06
7	03/06/97	14/07/97	<0.06	0.09	<0.05	<0.04	0.08

Site Key

1) Shivangoreni 2) Camisea 3) Armihuari - Satellite Dish
4) Armihuari - Shell Office 5) San Martin - Satellite Dish
6) Nuevo Mundo Community - Satellite Dish 7) Nuevo Mundo - Base Camp

(1) A motor grader throwing black smoke was working close by for a few days.
(2) Tube was found in radio room due to moving camp. Probable end date 23-27 June.
(3) Blank tube installed be error in Nuevo Mundo Community on 14 July 1997 but was removed on 17 July 1997.

Concentrations of the four organic species are all very low and in many cases below the level of detection of this method. Concentrations of benzene in ambient air are generally in the range 1-50 ppb. Higher levels urban areas and near petrol stations are common. All benzene concentrations measured were below the lower bound of this range. Toluene is the most prevalent hydrocarbon in the troposphere and WHO (1987) suggest that an upper bound for background levels is 0.2 ppb. Some of the measured concentrations are above this level indicating some sources of toluene in the area are contributing to background concentrations. Measured concentrations are well below guidelines set for the protection of human health. Ethylbenzene and xylene concentrations in unpolluted rural areas are generally below 1 ppb. Concentrations of these hydrocarbons at the sites measured were generally below this level. However, at the Shell offices at Armihuari and the satellite dish at San Martin concentrations were elevated above this background indicating local sources of hydrocarbons were influencing ambeint concentrations. Fuel use (vehicles/generators/helicopters) and fuel storage are the most likely sources in the area.

5.5 GEOLOGY

5.5.1 Geology

Geological Setting

The Camisea gas reservoirs are located within a Cretaceous, gas-bearing sequence, which constitutes a marine transgressive sediment deposited through subsidence and a marine ingression from a general northwest direction. From top to bottom, the vertical sequence within the cretaceous deposit is as follows:

- Vivian;
- Chonta;
- Nia Koatsuintari;
- Shinai;
- Ene.

The sandstone reservoirs within the sequence were originally deposited as sand bar and distributary channels within the coastal/shallow marine environment. The reservoirs are separated by marine claystone with limestone intercalcations (see *Figure 5.2*).

The reservoir sequence is underlain by Permian, Carboniferous and Devonian deposits. The cap rock is the thick (more than 1,000 m) Tertiary continental Red Bed formation.

A summary of the overall vertical sequence (lithostratigraphy), reservoir bearing rocks, non-reservoir rocks, seals and cap rock is presented below in *Table 5.5* and illustrated in *Figure 5.2*.

Table 5.5 Lithostratigraphy

Formation Name	Constituent rock
Lower Red Bed	Caprock/claystones/shales
Upper and Lower Vivian	Sandstone (gas bearing - Cashiriari only)
Upper Chonta	Claystones/shales/some limestones
Lower Chonta	Sandstones/intercalcated claystones/shales (gas bearing)
Basal Lower Chonta	Mainly sandstones
Upper and Lower Nia	Sandstone (gas bearing)
Esperanza	Claystone/shales, some limestones
Upper and Lower Shinai	Sandstone (gas bearing)
Ene and Copacabana	Limestone (gas bearing)

Lithostratigraphic continuity is good within the Study Area with similar reservoir and non-reservoir rock sequences being found over large distances.

Despite the overall continuity, the Lower Nia units demonstrate a wide range of thickness between the different well sites.

Outcrops/Surface Geology

The visible geology of the concession is made up of Tertiary sandstone, and lies exposed along major rivers and streams. Beach gravels are more complex, where poorly rounded limestone and flint along Kiutaparayeari Creek indicate deposits of calcareous sediments; metamorphism is also indicated by the presence of hornfels. Gravels along the Urubamba River are still more complex and, as shown by their roundness, have travelled long distances.

Seismic Setting

The geological sequence is folded in compressional, elongated anticlines with steep flanks associated with major thrust faults. Pagoreni and San Martin are both located in anticlines.

From seismic data, it is apparent that substantial horizontal movements are associated with the main thrust fronts eg the Picha thrust which borders the San Martin anticline. There is also evidence of minor thrust faulting in a sub-parallel direction to the main thrust trends. Evidence for cross-faulting is not conclusive.

Dip and thrust fault closure constituted the conditions for the accumulation of the gas reserves in the Vivian, Nia and Shinai formations.

Geological Setting of the Well Sites

The San Martin field was discovered in 1984. Gas rates were teastd from a number of sandstone intervals in the Cretaceous Nia and Shinai formations at a depth of 1,630 m sub-surface (mss). The subsequent downdip (named Segakiato) encountered a Gas Water Contact (GWC) and proved that no oil rim was present in the San Martin structure.

A further well, the Mipaya well, was drilled in the 1980's some 40 km to the north-west of San Martin to extend the structural picture of the area. The well indicated only small volumes of gas condensate but demonstrated the lateral extension of the gas-bearing sands. The Pagoreni site is between San Martin and Mipaya. The well will explore the gas-bearing potential of the Cretaceous and Permian sandstone reservoirs that are known to bear gas in the neighbouring San Martin and Cashiriari fields.

5.5.2 *Mineral Resources*

Source of Aggregates and Construction Materials

The geology of the area suggests that limited amounts and types of material are available for works involving concrete and aggregate. Tropical forest soils do not usually contain the clean grit and sand necessary to make concrete. Moreover, the large seasonal variation in river levels is likely to affect the availability of construction materials since during the rainy season many of

the rivers are subject to flooding and under such conditions the collection of construction materials would be very difficult. During the dry season flows and levels are lower and gravel beds are exposed and accessible.

Mining and Other Minerals

Other than hydrocarbons, there are no other known surface or subsurface mineral resources in the area, and there is no evidence of present mining activity of any extensive nature.

5.6 SOILS, VEGETATION AND LAND USE POTENTIAL

5.6.1 Background

The location of the well sites comprises hilly and level plain landscapes located on the banks of the Camisea and Urubamba Rivers. The area is classified as a humid tropical, pre-mountainous zone, with an annual average temperature of 24 - 25°C, with variable annual rainfall (3,000 - 3,500mm). Anthropogenic influences are limited to the banks of the Camisea River and are primarily associated with the presence and activities of the Camisea and Shivangoreni Machiguenga communities. The flora of the area is diverse; wild bamboo, which is characteristic of the area, is found in varying densities and dominates in some zones.

In May to June, 1997, studies were undertaken as part of the field survey to classify vegetation units and soils, to establish the sensitivity of the area to activities associated with proposed drilling operations

5.6.2 Methodology

Forestal Resource

Field vegetation sampling was undertaken according to the methodology set out in the Forestry Inventories in Tropical Forests (Malleux 1982). Sampling was undertaken by recording parcels of land in blocks of 10m by 50m, with an area of 500m^2 (sampling strip method). The following data were recorded for plots:

- predominating tree species;
- shrub-like, and herbaceous species;
- landscape type;
- disturbance rate;
- slope;
- soils;
- drainage;
- density;
- wood height;
- total height of trees;
- diameter of trees over 20cm (at chest height).

In addition, samples of some forestry species were collected and verified at the MOL herbarium, the Forest Sciences Faculty, at the National Agrarian University (Universidad Nacional Agraria - Lima).

Field data were also plotted onto the 1:25,000 physiographic map (see below) and verified using existing records for the area together with LANDSAT (1994) satellite imagery.

Soil Resource

The assessment of the soil resource was based on data obtained during field work performed at each well site in April and May 1997 and supplemented with the data obtained from the inventory reconnaissance, and the assessment of the natural resources of the Middle and Lower Urubamba (ONERN, 1987), and from the semi-detailed forestry and soil surveys of the course of Middle and Lower Urubamba (ONERN, 1990). Data were analysed, updated and corrected with LANDSAT (TM 1994) satellite imagery at a 1:100,000 scale, and topographic maps (GEOFOTO, 1997) at a 1:25,000 scale based upon air photographs taken in 1962, 1986, and 1993 at 1:60,00 ; 1:35,000; and 1:80,000 scales, respectively.

During the field work, further qualitative and quantitative data were obtained, through the verification, in situ, of physiography and through the completion of test pits (excavations of 2 m x 1 m and 1.20 depth), where a soil profile description was performed, registering the layers or horizons as well as width, colour, texture, consistency, presence of gravels or stones, speckling, etc. Soil cores were taken from each horizon and analysed in a laboratory.

Soil descriptions and map units were based on the Soil Survey Manual (revision, 1982) criteria. Soil taxonomy follows the definitions and nomenclature established in the soil taxonomy system (Soil Taxonomy, revision, 1994).

Land classification, based upon Potential Primary Use, was made in accordance with the Peruvian regulations, provided by Supreme Decree 0062175-AG, of January 22, 1975, and in accordance and with the extension established by the National Office for Natural Resources Assessment (ONERN, 1982).

5.6.3 *Description of the Exploratory Well Sites*

Pagoreni A

The site of the Pagoreni A well is located in a forest situated on a moderately dissected lower hill, with a system of 'lomadas' (small highlands) and hills of varying dissection. Elevations reach 80m above the river levels, and with slopes between 15 to 50%. Soils vary from deep to moderately deep, and are of moderate drainage.

The lower and medium parts of the hills appear to have soil conditions more suited to forestry than at higher elevations: the tress in these areas are

noticeably more vigorous than trees located on hill-tops. Bamboo (*Guadua* sp) was observed to be interspersed with trees, but in very low densities.

The forest of this physiographic unit constitutes a non disturbed primary forest. Forestry species recorded at the site are listed in *Table 5.6*:

Table 5.6 ***Forestry Species Recorded at Pagoreni A***

Scientific Name	Common Name
Aspidosperma sp	Quillobordón
Pouruma sp	uvilla del monte
Cecropia sciadophylla	cetico
Inga sp	guava de monte
Matisia cordata	sapote
Aniba sp, *Ocotea* sp	moena
Inga sp	shimbillo
Protium sp	copal
Virola sp	cumala
Perebea sp	chimicua
Pouteria reticulata	quina quina
Pithecellobium sp	pashaco
Guatteria chlorantha	carahuasca
Hirtella triandra	
Eugenia uniflora	
Calyptranthes paniculata	

In addition, palms, such as huicungo (*Astrocaryum chambira)* and huacrapona (*Iriarthea deltoidea)* were recorded.

The sampling shows an estimated forestry volume of 102m3/ha with 79 trees/ha of over 20 cm diameter at chest height.

The soil belongs to the INCEPTISOLES order, Large Group Dystropepts and Sub Group Typic dystropepts, locally known as 'Cheni soils'.

These soils are developed on clays, shales, and sandtones, with a certain level of development. It presents an ABC profile, with a cambric horizon and ochric epipedon, with a medium to moderately fine texture, permeability from moderate to slow, drainage good to moderate. Further details are presented in *Box 5.2*.

Box 5.2 ***Cheni Soils***

The Chemi soils are extremely acidic (pH r,1 - 4,6), low in available organic material (1,5%) and P (3,3 ppm), medium in available K (392 kg K20/ha); a cationic exchange capacity from 20 to 35 cmol(p+)/kg of soil, exchangeable acidity up to 14 cmol(p+)/kg of soil and a base saturation from 50 to 90%. Natural fertility is low.

Due to the edaphic conditions and according to the classification of lands for potential primary use, these lands are suitable for forestry (F2se), having a medium agricultural quality, and limitations due to poor soils and erosion.

Pagoreni D

The site of the Pagoreni D well is located in a structural high hill, with steep to extremely steep slopes (varying from 50 to 75%), and a varied topography.

Due to access limitations, forestry and soil sampling was completed in a lower, slightly dissected hill, corresponding to a primary forest without alteration, with slopes between 15 and 50%.

Forestry species recorded at the site are listed in *Table 5.7*.

Table 5.7 ***Forestry Species Recorded at Pagoreni D***

Scientific Name	Common Name
Matisia cordata	sapote
Crotón sp	sangre de grado
Uncaria tormentosa	cat's paw
Sapium sp	leche caspi
Protium sp	copal
Guarea macrophylla	requia
Ocotea sp	moena
Calatola venezuelana	palo ceniza
Rinorea lindeniana	
Mezilaurus sp	
Rinorea viridifolia	
Pausandra trinae	
Carpotroche longifolia	

Palms such as huacrapona, (*Iriarthea deltoidea*), and ungurahui, (*Jessenia* sp) were recorded.

The sampling shows an estimated forestry volume of 115 m^3/ha with 82 trees/ha of over 20 cm diameter at chest height.

The soil belongs to the ENTISOLES Order, Large Group Troporthents and Sub-Group Typic troporthents, locally known as 'Maingo' soils. These soils have the same characteristics as at Pagoreni CI. According to the potential primary use classification, these lands are not suitable for agriculture, grazing and forestry, and are restricted to protection lands.

The sampled soil belongs to the INCEPTISOLES order, Large Group Dystropepts and Sub Group Typic dystropepts, locally known as 'Chilichileja' soils. These are soils with genetic development, presenting an ABC profile, ochric epipedon and cambric horizon. They are deep soils, with a medium to moderately fine texture, having a yellowish red colour to dark brown. Drainage is slightly excessive, having a moderately fast permeability. Further details are presented in *Box 5.3*.

Box 5.3 ***Chilichileja Soils***

The Chilichileja soils show an extreme to strong acid reaction (pH 14,27). Their capacity of cationic exchange varies from 3 to 9 cmol (p+) / kg of soil. They contain from 3 to 9 cmol exchangeable aluminium(p+)/kg soil, and the base saturation is from 50 to 86%. Organic matter content is from low to medium, having a low available phosphorous, and from low to medium available potassium. Natural fertility is low.

According to the potential primary use classification, these lands are suitable for forestry (F2se), having a medium agricultural quality, with limitations due to poor soils and erosion.

Capironshianpiari River (Medium Terrace)

This site is located on a slightly inclined terrace, on at the right bank of Capironshianpiari river, a small tributary of the Urubamba river. Vegetation corresponds to a mature secondary forest, mixed with 'pacales' (*Guadua* sp). Trees generally have a small diameter and are below 25 m in height. Terrace slopes vary from 2 to 6%.

Forestry species are mixed with pacales (*Guadua* sp) (refer to *Table 5.8*).

Table 5.8 ***Forestry Species Recorded at Capironshianpiari River***

Scientific Name	Common Name
Inga sp	shimbillo
Cecropia sp	cetico
Bixa sp	achiote de altura
Matisia cordata	sapote
Guadua sp	pacal
Guarea glabra	requia
Faramea multiflora	
Acidotón sp	
Pentagonia parvifolia	
Endilicheria dysodantha	
Crepidospermun goudotianum	

The understory comprises species including *Calathea* sp and palms such as huicungo (*Astrocaryum* sp) and ungurahui, (*Jessenia* sp). The sampling shows an estimated forestry volume of 71 m^3/ha with 65 trees/ha, of over 20 cm diameter at chest height.

The soil described in test-pit 6, belongs to the ENTISOLES Order, Large Group Dytropepts and Sub-Group Fluventic dystropepts, developed on sub-recent alluvial material, with a genetic development, ABC profile, with a cambric horizon and ochric epipedon. The soils vary from moderately deep to deep, and exhibit a coarse to medium texture. Its colour is dark yellowish brown. The drainage is good to excessive, having a moderately fast permeability.

Chemically, it has a strongly acid reaction (pH 4,3). Its cationic exchange capacity is from 6 to 9 cmol (p+)/kg of soil. Its base saturation may reach 80%, being from low to medium in organic matter content, and low in available phosphorous, potassium and low natural fertility.

According to the classification of Potential Primary Use, these lands are suitable for permanent cultivation, having a low agricultural quality, and soil limitations.

San Martin East

The site of the SME-A well is located in a hilly landscape on a bare high hill of a moderate dissection, with slopes varying from 15 to 50%, having tertiary formations and heights from 80 to 300 m above ambient river level. Due to the 'pacal' (*Guadua* sp), the area is not accessible, hence forestry is not practised, and soil sampling *in situ* was not possible.

Pacal (wild bamboo, *Guadua* sp), is the dominate vegetation in these areas, showing a marked contrast with the surrounding tree mass.

These cane communities are smaller than trees, usually reaching 20 m average maximum height, and maximum diameters up to 10 cm.

Tree species associated with the bamboo are listed in *Table 5.9*.

Table 5.9 ***Tree Species Recorded at SME-A***

Scientific Name	Common Name
Inga sp	Shimbillo
Pouruma sp	uvilla
Guarea sp	requia sp
Perebea sp	chimicua
Poulsenia sp	yanchama
Clarisia racemosa	mashonaste

In the zone of dense pacales, the estimated volume is about 10 trees /ha, and in the zones where there is a balance between canes and trees, there are about 50 trees/ha, with diameters from 10 cm at chest height (INRENA, 1996)

Soils

According to the studies performed by (ONERN 1987, 1990) in this zone, there are two Large Groups of soils: Dystropepts in 60%, and Troporthents in 40%, belonging to the INCEPTISOLES and ENTISOLES order, respectively. These soils are known locally as "Chenil", and "Maingo", respectively.

The soil sampling point is located on a hillside, approximately 600m south of the San Martín East well site, near the Camisea river. This soil belongs to INCEPTISOLES Order, Large Group Dystropepts and Sub Group Typic dystropepts, mainly developed on sandstone (refer to *Box 5.4*).

Box 5.4 ***Soils at San Martin***

This soil shows a genetic development, with a cambric horizon and ochric epipedon. It has a moderately coarse to coarse texture, and a yellowish brown to dark yellowish brown colour. Drainage is good to slightly excessive, having a moderately fast to fast permeability.

Chemically, it has a strongly acid reaction and its capacity of cationic exchange is from 4,01 to 4,65 cmol (p+) / kg of soil. Its exchangeable acidity is between 2,03 to 2,47 cmol (p+)/kg of soil, and the base saturation is less than 50%. The natural fertility is low. (Photo 1)

According to the potential primary use classification, this soil belongs to the F3se - Xse association, formed by Sub-class F3se in 60%, and Xse in 40%, and is suitable for forestry, (having a low agricultural quality), and for protection lands, as the area exhibits limitations due to soils and erosion.

Summary

Key physiographic characteristics of the well sites are summarised in *Table 5.10.*

Table 5.10 ***Key Physiographic Characteristics of the Well Sites***

Well site	Forest-type by physiography	Average Volume ($m^3 ha^{-1}$)	Number of trees/Ha
Pagoreni A	Forest of low hills, moderately dissected	102.00	79
Pagoreni D	Forest of high hills	115.00	82
San Martin	Pacal Forest - of high hills	n/a	10-50

Soil type and land use potential associated with each of the well sites is summarised in *Table 5.11.*

Table 5.11 ***Types of Soil and Land Use Potential of the Well Sites***

Drilling Wells Potential	Soil Types	Potential Land Use
Pagoreni A	Typic dystropepts	Forestry
Pagoreni D	Typic troporthents ("Maingo)	Protected lands
San Martín East	Dystopepts/Troporthents	Forestry and Protected lands

5.6.4 *Natural Vegetation*

Pagoreni

The vegetation of the area was classified according to physiognomic, physiographic, and floristic criteria. Ten different units, with varying concentrations of trees and pacales, were recorded. These are summarised in *Table 5.12* and described in *Appendix E1.* The Vegetation Units Classification (the Forestry Map) is presented as *Figure 5.3.*

Table 5.12 *Vegetation Units: Pagoreni Vicinity*

Forest-type	AREA	
	Ha	%
Forests of terraces	1,165.70	7.64
Forests of paca of terraces	558.56	3.66
Forests of low hills	4,082.18	26.76
Forests with pacas of low hills	1,509.46	9.90
Forest of high hills	1,662.92	10.90
Forests with paca of high hills	3,481.74	22.82
Pacal	1,406.37	9.22
Wooded areas, gorges and rivers	516.01	3.38
Agriculture	620.37	4.07
Islands and sandbars	251.38	1.65
Total	**15,254.69**	**100.00**

San Martin-East

The San Martin-East exploratory well site is located north of the Camisea river (east bank). The area supports two vegetation units (see *Figure 5.4*) which have been classified according to physiognomic, physiographic and floristic criteria, as follows.

- *Paca-tree forest with slight to moderate dissected high hills (BPCa1)*: this unit occupies approximately 1,179.27 ha, (48.39% of the total assessed area) on slopes ranging from 12 to 25% (slight) and from 25 to 50% (moderate). Soils supporting this kind of forest are moderately deep to deep and exhibit good drainage. Wild bamboo (paca *Guadua* sp) dominates 80% of this forest-type. According to ONERN's inventory (1990), forest species prevailing individually in this forest are as follows:

  - *Iryanthera* sp (cumala);
  - *Shizolobium* sp (pashaco);
  - *Tabebuia capitata* (tahuari);
  - *Virola* sp (cumala colorada);
  - *Cecropia* sp (cetico);
  - *Ficus* sp (oje);
  - *Sapium* sp (caucho masha);
  - *Copaifera* sp (copaiba).

  ONERN (1990) reports that this forest is considered as having a poor timber potential, with an average volume of approx. 35,16 m^3/ha and 23,50 trees/ha with diameters of 25 cm at chest height.

- *Paca-tree forest, with moderate to strongly dissected high hills (BPCa2)*:occupies 1,257,86 ha (51.61% of the total assessed area), on hills exhibiting angular tops with slopes showing surface soils exceeding in some cases 100%. As in the former unit, the forest has associations of paca trees (*Guadua* sp) dominating lower parts with some medium-size trees probably due to surface soils at the tops. This forest differs from the former by supporting a larger number of trees. According to CHEVRON's EIA (1995) this kind of forest had an estimated volume of 32.9 m^3/ha with 18.40 trees/ha of 25cm

diameter and above at chest height. Forest species developing in this association include:

- *Sapium* sp (aucho masha);
- *Brosimum alicastrum* (manchinga);
- *Clarisia racemosa* (mashonaste);
- *Tabebuia* sp (tahuari);
- *Cecropia* sp (cetico).

5.6.5 *Landscape Types at Pagoreni*

General

Two Landscape Groups occur with the area of the Pagoreni well sites;

- the Plain or *Alluvial Landscape*, which is primarily located at the banks of Urubamba and Camisea rivers;

- the *Hilly Landscape*, located in higher zones away from the river valleys.

These landscapes are described below and illustrated in *Figure 5.5*.

Alluvial Landscape

Topographically, the Alluvial Landscape exhibits a more or less flat relief with alluvial material associated with the main rivers (Camisea and Urubamba), and their tributaries. The material transported by the rivers is continuously deposited at their banks, giving place to different geo-shapes, formed by recent and sub-recent sediments from the quaternary.

This great landscape occupies an area of 3,810 ha, corresponding to 25% of the total assessed area. It is formed by three levels of fluvial terraces, which are differentiated by their altitude above the river level. The different degrees of erosion of the high terraces, represented by gorges and erosive courses, give way to gently undulating and dissected terraces. They usually present slopes from 0 to 20%.

Within the Alluvial Landscape, the following landscape units may be found.

- *Islands (Is)*:are located within the main bed of Urubamba river, covering a total area of 52.32 ha, (0.34% of the assessed area). These accumulated sediments are temporary. However, there are some other islands achieving some stability, but liable to temporary floods.

- *Sandbars (Py)*: Also named river banks, sanbars are located at both banks of the Camisea river and the Urubamba river. Most are temporary, disappearing during the river swell cycle. They occupy an area of about 199.06 ha, (1.30% of the total assessed area).

- *Low Terraces (TB)*:are mainly located at the banks of Urubamba river, being scarce near the Camisea river. They occupy an area of 673.25 ha, (4.41% of the total assessed) area. They are less than 5m in height. Some of them are

subject to annual flooding during the highest rainy season, whilst others are sporadically flooded. They correspond to land with flat topography with slopes of 0 - 4 %.

- *Medium Terraces (TM):*occupy an area of 1,430.46 ha (9.38 % of the total assessed area). They are usually flat with slopes from 0 to 8%. They vary from the low terraces due to their higher altitude above the river. As such they are rarely flooded and reportedly present good drainage.

- *High Terraces (TA):* onstitute land formations with altitudes above 30m. They occupy an area of 652.03 ha, (4.72% of the total assessed area). They are formed by more ancient sediments, showing reliefs with slopes from 2 to 12%. Due to the degree of erosion and dissection, they are differentiated further in: Wavy high Terraces (Tao), with slopes from 4 to 15%, occupying an area of 299.06 ha. and located in the South-West of the Block; and in dissected High Terraces (Tad), whose relief reaches slopes from 4 to 20%. They occupy an area of 244.36 ha, (1,60% of the assessed area). Additionally, they are differentiated by talus (Td), occupying an area of 258.31 ha, (1.69% of the assessed area). These are geo-forms with a strongly inclined to steep reliefs. Their topographic characteristics show they are highly erosive.

Hilly Landscape

The study area is dominated by the Hilly Landscape. The hilly topography of this area exhibits slopes between 10 to 70%, sometimes reaching more than 75%. The landscape is made up by geoforms which vary between 20 m, and 300m. Some of the geoforms originated from denudation, and others are residual matter from the continental tertiary characteristic of the structural hills. Lithologically, they are formed by sandstones, silstones, clays, and shales. The origin of these areas are related to orogenic (mountain formation) movements, and to the action of hydric erosion, which together with the difference of altitude and to the dissection variable degree, give place to low hills, high hills, small highlands (lomadas), interhilly valleys, etc. The Hilly Landscape Group occupies an area of 10,929 ha, equivalent to 71.5% of the assessed area. Within the Hilly Landscape, the following landscape unit may be found.

- *"Lomadas" (CL) (Small Highlands)* The "lomadas" have a denudational origin, with slopes between 8 to 25%, and exhibit weak drainage network. The current erosion in the lomadas is not very obvious due to their surface slope and dense vegetation cover. They occupy an area of 420.58 ha, (2.76% of the total assessed area).

- *Bare Low Hills (CbD)* occupy an area of 5718.47 ha, (37.51% of the total assessed area). These hills are shaped by erosive processes, giving place to river beds and gorges, originating the so-called bare hills, not higher than 80 m. Based on the dissection degree, the following elements of landscape are identified:

  - *Slightly dissected bare low hills (CbD1):* occupying an area of 1816. 54 ha (11.92% of the total assessed area). Relief exhibits small gorges and

streams formed due to a slight hydric erosion. The slopes vary from 15 to 40%. Their distribution in the area is very scattered.

- *Moderately dissected bare low hills (Cbd2):* occupying an area of 3223.10 ha. They present a relief with slopes varying from 30 to 50%, originated by moderately deep beds or gorges, but of a constant erosive action, giving place to greater and deep gradients characteristic of cliffs. Morphologically, they vary in accordance with their lithology. They are formations from the tertiary, distributed in an aligned way along the structural hills.
- *Strongly dissected bare low hills (CbD3):* occupying an area of 678.83 ha. The high density of the drainage networks with slopes from 30 to 70%, caused by the increasing inclination of the slopes, give place to surfaces typifying the relief of these hilly formations.

- *Structural High Hills (CaE)* occupy an area of 4622.19 ha, (30.30% of the total assessed area). In this hilly region, sandy-shaly formations are predominant, as indicated by the presence of moderately resistant sandstones and shales. These are structurally aligned and mainly East-West oriented, following the general course of the Abancay deflection, such as seen to the north of Camisea river. They present a differential erosion shaping, with prominently edged tops, and slopes between 40 to 75% or more, where the fluvial network has been influenced by tertiarian structures, causing slopes with strong dissections. The inter-hilly small valleys (Vc) are found between the hilly slopes, occupying an area of 167.79 ha, (equivalent to 1.10% of the total assessed area). They are associated with the low hills and to the structural hills, and are originated by the rainfall action, which constantly erodes the hills slopes, forming inter-hilly depressed zones, and therefore small valleys with a more or less flat bottom, and others V-shaped valleys.Landscape units around Pagoreni are summarised in *Table 5.13*.

Table 5.13 ***Landscape Units Within Pagoreni***

Landscape Unit	Symbol	Area	
		ha	%
Alluvial Landscape			
• Islands	Is	52.32	0.34
• Sandbars	Py	199.06	1.30
• Low Terraces	TB	673.25	4.41
• Medium Terraces	TM	1430.46	9.38
• High Terraces	TA	652.03	4.27
• Wavy High Terraces	Tao	299.86	1.96
• Dissected High Terraces	Tad	244.36	1.60
Hilly Landscape	CL	420.58	2.76
Small Highlands (lomadas)			
• Slightly Dissected bare low hills	CbD1	1816.54	11.92
• Moderately Dissected bare-low-hills	CbD2	3223.10	21.13
• Strongly dissected bare-low hills	CbD3	678.83	4.46
• Structural high hills	CaE	4622.19	30.30
• Inter-hilly Valleys	Vc	167.79	1.10
• Talus	Td	258.31	1.69
ANTHROPIC AREAS, RIVERS & GORGES		516.01	3.38
Total		**15254.69**	**100.00**

Landscape Types at SME-A

Two landscape units occur within the area of the SME-A well site (and are illustrated in *Figure 5.6*).

- *Slightly to moderately dissected bare high hills (CaD1):* They show a relief with slightly edged tops, and slopes from 15 to 50%. Its surface shows moderately deep gorges and streams. This unit occupies an area of 1165.21 ha (47.81% of the area).

- *Moderately to strongly dissected bare high hills (CaD2):* These present a more uneven relief., the edged tops have slopes from 35 to 75%, and longer, forming a more dense joint of drainage networks and water courses. This unit occupies an area of 1,257.86 ha (51.61% of the total area).

These physiographic units have been developed on tertiary formations where the denudational processes have caused dissections of a variable density due to the presence of lithic material of a different nature. Likewise, gorges have been identified, some of which are dry. They occupy an area of 28.12 ha (1.15% of the total assessed area).

Table 5.14 summarises the units within the San Martin area.

Table 5.14 ***Physiographic Classification of SME-A***

		Area	
Physiographic Unit	**Symbol**	**ha**	**%**
Slightly to Moderately Dissected Bare High Hills	CaD1	1165.21	47.81
Moderately to strongly dissected bare high hills	CaD2	1243.80	51.04
Gorges		28.12	1.15
Total		**2437.13**	**100.00**

5.6.6 *Description and Classification of the Soil Units*

Overview

Soil units have been described and classified according to the Sub-order taxonomic unit. The soil map has been prepared according to soil sub-groups. Physiographic position and slope have also been considered as phases in the mapping process.

Soil Units: Pagoreni

The soil units located within the study area (refer to *Figure 5.7*) are distributed into ten co-associations and two associations of soils. The units are described in *Appendix E2*; soil taxonomy is summarised in *Table 5.15* and soil units are listed in *Table 5.16*.

Table 5.15 ***Soil Taxonomy***

Soil Taxomony (1994)				
Order	**Sub-Order**	**Large Group**	**Sub-Group**	**Soil**
ENTISOLS	FLUVENTS	TROPOFLUVENTS	TYPIC TROFLUVENTS	Sensa Mashiteri

	ORTHENTS	TROPORTENTS	TYPIC TROPORTHENTS	Huitiricaya Maingo
INCEPTISOLS	TROPEPTS	DYSTROPEPTS	FLUVENTIC DYSTROPEPTS	Miaria Huacaroya Pishite
		DYSTROPEPTS	TYPIC DYSTROPEPTS	Chilichileja Cheni Pagoreni

Table 5.16 ***Soil Units Recorded Within the Pagoreni Study Area***

					Area	
Soil Units	**Symbol**	**Proport. %**	**Physiographic Units**	**Slope %**	**Ha**	**%**
Co-association						
Mashinteri	Ma		TB,Is	0-4	111.02	0.73
Huitiricaya	Hu		TB	0-4	151.88	0.99
Sensa	Se		TB	0-4	462.67	3.03
Miaria	Mi		TM, TA, Tao	0-15	1761.28	11.54
Pishite	Pi		TM	0-4	457.45	3.00
Huacaroya	Hc		TM, TA	0-4	162.85	1.07
Pagoreni	Pg		Tad	8-25	244.36	1.60
Chilichileja	Cl		C1,CbD1,CbD 2,Cv	8-50	3175.67	20.83
Cheni	Ch		CbD2	15-50	2453.11	16.08
Maingo	Mg		Td	12-50	258.31	1.69
Association						
Cheni-Maingo	Ch-Mg	60-40	CbD3	25-75	678.83	4.46
Maingo-Miscellaneous	Mg-M	70-30	CaE	50-75	4622.19	30.30
Miscellaneous Areas					199.06	1.30
Anthropic Area, Rivers, Gorges					516.01	3.38
Total					**15254.69**	**100.00**

Soil Units: SME-A

Two soil taxonomic units have been established in the San Martín East study area. They are made up by Large Groups of soils (Soil taxonomy, 1994), and are cartographically distributed in two associations. This cartographic unit includes lithic outcrops, non-edaphic units deemed as miscellaneous areas. Phase by physiography and slope have been established.

Soils identified in the San Martín East area are described in *Appendix E3,* summarised in *Table 5.17,* and illustrated in *Figure 5.8.* The soil units indicate the following associations.

- Cheni-Maingo (ChMg). Formed by Cheni soil (60%), and Maingo soil (40%). Located in slightly to moderately dissected bare high hills, with steep slopes.

- Cheni-Maingo-Miscellaneous (Ch-Mg-M). Formed by Cheni soil (50%), Maingo soil (30%) and lithic outcrops (20%). Located in moderately to strongly dissected high hills, with very steep slopes.

Table 5.17 *Soils in SME-A Study Area*

Soil Units	Symbol	Proport. %	Physio-graphic Units	Slope %	Area Ha	Area %
Association						
Cheni-Maingo	Ch-Mg	60-40	CaD1	15-50	1165.21	47.81
Cheni-Maingo-Miscellaneous	Ch-Mg-M	50-30-20	CaD2	25-75	1243.21	51.04
Gorges					28.12	
Total					**2437.13**	**100.00**

5.6.7 *Classification of Lands by Potential Primary Use*

General

Using information relating to the soils, landscape and vegetation of the study area, it is possible to establish optimum land use potential, whether for agricultural, livestock, forestry, or protection use; as well assessing the management and conservation practices required to avoid their deterioration.

Pagoreni

The assessed area is mainly formed by lands suitable for:

- forestry production, covering 5860.78 ha (38.42% of the area);
- protection lands, covering 5518.88 ha (36.18% of the area).

A description of potential primary land use is presented in *Appendix E4*, summarised in *Table 5.18* and illustrated in *Figure 5.9*.

Table 5.18 ***Land Classification According to Potential Primary Use: Pagoreni:***

Group			Class			Sub-Class		
	Area			Area			Area	
Symbol	Ha	%	Symbol	Ha	%	Symbol	Ha	%
A (Clean cultivation)	758.75	4.97	A2	262.90	1,72	A2si	262.90	1.72
			A3	495.85	3,25	A3s	495.85	3.25
C (Permanent Cultivation)	1057.31	6.93	C3	1057.31	6,93	C3s	1057.31	6.93
P (Pasture)	1542.76	10.11	P3	1542.76	10,11	P3s	738.80	4.84
						P3se	803.96	5.27
F (Forestry)	5860.98	38.42	F1	526.51	3.45	F1se	526.51	3.45
			F2	5334.47	34.97	F2se	5334.47	34.97
X (Protected Lands)	5518.88	36.18				Xse	5518.88	36.18
Subtotal							14738.68	96.62
Anthropic areas, rivers and gorges							516.68	3.38
Total							**15254.69**	**100.00**

Two groups of potential primary use have been identified in this zone. They are distributed in one co-association, and in one association.

- *Lands suitable for forestry (F).* The land occupies 699.13 ha (28.69% of the total assessed area). Due to limitations, the land is not considered suitable for clean cultivation, permanent cultivation or pasture.

  - *Class F3.* Lands suitable for forestry, with a low agricultural quality. The following sub-class has been identified.

  - *Sub-Class F3se.* These lands show edaphic and erosional limitations. They are soils with a low natural fertility. Taking into account the environmental conditions in which they have developed, suitable programs for forestry exploitation are required, emphasising on soil preservation. They are found in slightly to moderately dissected bare high hills, and include Cheni and Maingo soils.

- *Protection lands(X).* This land use occupies 1709.88 ha (70.16% of the total assessed area). They are considered as lands not suitable for agriculture, nor for permanent, grazing and forestry production. They are exclusively useful to protect hydrographic basins, wildlife, etc. This group of lands is predominant in the zone, so any intervention requires programs to control soil erosion and to preserve vegetation. They are found in slightly to strongly dissected high hills, and include Cheni and Maingo soils, as well as miscellaneous areas. Due to their edaphic factor limitations and to erosion risks, sub-class Xse has been identified.

Potential land use in the SME-A study area is summarised in *Table 5.19* and illustrated in *Figure 5.10.*

Table 5.19 ***Potential Primary Use of SME-A Zone***

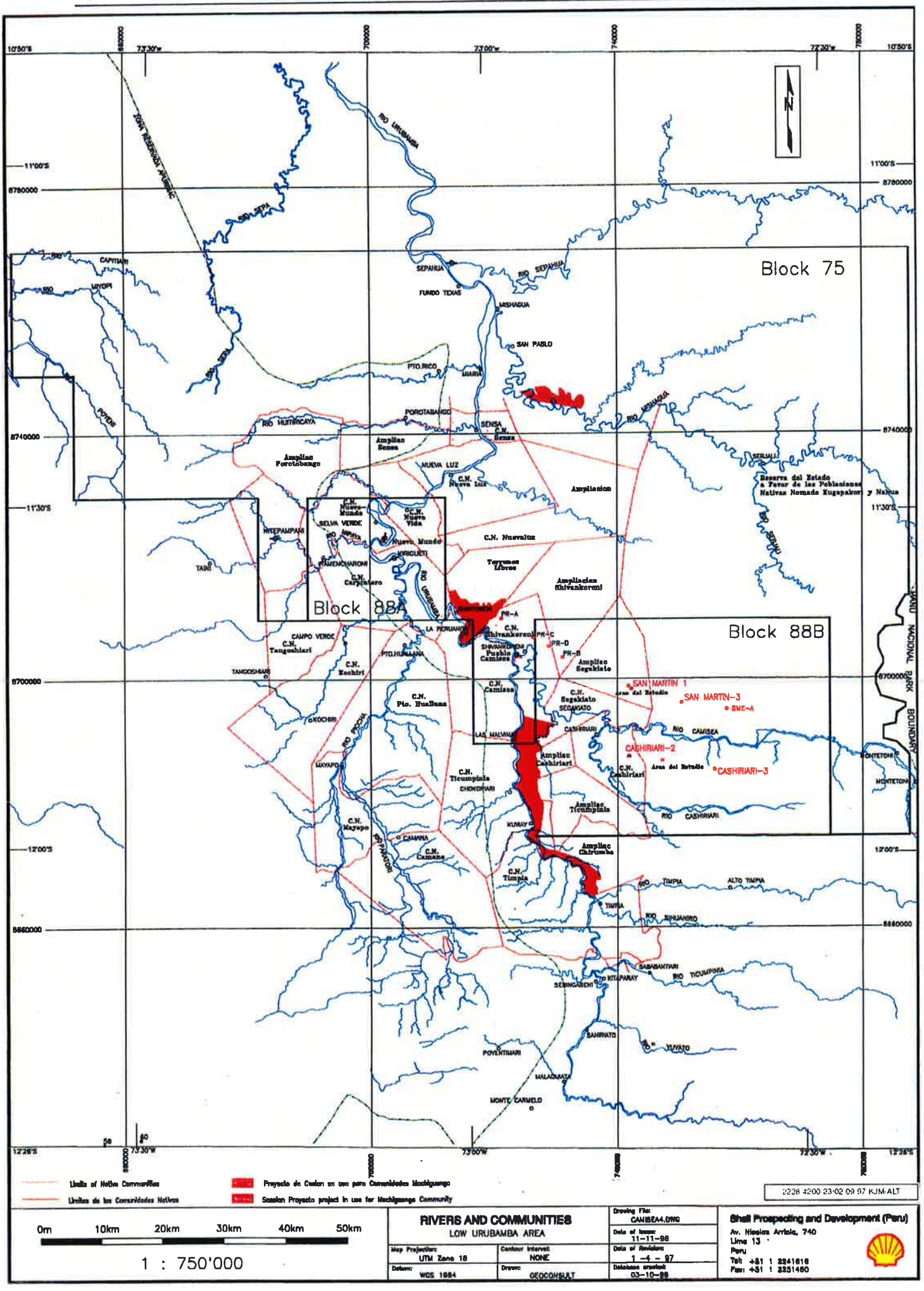
Group %	Class	Sub-Class	Physiographic Unit	Slope %	Soils Included	Area (Ha)
Association F-X 47,81	F3	F3se-Xse	CaD1	15-50	Ch,Mg	1165.21
Co-association X 51,04		Xse	CaD2	35-75	Ch,Mg,M	1243.80
Gorges1,15						28.12
Total					**2437.13**	**100.00**

5.7 HYDROLOGY, SURFACE WATERS AND GROUNDWATER

5.7.1 General Description

Figure 5.11 shows the main rivers, streams and hydrological features of the Study Area.

Figure 5.11 *Map of the Native Communities and Hydrology.*



5.7.2 *Hydrology*

The Study Area is characterised by a complex network of streams and rivers of different orders. In most cases, streams near the well sites are 1st-order (the Cashiriari and Camisea Rivers appear to be 3rd-order streams; the Urubamba River is a 4th-order stream). An exception is the existing Cashiriari-1 wellsite, reported to be 4-hours walk to the nearest stream, and Cashiriari-2, which is within 300 m of Kuitaparayeari Creek, a 2nd-or possibly 3rd-order stream.

During the April 1996 field survey, streams were turbulent and fast, with 3rd-order streams (Cashiriari and Camisea Rivers) flowing between 1 and 1.5 ms^{-1} and the Urubamba flowing between 2 and 3 ms^{-1}. At flood stage, the Urubamba is reported to flow between 2.3 and 3.7 ms^{-1}, this latter figure being in the range of extremely rapid but not yet ultra-rapid, when air entrainment introduces instability. Numerous rapids and stationary waves were observed. During the field survey in the higher reaches of the Camisea River the boat had to be off-loaded and dragged through shallow water.

Despite the quality of most 1st-order streams being obscured by moderate turbidity, their biological condition was otherwise good. All streams supported populations of fish, insects, and other creatures. The clarity of rivers upstream of the Urubamba generally increased with increasing stream order; downstream of the Urubamba, the situation became reversed as stream transparency decreased. Turbidity is seasonal, so that during the dry season the rivers are reported to run shallow and clear. This feature is enhanced by the appearance of point bars and riffle-pool sequences, which occur at meanders or at spacings of 7-8 channel widths. During the dry season they separate the stream profile into a series of shallow, slow flowing ponds into which suspended sediment would settle.

Third and fourth-order streams appear to be widening, probably best expressed as an increase of width-depth ratio with a likely, concomitant decrease of channel depth. Knighton (1984) describes how variations in the discharge of suspended sediment and bed material load can induce changes in such characteristics as channel width, meander wavelength, and channel slope. One result is the undercutting and collapse of river banks accompanied by their subsequent delivery of fine to large-sized sediment directly into channels. Cobble and boulder-sized materials appear to deposit in the mid-channel of long, straight reaches and at point bars at bends and turns. Both locations serve to direct flows against the banks, which they undercut; both serve to increase the difficulty of navigation.

5.7.3 *Water Quality*

General

Surface water quality, sediment and benthic monitoring were conducted as part of the field evaluation for the well sites in Pagoreni and SME-A. Over 16 sampling stations were monitored mainly in the mainstream of the Camisea and Urubamba rivers and numerous smaller tributaries of the study area. The exact location of the sampling stations are presented in *Appendix F1*.

At each sampling station, physical-chemical parameters were recorded to characterize current environmental conditions such as temperature, conductivity, pH and dissolved oxygen. Water samples were hand collected using a one liter container to draw subsurface water into corresponding sample bottles. The field sampling procedures, containers, and sample preservatives followed specifications on analytical methods presented in APHA, (1989), and subcontractor laboratory field manual (Envirolab, 1995). All analytical methods followed EPA 600/79-020 and Standard Methods (APHA, 1989). A complete description of sampling stations with their corresponding physical-chemical characteristics are provided in *Appendices F1* and *F2*.

Results

The analytical results obtained from field samples analysis indicate an overall good water quality at the monitored locations comparable with previous water quality surveys conducted in the region (*ie*, ERM, 1996) . Results obtained during the field study are commented by sample type indicating for every case the significance of the analysed parameter in the overall water quality condition of the study area.

Surface Waters

River and stream conditions in the area appeared within normal range regarding the monitored parameters. The surface water color and flow were consistent with characteristics of white waters rivers, where the amount of suspended solids develops a range of water color from whitish to clayish, depending on the season of the year (*eg*, rainy or drier periods). At large, surface water bodies in the Camisea and Urubamba region are fast moving, with flows from 1.5 to 2.5 ms^{-1}.

Physico-chemical Parameters

The monitored field parameters indicate acceptable range for biological activities of aquatic fauna in all sampled stations. Dissolved oxygen recorded during the field study ranged from 7.9 to 9.0 mgl^{-1}, indicating well oxygenated surface waters. Only the sample from the Shivangoreni creek (Station 11) located east of the village showed annoxic conditions with readings of dissolved oxygen below 1 mgl^{-1}. This sample was collected early in the morning (07:00) which could explain the low D.O. readings (ie, the aquatic vegetation consume oxygen during the dark phase of photosynthesis). The stream at sampling time had very little flow. Abundant organic waste mostly domestic garbage was observed in the creek by the field crew.

The pH readings during the field sampling ranged from 7.9 to 8.8, indicating a tendency toward the alkaline side of the pH scale in agreement with the basic nature of the limestone and sandstone bedrocks present in the region (ONERN, 1988). The lowest pH reading was recorded also in Shivangoreni creek (6.2) possibly due to the heavy organic load of this small body of water that undergoes cycles of build up and decomposition generating an increase of organic acids (ie, humic or fulvic acids).

Water temperature measured at the sampling stations ranged from 24.5 to 28.6 °C, whereas the ambient temperature was typically one degree higher between 25.0 to 29.0 °C. The variability among station readings were attributable to shade and canopy effects. Stations in deep valleys surrounded by abundant riparian vegetation are cooler than stations located in open spaces at similar time of the day.

Inorganic Salts

The levels of inorganic salts in water are measured by the readings of the dissolved solids (*ie*, total and suspended), conductivity, and chlorides. Turbidity of the surface water sampled was evident in over 60% of the monitored stations, and total dissolved solids in corespondance were >100 mgl^{-1}. Similarly, conductivity readings at sampling time were > 150 μScm^{-1}, indicating a direct correlation with the amount of suspended particles in the water. Most of the observed particles were clayish in color originated from surface runoff, this was particularly evident in the Camisea River near the docking area of the Shivangoreni Community were a brownish tint colored the water for several days.

Chlorides, on the other hand, were very low. Registered values were < 10 mgl^{-1} in all sampled stations, reflecting conditions of areas with limited chloride sources and absence of any produced waters discharges.

Silicates

A continuous weathering processes of sedimentary rocks (*eg*,sandstone and limestone) are likely to be the main source of silicates in surface water. The measured range varied between non-detectable (ND) in small creeks to up to 25.2 mgl^{-1} in the larger rivers. Silicates are the main source of silica ion which are abundant in some formation waters. The reported levels of silicates here are low (*ie*, average 15.2 mgl^{-1}) and are consitent with the geological makeup of the lower Urubamba region.

Nutrients

Surface water nutrients measured included Phosphate, Nitrates, and Ammonium Nitrogen. In agreement with tropical conditions there is negligible amounts of nutrient available in the water, since the rainforest nutrient cycle forms a close loop that traps all the available sources of these essential compounds. The range of analyzed Phosphate was from 0.03 to 0.15 mgl^{-1} and Nitrate ranged from non detectable (ND) to 0.23 mgl^{-1}. Nitrogen ammonium in the sampled stations ranged from non-detectable to 0.01 mgl^{-1}. The nutrient parameters are also indicators of agricultural runoff and organic eutrophication, specially in the rain forest where the background levels for nutrients is almost nill. The obtained results show good environmental conditions and the absence of organic pollution in the study area.

Total Petroleum Hydrocarbons

Analyses by Gas Chromatography applying USEPA (California modified) method 8015, to measure amounts of diesel range (C14 -C20) hydrocarbon in

surface water samples from the study area did not reveale measureable levels of petroleum hydrocarbons. All surface water samples analyzed were below detection level (*ie*, 0.5 mgl^{-1}) indicating uncontimated conditions in regard to hydrocarbons at the stations sampled.

Trace Metals

Heavy metals analyzed during the study included barium, aluminum, lead, mercury, cadmium, copper and zinc. The analytical results indicate non-detectable levels of these heavy metals with the exception of zinc. Measured zinc levels ranged from 0.01 to 0.13 mgl^{-1} , although these values are below the acceptable drinking water levels (the *Ley General de Aguas* establishes 5 mgl^{-1} as the maximum zinc level for drinking water in Peru) they may have biological significance. The EPA red book (Thurston *et al*, 1979) indicates that the protection zinc levels for aquatic biota must be less than 0.01 mgl^{-1}. However, this concentration is subject to local background conditions and water hardness. Based on observed conditions of the sampling stations, it is likely that baseline zinc levels are higher in the region as a result of the mineralogical characteristic of the Urubamba and Camisea watersheds (ONERN, 1988).

Sediments

In order to characterize sediment conditions regarding key environmental parameters such as trace metals, organic matter, and hydrocarbons, selected stations were sampled for sediment analysis. The chosen stations were those from smaller streams with depths less than 1.5 m and moderate flows between 0.5 to 1.0 ms^{-1}. A total of 12 stations were sampled for sediment analysis. The samples were scooped *in situ* with a stainless steel through retrieving approximately 500 g of fresh sediment. The samples were kept with on-site water and maintained as cool as possible before analysis. The applied sampling methodology allowed for only discrete screening of sediment conditions, since no sample replicates were collected for statistical inference. The transit period of these samples from the field to sub-contractor laboratory was less than 8 days. Analytical procedures followed standard water procedures (APHA, 1989) unless otherwise indicated.

Contrary to the surface water samples there were positive readings of TPH in the sediment samples analyzed. Five samples, one from the Camisea River and four from smaller creeks, presented hits of hydrocarbons with a range from 30 to 150 $mgkg^{-1}$. These levels indicate that possible non-source pollution at random scale occurs in the area, likely due to outboard engines traffic or careless fuel handling. Evidently, any small spill of fuel or oil remains bound in the sediment and apparently does not leach to surface waters. All the stations were sampled for surface water TPH analysis without obtaining a single hit.

Levels for organic matter in sediments were low in all samples (< 2.7 mgl^{-1}). The sediment samples on small creeks were higher compared with major rivers. The contribution of organic sources are limited to the falling vegetation along the water course, nonetheless water flow fluctuations of the system (*ie*, heavy downpour and dry spells in short amount of time) hamper

establishment of detritivorous organisms and therefore completion of an organic matter cycle.

Trace metals in general were also below detection limits (*eg*, mercury, cadmium, and lead). In contrast, zinc, aluminum, copper, barium and iron were in high concentrations in most of the sediment samples, reflecting parent material deposition rich in clay minerals likely illite or montmorillonite (Hounslow, 1995). Zinc ranged from 30.0 to 49.0 $mgkg^{-1}$; copper ranged from ND to 17.8 $mgkg^{-1}$; barium ranged from ND to 62.9 $mgkg^{-1}$; aluminium ranged from 0.5 to 0.8 %; and iron from 1.4 to 2.0 % respectively. The mineralogical analysis of soil samples, previously reported by ONERN (1988) indicates higher levels (> 20%) of the above metals, this indicates the mineral potential of the region.

The sediment samples were also analyzed for Redox Potential (Eh) to determine the reducing or oxidizing capability of the sediment system. This parameter indicates how Redox reactions will occur and how easy or difficult free metal ions could be released into solution. Redox potential values ranged from -59 to +303 mv emcompassing reducing conditions in Shivangoreni creek to oxidizing ones in the Armihuari creek station. Inference of potential release of mineral species under those conditions are a function of pH and carbonate levels in sediment interstitial and surface waters. Both conditions in the analyzed samples suggest that the sediment system is rich in CO_3^{-2}, where the metal ions such as iron will tend to remain bounded to organic compounds or mineral complexes in the sediment.

To estimate sediment particle size. The selected samples were screened through estandar mesh series (Buchanan, 1971) indicating that the predominant particle diameter of the samples ranges from medium to fine sand (0.4 to 0.2 mm) particle size. Although in the Urubamba and Camisea rivers is common to find large boulders and cobbles, the smaller streams tend to have finer sediment from the sandstone and limestone runoff.

5.7.4 *Hydrogeology*

Background

As part of the Environmental Impact Assessment, Water Management Consultants (Peru) S.A. (WMCSA) completed a desk study of subsurface hydrogeological conditions within the vicinity of the well sites.

Sources of information used in the desk study are listed in *Table 5.20*

Table 5.20 ***Sources of Information***

Organisation
Servicio Nacional de Meteorologia e Hidrologia (SENAHMI)
Ministerio de Energia and Minas
Ministerio de Agricultura
Ministerio de Salud Publica
Direccion General de Salud Ambiental

Organisation
Instituto de Recursos Naturales (INRENA), Ministerio de Agricultura
Peru Petro
Instituto Geografico Nacional.

Key references used in the desk study are listed in *Table 5.21*.

Table 5.21 ***Key References***

Information collected
Estudio del potential de los recursos naturales de la zona del Rio Camisea, February 1967, Republica del Peru, Oficina Nacional de Evaluacion de Recursos Naturales (ONERN).
Reconocimeinto de los recursos naturales bel Curso medio del Rio Urubamba, 1964, Republica del Peru, Oficina Nacional de Evaluacion de Recursos Naturales (ONERN).
Inventario y evaluacion de los recursos naturales del medio y bajo Urubamba (reconocimiento), 1987, Republica del Peru, Oficina Nacional de Evaluacion de Recursos Naturales (ONERN) y La Corporacion Departmental del Cuzco.
Map sheet Camisea, Peru 2347 (24-q).

Related information, concerning climate, geomorphology and hydrology, is presented in *Sections 5.4, 5.6.2* and *5.7.2*, respectively.

Precipitation Infiltration

Relatively high rainfall, especially over the wet season months, contributes to surface water runoff and stream flow in the catchment areas flowing under gravity to lower elevations. During the wet summer months, existing flows increase significantly whilst other valleys, previously dry during the dry season months, may begin to flow. A proportion of the precipitation that reaches the land surface infiltrates to the subsurface and is transported under unsaturated or saturated flow conditions. The proportion of precipitation that infiltrates and contributes to the subsurface hydrological system depends on the nature of the rainfall event and pattern, the ground surface cover, and topography.

Factors such as the rainfall event intensity and duration are important in the infiltration mechanism. Low-intensity rainfalls of long duration, rather than high-intensity of short duration, increase the proportion of rainfall contributing to infiltration. During the wet season, infiltration can probably be considered constant with a decline in infiltration occurring at the end of the season. When the ground surface has an opportunity to dry out during the dry season, infiltration is minimised. Upon commencement of wet season rains, a soil wetting process occurs until a steady state flux is again attained.

The nature of the ground surface and its ability to infiltrate water is an important consideration in the estimation of precipitation infiltration. Low permeability soil cover is not conducive to infiltration and evaporation and runoff condition will prevail. Steep slopes also promote runoff and limit infiltration. In the Camisea region, heavily vegetated terrain implies that evaporation and evapotranspiration processes (system losses) are significant components in the overall hydrological cycle.

Groundwater Movement

Steep slopes, high rainfall on low permeability, vegetated slopes in the Pagoreni/San Martin district all suggest that infiltration and contribution to subsurface hydrology is limited (roughly estimated at 5 to 10 percent of total precipitation). Infiltration and recharge on upper catchment areas predominantly is transported as interflow in the upper soil horizons and high permeability bedrock zones before being discharged in topographic lows such as valley bottoms. The contribution of precipitation infiltration to deeper system recharge and through flow is considered minimal.

Deeper system groundwater occurrence and flow is controlled by the presence and nature of rock mass fracturing. It is generally considered that, although groundwater velocities may be high in fractured media, the porosity is usually low (about 1 to 5 percent). Rock mass fracturing and fracture porosity usually decreases with depth in response to higher rock mass pressures encountered. Development of deeper system fracturing and aquifer systems is dependent on the specific lithological and geological structure conditions. Bedrock faulting creates high permeable pathways parallel to the fault plane and low permeability barriers perpendicular to the fault plane.

Groundwater Quality

With depth, throughflow is much less and residence times of groundwater are much longer which is reflected in groundwater quality. Longer periods of groundwater - rock interaction can produce highly mineralised waters with very high dissolved ion concentrations that could be described as brines. Cross contamination of aquifers with markedly different water chemistry characteristics is an issue to be addressed in well drilling, testing and abandonment operations.

Principal Hydrostratigraphic Units

The principal hydrostratigraphic units are described as follows.

- *Fluvial-alluvial deposits (Quaternary age).* Superficial deposits of alluvial sands and gravels are found lining valley bottoms and typically have a thickness no greater than a few tens of meters. Typically these deposits are poorly sorted and may show lateral and vertical variability with the development of lenses and layers of different hydraulic properties. Intrinsic permeabilities of these deposits are usually at least an order of magnitude above *in situ* rock mass material.

- *Red Bed Formation (Tertiary sandstones).* Tertiary sandstones of the Huayabamba Group dominate the surface geology in the area of the well sites. Commonly called the Red Bed formation, this sequence of consolidated continental deposits is interpreted to be in the order of 500 to 700 m thick and deposited conformably on underlying Upper Cretaceous rocks. Lithologically, the formation consists of layers of claystone, siltstone and sandstones and primary permeability is interpreted to be low. The consolidated nature of the rock units means that the development of secondary permeability of faults and fractures would control groundwater occurrence and flow. Where sufficient continuous fracturing of the rock mass occurs it is anticipated that permeabilities will be enhanced and groundwater throughflow and storage will be greatest.

- *Vivian Formation (Upper Cretaceous).* Consisting predominantly of quartz arenites the thickness of this sequence ranges from 60 to 200m. The sandstones are reported to be gas-bearing indicating some primary permeability and storage characteristics. The Vivian Formation is transitional with the underlying Chonta Formation of Middle to Upper Cretaceous age (ONERN, 1987).

- *Chonta Formation (Middle to Upper Cretaceous).* This Formation consists of a sequence of calcareous claystones and shales of at least 300 m in thickness. Some coarsening in texture towards the base of the sequence may suggest enhanced primary permeability in this zone.

- *Nia Formation, Shinai Formation, (Lower Cretaceous).* This Formation is composed of fine-grained quartz sandstones of littoral zone origin with an estimated thickness of 200 m. It has, however, been noted to reach up to 1,300 m in thickness (ONERN, 1967). The Nia and Shinai formations are reported to be gas-bearing.

5.7.5 *Aquatic Ecology and Fisheries*

General Aquatic Habitats

The rivers of the Study Area are of the white-water variety: high in suspended sediments but low in nutrients and organic matter and with a neutral pH. These rivers form depositional areas and may be direct, meandering or braided depending on the topography. The main river of the area, the Urubamba, does have a distinct floodplain and forms meanders, at least downstream from Camisea. Upstream from Camisea, the Urubamba is more of a montane river with rapids and waterfalls. Other rivers of the Study Area are also white-water type but have less well developed floodplains.

There are probably few water courses of the black-water variety (acidic, high in humic and fulvic acids, extremely low in suspended solids) except for smaller streams draining localised 'aguajales' or sandy sections. The deeply dissected 'colina' topography of this region suggests that surface water flow occurs in low-volume (except during rains) 'quebradas'. 'Cochas', the Amazon oxbow lakes, are extremely common along lowland rivers in the Amazon basin. The high flows, erodible sediments and wide, flat floodplains assure extensive meandering creating wholly or partially closed off oxbow

lakes. At low river flows, they can be wholly or partially stagnant but at higher flows are subject to periodic inflows or flooding from the associated rivers. In the Study Area, 'cochas' may be associated with the main rivers but due to the fractured and relatively steep topography they are probably not common. Wherever they are present, cochas and lagoons constitute an important resource as breeding grounds for fish and wildlife.

Fish

Fish have outstanding importance in the nutrition and economy of the native and immigrant populations in the Peruvian Amazon. Some reports (GEMA 1993) indicate that up to 70% of the protein consumed comes from fish, suggesting that fishing is an important activity for many of the native communities and this was borne out in consultations with local communities in the Study Area.

Important food species of the Peruvian Amazon region are *Arapaima gigas* ('paiche'), *Colossoma macroponum* ('gamitana'), *Brachyplatostoma filamentosum* ('dorado'), *Brachyplatystoma juruense* ('bagre grande'), *Pseudoplatystoma tigrinum* ('tigre zúngaro'), and *Pseudoplatystoma fasciatum* ('doncella'), all of which have experienced serious decline in more heavily populated areas outside the Study Area (Pulido, 1991). Many other species of common fish are also harveastd, such as *Brycon* sp. ('sábalo'), *Leporinus* sp. ('lisa'), *Mylossoma aureum* ('palometa'), *Astyanax* sp. ('mojarra'), and others.

An additional fish resource in the Amazon region is the enormous diversity of small, decorative fish species that are sought after by tropical fish enthusiasts. To date 736 fish species have been identified in the Peruvian Amazon but it is estimated that the true total may exceed 1000 (Pulido, 1991). Many of these species are small, endemic, decorative, and potentially conomically valuable tropical fish species.

In the Study Area, the relative lack of flooded wetlands and lagoons may diminish the abundance of fish resources except in the Urubamba floodplain. Many of the species mentioned above occur or dominate in open rivers so they may be expected to be found in the Camisea, Cashiriari and Urubamba Rivers. Their importance in the local economy may still be significant. A list of some important fish species reported to be used for native community consumption in the study area is presented in *Table 5.22*.

Table 5.22 ***Fish Species Reported in the Study Area as Important for Local Consumption. (Species name from ONERN (1988) and Ortega (1994)).***

Species	Common Name	Family	Relative Abundance
Brycon sp.	Sábalo	Characidae	High
Astyanax fasciatus	Sardina	Characidae	High
Astyanax sp.	Mojarra	Characidae	High
Colossoma macrocarpum	Paco	Characidae	Moderate
Hoplias malabaricus	Fasaco	Erythrinidae	Moderate

Species	Common Name	Family	Relative Abundance
Brachyplatystoma juruense	Bagre	Pimelodidae	Moderate
Bujurqina sp.	Bujurqui	Cichlidae	High
Crenicichla sp.	Bujurqui	Cichlidae	High
Pseudoplatystoma fasciatum	Doncella	-	High
Leparinus sp	Lisa	-	High
Mylossoma aureum	Palometa	-	High

Benthic Fauna

Simultaneously with sediment sampling collection at few stations, a split sample was analyzed for benthic fauna. This preliminary sampling was done in order to provide a qualitative indication of main benthic groups occurring in the study area. The analysis shows poor benthic fauna in these streams since the amount of organic matter available for benthic fauna was also reduced. This low availability is not because of the lack of detrital material, on the contrary, vegetation of riparian sources are abundant. The main reason is that the hydrological system of fast moving waters hamper the establishement of debris and scavenger organisms, reducing the food chain of the benthic community to a few specialists organisms.

The benthic group most frequently found in the samples (ie, Diptera) demonstrates that this opportunistic groups represented by *Culex*, *Aedes*, and *Chironomus* genera are dominant in the study area. Hydroids, Ostracods, and Ephemeroptera were also present.

5.7.6 *Other Water Resource Issues*

Many of the rivers and watercourses are used for navigation and potable water supply. Some communities also have wells to exploit surficial groundwaters. Water as a resource in the context of the local communities is discussed further in *Section 5.12*.

5.8 *VEGETATION AND FLORA*

5.8.1 *General Description*

As stated in *Section 5.6.2*, the Study Area has a distinctive relief characterised by rolling hills and mountains with slopes that can vary from 25 to 70%. Using the traditional classification of life zones described in ONERN (1987), the Study Area corresponds to the very humid tropical pre-mountainous (bmh-PT) zone. This is a humid ecosystem with a tendency towards being very humid with an average annual rainfall of 3,500 mm and extremes of 3,000 to 4,000 mm. The annual average temperature is 22°C. This ecosystem is found along low and high hills which are slightly to severely dissected and have shallow soil structures and heavy surface runoff. This type of area is

generally not appropriate for agricultural activities nor for intensive logging activities.

The existing vegetation is evergreen with vines and 'bejucos' cover, with epiphytes of the Bromeliacea family (orchids). The main strata of the forest can be classified as dominant, co-dominant, suppressed and compressed. Some tree species can exceed 45 m in height.

Extensive patches of wild bamboo (Guadua sp.) are an important feature of the forest in the Study Area. This bamboo forest is known in the area as 'Pacales'. The Pacales forests tend to be located on alluvial plains. In the higher hills and mountains, Pacales are scarce or completely absent.

Some portions of the Study Area support locations with good potential for logging. The amount of trees, volume, and species diversity per hectare seem to have the potential to support a moderate level of extraction. This contrasts with the largely monotypic Pacales forest that has few individuals of the species Pashaquilla and members of the Musacea and Piperacea families. The bamboo forests are located mainly on hillsides with steep slopes whereas the woody species tend to prefer flat areas with gentle slopes.

The main forestry species that characterise the area are members of the Lauracea family including the genera Aniba, Ocotea, Persea, and Nectondra. This family includes valuable wood species such as tornillo (*Cedrelinga catenoeformis*), cedro (*Cedrela odorata*), sapote (*Matisia* sp.), Shimbillo (*Inga* sp.), quinilla (*Manilkara bidentata*), capirona (*Calycophylum* sp.), requia (*Guarea* sp.), Cumala (*Virola* sp.), upuna (*Chorisia integrifolia*), pashaco (*Shizolobium* sp.), and oje (*Ficus antihelminthica*). Common palm species include huacrapona (*Iriatea* sp.) and ungurahui (*Oenocarpus bataua*). Less densely distributed species include cashapona (*Socratea* sp.), shapaja (*Sheela cephalotes*), and pijuayo (*Bactris gasipaes*). Common ferns in the area include members of the genus Pteridium and tree ferns such as *Cyathea* sp. and *Dicksonia* sp.

5.8.2 *Vegetation Classification and Wider Regional Context*

Introduction

The ecological structure and floristic composition of the rainforest is determined by the complex interplay of water, topography and soil. The very high rainfall prevalent throughout the Amazon basin ensures that drainage (or lack thereof) interlinked with soil quality, becomes the fundamental factor in determining community structure. Flooded areas are characteristic of the lowland rainforest, where relatively limited areas are considered `terra firme' forest. Flat, poorly drained or low areas adjacent to the rivers are subject to permanent or periodic flooding. In the weastrn rainforest regions adjacent to the mountains, the topography is steeper, higher and more fractured, leading to better drainage. Consequently , altitude and physical relief become the primary determinants of community structure.

There are a number of classification schemes for the distinct ecosystems and communities of the rainforest. In the Holdridge `life zone' system (Holdridge 1975), the primary factors are latitude, precipitation and altitude. By these

criteria, the Study Area is to be found in the intersection between subtropical (ie a distinct dry season) and tropical environments, as well as including montane, premontane and lowland varieties of both climate zones. The vegetation life zones are humid, very humid or pluvial forest at all altitudinal and latitudinal zones. The topography of the Study Area suggests a complex intergradation between these zones, with many transitional states.

In terms of the ecological classification system of biogeographic zones (CDC-UNALM 1984), the Study Area is included in only one of the major biogeographic provinces: the Amazonic rainforest (high and low). Another major biogeographic province, the Yungas or cloud forest province generally starts at about 1,000 m and although extensive to the south is probably not represented in the Study Area.

The fundamental characteristics of the zones, which are present within the Study Area or nearby, can be summarised as follows.

- *Below 500 m*: lowland rainforest climate; Cw soils: luvisol/acrisol vegetation; 'terra firme' and flooded forests/swamps. This is the dominant zone in the Study Area.

- *500 m - 1,000 m*: highland rainforest climate; Cw soils; acrisol vegetation; 'terra firme' high rainforest. This is quite common within the Study Area.

- *1,000 m - 2,000 m*; low 'yungas' climate; Cw-Dwb soils; kastanosol vegetation; cloud forest. May be present in Urubamba Mountains above the Study Area; also present in the Vilcabamba Range.

- *2,000 m - 3,500 m*: high 'yungas' climate; Dwb soils; combisol vegetation; dwarf forest and 'pajonal'. This region is also known as the 'ceja de la selva' or 'forest eyebrow'. May be present at the highest elevations of the Urubamba Mountains above the Study Area.

These vegetation (or habitat) types and their subdivisions are described in detail in the EIA for the Appraisal Drilling Campaign, and briefly below.

Lowland Rainforests

Lowland rainforests broadly fall into two types:

- alluvial (or `bajial') lowland forests;
- terra firma (or altura) forest.

The former can be further divided into permanently, seasonally and occasionally flooded categories, however, none of these is likely to occur to any significant extent in the Study Area, although they may be a little more common in the Urubamba floodplain.

Tropical and subtropical lowland rain forests can be divided into poorly drained flats and terraces and hills.

The fractured topography of the Study Area suggests a limited importance for Poorly Drained Flats communities. Terraces and hills communities are the most common lowland forest types in the study area.

Floristic composition of the 'terra firme' rainforests of all types is characterised by a `mosaic' pattern depending on successional stage. Soil type also plays an important role. Certain trees are typically present in foothill areas but absent from more distant rainforest regions. These include *Celtis schippii*, *Tabebuia chrysantha*, and *Mansoa parvifolia*. It has also been suggested that forests along the foothills may actually be predominantly secondary indicating that agricultural practices have probably cleared the area at times in the past (ONERN, 1993).

Species diversity tends to correlate with soil type (higher in rich or intermediate lowland soils) and with climate (lower in subtropical areas with distinct dry seasons). The Study Area compresses many different climatic zones, soil types, and eco-geological patterns in a small area, suggesting an ecosystem which is complex and potentially rich in places.

A factor that may contribute to rich species diversity for both plants and animals in the Urubamba River valley as a whole is its status as a potential Pleistocene refuge (Lamas 1979). It is thought that during the Pleistocene ice ages, the climatic conditions in the Amazon Basin changed so that the forest retreated into isolated pockets to be replaced by savannas. The remaining forest refuges served as incubators for new species of rainforest organisms, accounting for some of the observed biodiversity of the Amazon. The Urubamba Valley (including the Study Area) has been proposed as one such site (of eight in Peru) and therefore may warrant extra attention.

Tropical and Subtropical Highland Rainforests

The highland rainforest starts at around 500 m altitude and extends upwards to the cloud forest at 1,000 m. Floristically it is similar to the adjacent `terra firme' lowland forests but is characterised by higher rainfall (>3,200 mm/year), a more fractured topography and consequently better drainage. There are no flooded areas and streams are 'white-water' and torrential, with 'pongos' or rapids where the underlying rock surfaces are exposed. Ridges of native rock may occur.

The so called 'Fitzcarrald vegetation' apparently also reaches into areas above 500 m so the 'pacal' described above may be characteristic of this zone as well.

5.8.3 *Endangered and Threatened Plant Species*

The protection of endangered plants and animals is regulated by resolutions RM 158-77-AG (1977) and RM 01082-90-AG (1990). The 1977 list did not include any plants, although a few (of which only one is a rainforest species) were included in the 1990 update. In 1989 all commerce in orchids was temporarily banned (RD 037-89-AG and RD 019-90-AG/DGFSS) to deter the indiscriminate traffic of unique species.

A survey of the protected areas and parks of Peru (CDC-UNALM, 1991) catalogued rare and endangered species from a wide range of plant species. In addition , studies undertaken by the Smithsonian Institution [1] , on behalf of SPDP, have demonstrated that the Camisea Region's floral diversity approaches that of the Manu National Park.

5.9 FAUNA

5.9.1 *Overview*

Tropical rainforests in Southeastern Peru are recognised as being one of the biologically richest and most diverse areas of South America and hence the world. Previous research work within different vertebrate groups has been carried out in the area of Manu National Park and the Tambopata-Candamo reserved area. Mammal fauna in this area is extremely rich, supporting almost 50% of the total terrestrial mammals found in continental Peru (Pacheco *et.al.*,1993). As to diversity of amphibians and reptiles, since 1979 inventory and monitoring works have been carried out in the area of Manu National Park and there are several works such as Rodriguez & Cadle (1990), Duellman & Salas (1991) and Morales & McDiarmid (1996) showing the richness of the area. These two groups are important, as they are used as *indicators* of the forest condition and supply elements for the evaluation of possible changes associated with activities in the area of study.

In terms of invertebrates, anthropods are excellent indicators of forest health and productivity. They also constitute the main component of the earth's biological diversity.

This section of the Report therefore reviews the faunal interest of the potential well sites in terms of:

- mammals;
- amphibians and reptiles;
- anthropods.

5.9.2 *Area of Study*

As part of the Environmental Impact Assessment, faunal surveys were undertaken at the drill sites. The methodologies adopted for the faunal surveys are presented in *Appendices G1* and *G2*. The faunal habitat at the survey sites can be summarised as follows.

- The forests of the Pagoreni area are primary, mature forests, located in hilly areas of medium elevation and relatively steep slopes(30 - 40°). Tree canopies can reach 30-35 m height, with a high number of epiphytes and lianas (woody vines). Understorey is scarce because of the limited amount of light reaching the ground.

(1) Proceedings from the Workshop on Biological and Cultural Diversity of the Lower Urubamba, Peru, 2-4 September 1996. Organised by the Biodiversity Programs of the Smithsonian Institution, sponsored by SPDP.

- At the San Martin site, the vegetation is typified as a mixture of a primary forest with a significant quantity of bamboos or 'pacal' (*Guadua* spp. Poaceae), forming very dense aggregations.

5.9.3 *Mammals, Amphibians and Reptiles*

Mammals

A total of 26 species of mammals was recorded at the two sites during the survey (refer to *Table 5.23*).

The most common records are for *Tayasu pecari* and *Mazama americana*, their footprints being recorded in both sites, frequently close to river banks and cloughs. Several of the recorded species were directly observed; this indicates that there is minimal human disturbance of the forest.

Tapirus terrestris, Pecari tajacu, Tayasu pecari, Mazama americana, Agouti paca and *Dasyprocta* sp. are frequently consumed in the nearby communities and are of economic importance. Inhabitants report that these species are plentiful and regularly hunted.

Amphibians and Reptiles

A total of 25 species herpetofauna was recorded in the two sites, comprising 17 species of amphibians and eight species of reptiles (refer to *Table 5.24*).

Amongst the species of economical importance for local communities includes *Leptodactylus pentadactylus,* which is occasionally consumed by the inhabitants, and *Caiman crocodilus, Podocnemis unifilis* and *Geochelone denticulata* which are consumed more frequently. Inhabitants of communities also collect 'taricaya' (*Podocnemis unifilis*) eggs for consumption, which provide them with an additional protein source. The egg collection takes place during the egg-laying season for taricaya, between July and August, in the sand beaches when the level of the river is low and rains are not so frequent.

Podocnemis unifilis and *Caiman crocodylus* are considered as species in vulnerable condition (Pulido, 1991).

Table 5.23 Mammal Species Recorded at Pagoreni and San Martin[1]

Species	Common Name	Site		Status
		Pagoreni	San Martin	
Xenarthra				
Dasypodidae				
Dasypus novemcinctus	Carachupa	p		N
Primates				
Cebidae				
Alouatta seniculus	Coto Monkey	c		A
Ateles paniscus	Maquisapa	c		E
Cebus apella	Black Machin	c		V
Cebus albifrons	White Machin	c		V
Lagothrix lagothricha	Choro	c		E
Saimiris sciureus	Little Friar	c		V
Callitrichidae				
Saguinus imperator	Big Moustache Titi	o		V
Saguinus fuscicollis	Pichico	o		V
Carnivora				
Procyonidae				
Nasua nasua	Achun	c		N
Potos flavus	Chosna	c		I
Mustelidae				
Eira barbara	Manco		o	I
Felidae				
Herpailurus yagouaroundi	Black Tigrillo	c		I
Leopardus pardalis	Tigrillo	cr, h		I
Panthera onca	Tiger, Otorongo	h		V
Puma concolor	Red Tiger, Puma	c		N
Perissodactyla				
Tapiridae				
Tapirus terrestris	Sachabaca	cr		N
Artiocdactyla				
Tayassuidae				
Pecari tajacu	Sajino	cr		N
Tayasu pecari	Huangana	o, h	h	N
Cervidae				
Mazama americana	Red Deer	o, cr	h	N
Rodentia				
Agoutidae				
Agouti paca	Majas	o		N
Dasyproctidae				
Dasyprocta sp.	Aguti		h	N
Echimydae				
Dactylomys dactylinus	Bamboo Rat	c		N
Hydrochaeridae				
Hydrochaeris hydrochaeris	Ronsoco		h	N
Sciuridae				
Sciurus sp.	Red Squirrel	c		N
Lagomorpha				
Leporidae				
Sylvilagus brasiliensis	Rabbit	c	h	N

[1] c = Communication, cr = Cranium, h = Footprints, o = Observed, p = Skin, E = Extinction vias, V = Vulnerable, I = Undetermined, N = Not included

Table 5.24 Amphibians and Reptiles Recorded Area at Pagoreni and San Martin[1]

Taxa	Habitat	Activity	Pagoreni	SME-A
AMPHIBIA CLASS				
ANURA ORDER				
Bufonidae				
Bufo marinus	T	N	o,c	
Bufo gr. Typhonius	Ar, T	D	O	
Dendrobatidae				
Epipedobates macero	Ar, T	D	c	
Epipedobates pictus	Ar, T	D		o,c
Hylidae				
Hyla bifurca	Ar	D	o,c	
Hyla boans	Ar	N	o	
Hyla fasciata	Ar	N	o	
Hyla leuccophyllata	Ar	N	o,c	
Hyla minuta	Ar	N	o	
Hyla parviceps	Ar	N	o,c	
Phyllomedusa tomopterna	Ar	N	o	
Leptodactylidae				
Eleutherodactylus fenestratus	Ar	N	o	
Eleutherodactylus cf. peruvianus	Ar	N	o	o
Leptodactylus pentadactylus	T	N	o	
Leptodactylus rhodonotus	T	N	o	
REPTILIA CLASS				
CROCODYLIA ORDER				
Alligatoridae				
Caiman crocodilus	Ac, T	D, N	o	
TESTUDINES ORDER				
CRYTODIRA SUBORDER				
Testudinidae				
Geochelone denticulate	T	D	o	
PLEURODIRA SUBORDER				
Pelomedusidae				
Podocnemis unifilis	Ac	D	o	
SQUAMATA ORDER				
SAURIA SUBORDER				
Gymnophtalmidae				
Neusticurus ecpleopus	Ac	D	o	
Polychrotidae				
Phyllomedusa vaillanti	Ar	N	o, c	
Scinax pedromedinai	Ar	N	o, c	
Teiidae				
Ameiva ameiva	T	D	o	
Kentropyx pelviceps	T	D		o
Serpentes Suborder				
Colubridae				
Hellicops angulatus	Ac	N	o	

(1) Habitat: AR = Aborent; AC = Aquatic; T = Terrestrial
Activity: D = Diurnal; N = Nocturnal
Location: PAN = Pagoreni; SME = San Martin-East Typing of recording; o = Observed Specimen; c = Auditive Recording

5.9.4 *Arthropods*

Background

Arthropods (insects, spiders, mites and relatives) constitute the main component of the biological diversity in our planet. Approximately 75% of all animal species belong to this group. This proportion continues to increase as more studies in tropical regions are undertaken. Besides their species richness far exceeding other groups, arthropod biomass alone can easily surpass that of vertebrates for a given area (Wilson 1987). Arthropods play a key role in the structure and dynamics of forest ecosystems. They are important as herbivores (regulate plant growth), predators including parasites (regulate animal populations), pollinators (assure plant reproduction) and nutrient recyclers (decompose dead organic matter). Most arthropod species are sensitive to environmental changes. These changes can be spatial or temporal. Environmental gradients (eg gradual changes in water availability, salinity, temperature) limit the distribution of some species. Thus, habitat heterogeneity augments the number of species at a larger scale. Temporal changes in arthropod activity occur daily, as different species are active during the day and night. The composition and density of arthropod communities also changes throughout the year, many species have higher densities during the rainy season, while different species are more abundant during the dry season.

Many groups remain poorly studied, specially of the so-called 'lower' organisms (ie arthropods). Several studies on the entomofauna of the Tambopata Reserved Zone were published in the Revista Peruana de Entomologia Vol. 27, 1984 and included papers on Odonata (Paulson 1984), Cicindelidae (Pearson 1984), Asilidae (Fisher 1984), Tabanidae (Wilkerson & Fairchild 1984), Lepidoptera (Lamas 1984a, 1984b) and Euglossine bees (Dressler 12984). A recent volume has been published on the studies carried out at the Pakitza station in the Manu Biosphere Reserve (Wilson & Sandoval 1996). Arthropod studies in this volume are those on butterflies (Robbins et. al. 1996), spiders (Silva & Coddington 1996), Cicadoidea (Pogue 1996), Mutilidae (Quintero & Cambra 1996), Carabidae (Erwin 1996), Trichoptera (Flint 1996) and Odonata (Louton *et al* 1996). The lower Urubamba region has been recently the subject of a workshop on biological and cultural diversity (Wilson *et al* 1996), but no assessment of the arthropod fauna was included.

Survey

A survey of the arthropod diversity was undertaken at the proposed well sites based on a set of samples collected during visits to the target locations. The methodology for the survey and diversity assessment is presented in *Appendix G2.*

Results of Arthropod Assessment

The observations at the four locations surveyed allow a division of the habitats in two main types: the Pagoreni site (including wells A, C1, C2 and D) in one group, and San Martin-East site.

The forest at Pagoreni is typified by a canopy reaching 30-35 m, with a mixture of large and smaller trees, with a high number of epiphytes and woody vines. The understory is rather open and scarce due to the limited amount of light reaching the ground. Leaf litter covering the soil is thick and can be as high a 100% coverage per square meter.

The forest at San Martin is a mixed forest with dense aggregations of bamboo or 'pacal'. Tree canopies can reach 30 m, but may be interrupted by dense aggregations of bamboo, particularly in areas of new clearings or steep slopes (by landslides, etc). The bamboo is a very aggressive species, and its dominance in the area can hardly be attributed to human disturbance. Most of the productivity at these locations is probably tied up to the bamboo. Ubiquitous bamboo also has a strong influence on young treelets: the forest seems to have a good number of trees with broken tops and arreastd growth. This is the result of the bamboo shots growing straight up and outpacing young trees, and since their internodes are full with water, strong winds cause these shots to collapse and fall affecting and probably breaking young tree tops. Understorey is very thick and difficult to walk in due to fallen bamboo or thick bamboo stands mixed with the forest. Leaf litter is thin and dominated by bamboo leaves.

Biodiversity of Arthropods

A total of 193 species of arthropods was collected. Collections of arthropods in tropical habitats will yield a high number of species. The composition and abundance of arthropod communities will be influenced by a number of factors. An assessment on the biodiversity of this group in a given area needs to be considered in relation to the time of year, collecting effort and habitats considered. *Table 5.25* summarises the arthropod groups collected at each of the surveyed sites. Samples are broken down by locality, collecting technique and are arranged taxonomically. There was almost no overlap of species represented on each of the different sampling methods employed.

Table 5.25 presents an estimate of the number of different species (not individuals). More abundant groups constitute the Coleoptera (51 species), the Hymenoptera (30 species) and the Orthoptera (20 species). Heteroptera and Homoptera together (old Hemipteroidea) sum up 25 species. These results reflect the general diversity of these important orders on a global scale. The one important exception is the Diptera, which is as diverse as Coleoptera or Hymenoptera. However, only eight species of this group were recorded. This is assessed to be an artefact of the sampling procedure. Malaise trapping usually yield high numbers of Diptera both on species composition and species abundance. It is likely, therefore, that these traps were not left out for sufficient time to accumulate a good sample.

At a family level, the most diverse groups in the samples constitute the Formicidae and the Staphylinidae. Ants are very important components in any forest ecosystem, and the high diversity of this group in these samples is explained by the fact that they are highly mobile insects, and are usually collected in several of the sampling methods. They are very abundant in the litter samples, are important in the understory and on logs.

Staphylinidae is one of the most diverse groups of Coleoptera, and has colonised many habitats. These insects are very abundant in litter samples and on rotten logs. Many are active predators and feed on either smaller arthropods or decaying material.

The distribution of species by collecting technique is a reflection of the collecting effort. To study the diversity of the arthropod fauna it is necessary to employ techniques that are repeatable and allow for quantitative treatment. This repeatability is achieved by passive trapping, where any collector bias is removed. The replications will guarantee the representativity of the samples, as the species accumulation curve will flatten out with repeated sampling. This will allow for comparisons across localities. It would appear that the manual collecting (that is the occasional collecting: light, night walks) is most productive. However, for a long-term monitoring effort this is not feasible and cannot be treated or interpreted quantitatively (due to potential collector bias).

Outside of the samples, it is possible to make general observations on the arthropod fauna, based on visits to the localities. Many groups of insects are expected to be found or were observed during the visit. Among the most prominent are the Lepidoptera. Groups such as Morphidae (*Morpho*, several species), Heliconiidae (*Heliconius*, etc.), Ithomiidae (*Ithomia*), Pieridae (*Pieris*), Nymphalidae (*Agrias, Prepona*), Uraniidae (*Urania*) were observed along creeks or on the river beaches. Crepuscular butterflies such as Brassolidae (*Caligo*) were seen close to the banana plantations near the village. Among large Coleoptera, common species likely to be expected at the locations are Scarabidae (*Megasoma, Dinastes*), Cerambycidae (*Acrocynus, Callipogon*), Buprestidae (*Euchroma*), Curculionidae (*Rhynchophorus*). Less conspicuous groups are expected such as Mantidae, Phasmidae, Acrididae. It is interesting to note that Acrididae would seem to be more abundant in the Pagoreni sites, whereas Tettigonoidea has been found to be more prevalent at San Martin.

Table 5.25 ***Arthropods collected at the Sites***

Well Site Location	**PG-A**					**PG-D**				**SM-E**	**SHK**		**Total**
Sampling Method	Sw	Lg	Lt	Ma	Ck	Sw	Lg	Lt	Ma	---	Li	Ni	
Ephemeroptera										*	1		1
Orthoptera													20
• *Acrididae*						1				*	1	2	4
• *Gryllidae*										*	1		1
• *Gryllotalpidae*											1		1
• *Terrigonidae*	3					2				**	1	6	13
• *Tetrigidae*	1												1
Phasmoptera		1											1
Dictyoptera													7
• *Blattidae*	2	3	1							*			6
• *Mantidae*		1								**			1
Dermaptera										*			4
• *Forficulidae*	1					1					1	1	4
Psocoptera	1									*			1
Homoptera													17
• *Cicadidae*										*	1		1
• *Cicadellidae*	3			1		2			1	**	3	1	11

Well Site Location	PG-A					PG-D				SM-E	SHK		Total	
Sampling Method	Sw	Lg	Lt	Ma	Ck	Sw	Lg	Lt	Ma	---	Li	Ni		
• *Cercopidae*	1									*			1	
• *Fulgoridae*	2					2				*			4	
Heteroptera														16
• *Coreidae*						1				*			1	
• *Lygaeidae*										*			1	1
• *Miridae*						3				*			3	
• *Pentatomiddae*						1				*	3	1	5	
• *Reduviidae*		1				1				*	1	2	5	
Neuroptera														2
• *Chrysopidae*										*	1		1	
• *Myrmeleontidae*											1		1	
Coleoptera														51
• *Anthribidae*						1				*			1	
• *Chysomelidae*				1		4				*	2	3	10	
• *Carabidae*										*		1	1	
• *Coccinellidae*										*	1		1	
• *Curculionidae*							3		2	*	1	3	9	
• *Elateridae*		2					1			*			3	
• *Erotylidae*		1								*		1	2	
• *Psephenidae*				1									1	
• *Scarabaeidae*						1	1			*	3	2	7	
• *Staphylinidae*		5	4			1		4	1	*			15	
• *Tenebrionidae*										*	1		1	
Trichoptera				2						**				2
Diptera														8
• *Asilidae*										*		1	1	
• *Syrphidae*				1					2	*			3	
• *Tabanidae*				3						**			3	
• *Tachinidae*				1						*			1	
Hymenoptera														30
• *Apidae*						3			1	*			4	
• *Braconidae*				1						*			1	
• *Chalcidoidea*			1					1		*			2	
• *Evaniidae*				1									1	
• *Formicidae*			4	3		3	2	4		**	1		17	
• *Ichneumonidae*									1	*			1	
• *Sphecidae*									1	*			1	
• *Vespidae*				1					1	*	1		3	
CHILOPODA					1			2	1	*				4
DIPLOPODA		1	2			1		2		**		1		7
SCORPIONIDA								1		*				1
PSEUDOSCORPIONI								1		*				1
DA ARANEAE		7				4		1		*		1		13
SOLIFUGA		1								*				1
CRUSTACEA					1					*				1
Total de especies	**14**	**23**	**12**	**16**	**2**	**32**	**7**	**16**	**11**	**---**	**27**	**28**	**188**	

Samples are presented by locality and method of collect. **PG-A** = Pagoreni A, **PG-D** = Pagoreni D, **SME** = San Martin-E, **SHK** = Shivangoreni, **Sw** = Sweeping, **Lg** = log, **Lt** = Litter, **Ma** = Malaise, **Li** = Ligth, **Ni** = Collect during the night. (NOTE: San Martin-E locality records: * probably found, ** probably found and very abundant)

5.9.5 *Economically Important Wildlife Resources*

The animals of the rainforest have always provided an essential part of the economic and social livelihood of the native communities. Hunting and fishing is an integral part of the native culture which until modern times did not greatly affect the populations of wildlife. However, systematic hunting with modern weapons and larger scale fishing in areas along the rivers more heavily populated by settlers has caused a decline in the population of popular game species outside the Study Area.

In recognition of the importance of subsistence hunting the government in D.S. 934-73-AG (1973) specifically allows the continued hunting of a list of common food and hide species. The rainforest species concerned are listed in *Table 5.26*. Many of the species are among the most ubiquitous of rainforest animals, although some, such as the tapirs, may be experiencing a decline in numbers in more heavily populated areas away from the Study Area (Pulido, 1991).

Table 5.26 ***Species of Economic Importance Authorised for Subsistence Hunting in D.S. 934-73-A. Common Name Presented First in English (e:) and in Spanish (s:)***

Species	Common names	Comments
Mazama americana	e: red deer, s: venado rojo	forest and riverside deer, source of meat and hides
Tayassu tajacu	e: collared peccary, s: tajino	ubiquitous herbivore, source of meat and hides
Tayassu pecari	e: peccary, s: huangana	similar to above
Tapirus terrestris	e: lowland tapir, s: sachavaca	forest and riverside herbivore, a meat source
Cuniculus paca	e: paca, s: majaz	
Dasyprocta fuliginosa	e: - s: añuje	marsh and terrestrial herbivore, a meat source
Hydrochaerus	e: capybara, s: ronsojo	common aquatic mammal of rivers and marshes, source of meat and hides
Dasypus novemcinctus	e: nine banded armadillo, s: carachupa	insectivorous mammal along riversides, source of meat
Columba sp.	e: forest doves, s: palomas de selva	forest bird, meat and egg source
Penelope jacuacu	e: mountain turkey, s: puka cunga	forest bird, feeds on fruit on ground but nests in crowns, source of meat
Dinomys branickii	e: pacarana, s: machetero	a medium size rodent, a marsh herbivore source of meat
Crypturellus sp.	e: forest partridge, s: perdices de selva	forest birds, meat and egg source
Geochelone sp.	e: Amazon tortoise, s: motelo	forest and riverside herbivore, meat and eggs

Many other kinds of wildlife are used by the native population for food, hides and decorative feathers: for example boas, currasows, and parrots. Similarly,

others have economic importance outside of the native communities such as venomous snakes used for extracting antivenom serum, songbirds and parrots for pets, monkeys for biomedical research, and tropical fish for aquarium enthusiasts. Undoubtedly, poaching of `protected' species still occurs as well, as there is an illegal international market for pelts of jaguars and ocelots and for live animals such as macaws and monkeys.

5.10 PROTECTED AREAS

The Study Area of the Urubamba valley is currently not part of any protected natural area. However, protected areas are to be found relatively nearby, these include the following.

- The land from the western bank of the Urubamba River to the eastern bank of the Eni River including the entire northern portion of the Vilcabamba Range (Cordillera Vilcabamba) comprises the Zona Reservada (Provisional Managed Resource Area) of Apurimac. Established in 1988 under RS 0032-90-AG/DGFF, it replaced the previous Apurimac National Forest. The zone encompasses 1,669,000 ha of rainforest, cloud forest and mountain environments. A Zona Reservada is the lowest level of protection in Peru, implying a temporary protection until a more permanent designation for the land in question has been determined. The eastern border of the zone is the Urubamba River, approximately 25 km west of the nearest well site.

- Slightly more than 25 km to the east of the easternmost wellsite, beyond the hydrologic divide of the Urubamba Mountains and the Fitzcarrald Divide, is the border of Manu National Park, the premier national park of Peru. It comprises, together with some other adjacent units, the Manu Biosphere Reserve. Established in 1973, it encompasses 1,532,000 ha of mountain highlands, cloud forest and lowland rainforest and is listed as a World Biosphere Reserve by the United Nations. Since the Camisea River flows away from the border of the Manu, which lies across a several thousand meter high divide, it is extremely unlikely that the proposed activities will affect the park directly. However, the park is the best studied part of the Peruvian Amazon and data about the flora and fauna of Manu may be applicable to the nearby but less well studied Camisea watershed as well.

5.11 SOCIO-CULTURAL CHARACTERISTICS

5.11.1 *Overview*

Communities

The well sites are located in an area inhabited exclusively by an indigenous Machiguenga population from the Arawak (or Pre-Andean Arahuaca) linguistic family. The population is located in a series of small settlements, situated in the main river banks. Together, the settlements comprise a community network, connected by kinship.

Chapter 6

Assessment and Mitigation of Impacts

6 ASSESSMENT AND MITIGATION OF IMPACTS

6.1 ASSESSMENT OF IMPACTS

6.1.1 *Introduction and General Approach to EIA*

This Chapter focuses on identifying residual environmental impacts, in light of the mitigation measures proposed.

The general approach followed in this EIA is shown in *Figure 6.1*. It acknowledges that some mitigation is built into design, that further mitigation may be necessary as the significance of potential impacts is assessed and that ultimately there will be impacts which are unavoidable. It also acknowledges that there can be uncertainty over a number of matters such as:

- the precise baseline environmental quality and characteristics;
- the accuracy of impact prediction;
- the effectiveness of mitigation measures, especially previously untried ones.

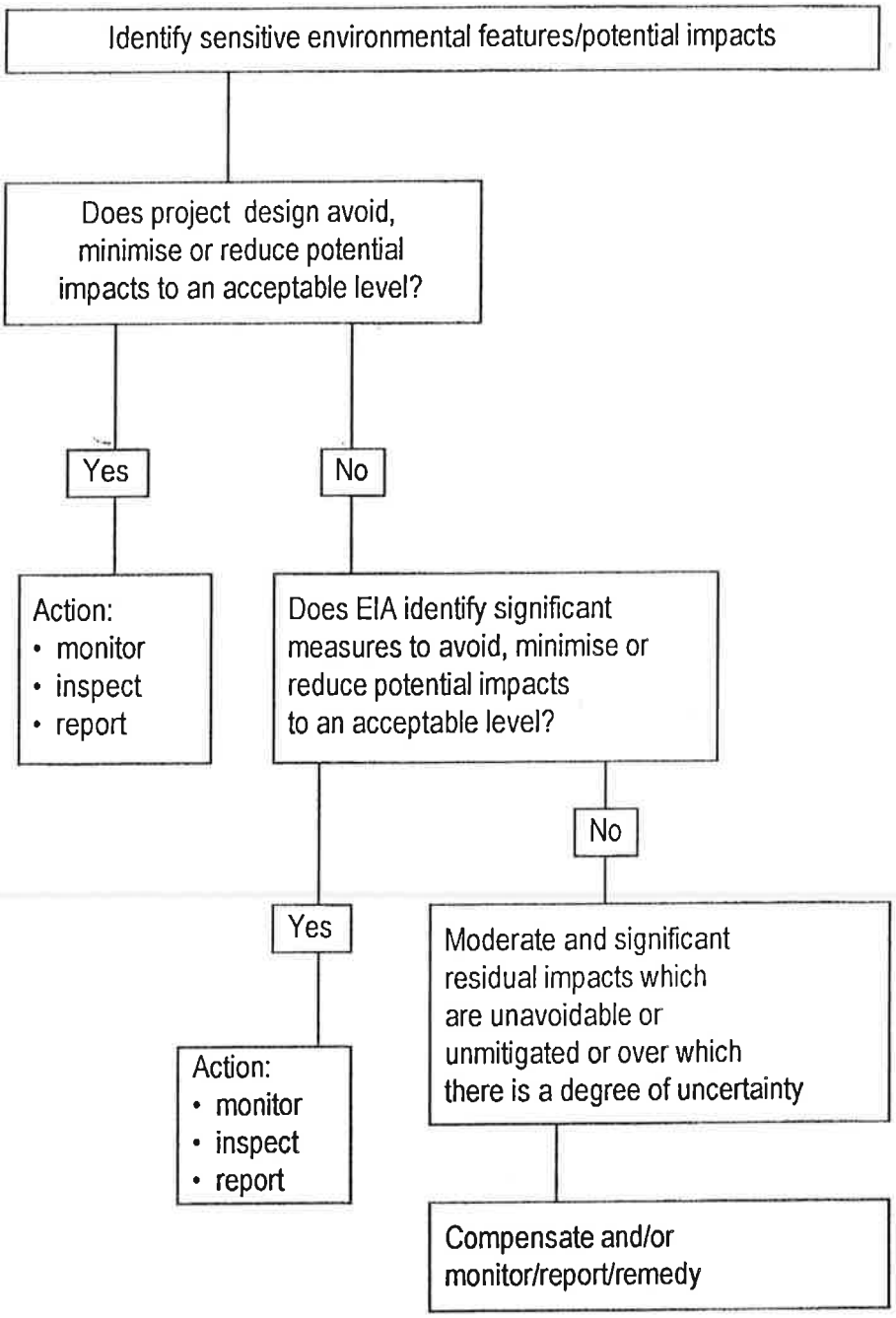
For these reasons further survey and monitoring work form key recommendations. However it is also worth noting that now that SPDP is actually operating a drilling rig in the Camisea area we have a better appreciation of the types of impacts that arise, together with their likely severity. An excellent example of this is the effects of noise. An ERM noise specialist joined the field survey team and in addition to collecting baseline noise levels of the potentially affected communities, was able to measure actual noise levels from such sources as drilling rig, helicopters and river craft. Information of this nature is invaluable in the EIA since it not only allows impact prediction to be made more accurately but adds confidence to the management of such impacts.

It should be noted that exploratory wells at Pagoreni will be drilled by the rig currently on site for the Appraisal Drilling Campaign. The exploratory drilling will also be supported by the same logistical activity, based at Nuevo Mundo, as is being used for appraisal drilling. Since these facilities are in place and in use it is not proposed to revisit the impacts caused by them, other than to introduce the results of some specific field research on noise disturbance caused by aircraft and river traffic. This is addressed under the heading of 'Socio-Cultural Impacts' (see *Section 6.3*).

6.1.2 *Identification and Classification of Potential Impacts*

Exploratory drilling is a long established part of oil and gas field development and the drilling activities which may potentially give rise to environmental impacts are generally well known. Likewise, the potential environmental impacts associated with oil and gas development activities in remote tropical rainforest locations are also well documented, being the subject of dedicated guidance issued by the Peruvian Ministry of Energy and Mines and the E&P Forum. In the execution of this EIA, ERM has applied this accumulated

Figure 6.1 *Generalised EIA Approach Used*



knowledge of generic sources of potential impact to the particular drilling campaign activities and mitigation measures proposed by SPDP, and has then assessed the likely significance of potential impacts on the local environment of the Camisea region.

For each category of environmental receptor (such as water resources or ambient air quality) the potential impacts of activities under the exploratory drilling campaign have been identified. In each case due cognisance has been taken of mitigation measures inherent in SPDP's design of the drilling programme. These potential impacts have been assessed and, where appropriate, additional mitigation measures have been proposed for inclusion. Potential residual impacts have been classified according to their likely level of significance. Finally, where further action is deemed necessary (such as monitoring) this has been identified. The accompanying Environmental Management Plan (EMP) incorporates all mitigation measures and further actions proposed.

6.1.3 *SPDP's Role in this Assessment of Environmental Impacts*

This Camisea exploratory drilling campaign EIA has evolved as a result of close cooperation between ERM, who as independent consultants have had a free hand in the drafting of this Environmental Statement, and SPDP personnel who will be personally responsible for ensuring the full implementation of the various measures proposed. SPDP has given its unequivocal commitment to implement all the measures presented in this EIA, each of the measures having been previously subjected to scrutiny within SPDP prior to the company's agreement. This in turn has enabled ERM to assess the significance of impacts with a level of surety not always possible in an EIA.

Peruvian EIA regulations mandate approval of an Environmental Management Plan outlining the mitigation measures and monitoring programmes that will be implemented by the proponent. The EMP for this exploratory drilling campaign has also involved close cooperation between the SPDP Camisea project team, currently engaged in appraisal well drilling in the area, and ERM. It is the culmination of a thorough scrutiny of the Environmental Impact Assessment to ensure that all relevant design features, additional mitigation measures and further actions, which have been proposed by ERM and accepted by SPDP, are documented within an unambiguous implementation plan which clearly identifies responsibility for implementation.

6.1.4 *Assessing the Significance of Impacts on the Environment*

All development imposes some disturbance to aspects of the environment because of physical impacts on natural systems or due to interference with human activities and human systems. Often such impacts are slight or transitory and have an effect which may be regarded as insignificant. This assessment seeks to predict the occurrence and potential significance of environmental impacts associated with the proposed exploratory drilling campaign and to suggest measures by which they may be avoided, reduced,

remedied or compensated for. Criteria for identifying the significance of impacts include:

- is there strict compliance with any relevant laws or regulations?
- could any relevant environmental standards or guidelines be breached?
- could any government policies or plans be adversely affected?
- is the issue of concern to officials, non-government organisations or members of the public?
- will public socio-economic conditions, health or amenity be affected?
- will the rights of people and their ability to enjoy their customary way of life be affected?
- is their any long term or permanent damage to ecological systems or natural assets of national, regional or local value?

6.1.5 *Classification of Impacts*

Potential impacts associated with the proposed drilling campaign have, where practicable, been identified according to the following regime.

- *Type*, ie positive, negative.
- *Potential significance* of environmental impact, according to the following qualitative scale:
    - significant;
    - moderate;
    - insignificant.
- *Nature*: depending on circumstances it may be appropriate to distinguish between those impacts which are local or regional, of short or extended duration, direct or indirect.

Classification of impacts to the 'natural environment' (habitats, flora and fauna) are discussed further in *Section 6.1.6*.

Due to the short duration of the entire drilling campaign and in particular the short duration of the construction, installation, drilling and testing phase at each of the wellsites (anticipated to be approximately six months per wellsite albeit with an approximate six month gap between site preparation and start of drilling), impacts during construction and operational phases of the campaign are for many receptors the same (for example disturbance to wildlife). For this reason construction and operation impacts have not been assessed separately, as per EIA practice for longterm activities.

SPDP has committed not to construct any new roads or access paths from outside the region or to re-open old roads to the proposed wellsites; all

transport of equipment, materials and personnel to the will continue to be by helicopter; analysis of impacts associated with access road construction and maintenance is, therefore, not an issue.

Impacts are considered under the following groupings:

- impacts on the natural environment arising out of drilling activities;
- socio-cultural impacts arising out of drilling and logistics support programme activities.

6.1.6 *Ecological Impact Assessment Criteria*

Habitat and Species Evaluation Criteria

Habitats are assessed according to widely accepted criteria of which the most important are naturalness, extent, rarity and diversity; these and the others are summarised below in *Box 6.1*.

Box 6.1 Factors to Consider in Evaluating the Quality of Affected Habitats

Whether any plant or animal species is present that is nationally or locally rare, especially Red Book of Peru Species or species protected under Peruvian legislation.

Whether any plant or animal communities are present which are nationally or locally uncommon or suffering serious reduction nationally or locally. The diversity of the habitats and their individual species richness are important. In general, the greater the total number of species recorded the greater the conservation interest of the area. Whether the habitat contains a nationally or locally important population of a particular species. Whether the habitat is a representative example of one with other special interest or value.

The 'naturalness' of the habitat must be assessed. Naturalness and diversity can be strongly correlated and recreated habitats tend to be more species poor than their natural or seminatural equivalents.

The fragility and sensitivity of the habitat and its ability to recover from disturbance must be considered. This criterion is linked also to size, naturalness and rarity but generally fragile sites are usually highly fragmented, decreasing rapidly in extent and number and difficult to recreate.

The recorded history of the site is important. The loss of an irreplaceable biological record would be particularly significant. Such records may also be of archaeological and historical value.

Whether at the local level the habitat is an ecological corridor between other isolated habitats of ecological importance.

Whether any species has cultural significance (for example, as a resource utilised by local Machiguenga communities).

Whether the area constitutes a key hunting and/or fishing grounds for local Machiguenga communities.

The amenity value of the site should be noted.

The research value and education potential of the site are important.

Species are similarly assessed according to accepted criteria such as rarity and the extent to which they are under threat. The importance of species to wider communities is also considered and the protection of species under national legislation is also taken into account.

Assessment of Significance Criteria

The assessment of the relative significance of ecological impacts is a subjective judgement and it is often difficult to attach definite levels of significance to impacts in the way that quantitative prediction allows. However, the definitions in *Box 6.2* may be used to qualify impact.

Box 6.2 ***Criteria Which May be Used to Assess the Significance of Ecological Impacts (Source: Duinker and Beanlands),***

Major (or Significant) Impact	A *Major Impact* affects an entire population or species in sufficient magnitude to cause a decline in abundance and /or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependant upon it, to its former level within several generations*. A major impact may also affect a subsistence or commercial resource use to the degree that the well being of the user is affected over a long term.
Moderate Impact	A *Moderate Impact* affects a portion of a population and impact may bring about a change in abundance and / or distribution over one or more generations*, but does not threaten the integrity of that population or any population dependent on it. A shortterm effect upon the well being of resource users may also constitute a moderate impact.
Minor (or insignificant) Impact	A *Minor Impact* affects a specific group of localised individuals within a population over a short time period (one generation* or less), but does not affect other tropic levels or the population itself.

*These are generations of the animal/plant species under consideration not human generations. It should be noted that the restoration potential of an affected habitat also needs to be considered in applying the above criteria.

The significance of ecological impacts is also intrinsically related to the conservation value of the habitat/species affected as set out in *Box 6.1*.

6.2 IMPACTS ON THE NATURAL ENVIRONMENT - DRILLING

6.2.1 *Range of Impacts Considered*

The range of potential impacts associated with the proposed drilling campaign has been identified, and is discussed in this Chapter (not in order of

importance but in a sequence which facilitates development of the impact assessment process) as follows:

- geophysical (including soils and aggregates);
- aquatic resources (including surface and groundwater quality);
- ambient air quality;
- flora;
- fauna (including the effects of noise);
- land use and resource loss;
- social impacts (these are discussed in *Section 6.3*).

Generally each subsection follows a sequence:

- activities giving rise to impacts;
- potential impacts;
- assessment of each potential impact, together with mitigation measures proposed;
- summary of significance of residual impacts, uncertainty and further actions.

6.2.2 *Geophysical Impacts (including soils)*

Activities Giving Rise to Geophysical Impacts

Geophysical impacts, including soil impacts, will be caused by:

- landtake at each wellsite which will arise out of the need to provide the facilities described in *Section 3.7.1*;
- cut-and-fill operations to level and develop each drill site;
- laying of a pipe to abstract water from a nearby stream at each wellsite; spillages and discharges from each wellsite;
- extraction of construction material (gravel) from river beds.

Potential Geophysical Impacts

Potential geophysical impacts anticipated are:

- increased risk of land slippage/slumping and accelerated soil erosion;
- interruption of subsoil and overland drainage patterns;
- alteration of soil quality by loss of topsoil and overburden;
- contamination of soils arising from spillages and contaminated discharges;
- damage to river banks, mobilisation of suspended solids.

Increased Risk of Land Slippage/Slumping and Accelerated Soil Erosion

Wellsite design (see *Section 3.7*) incorporates the following principles:

- select a site location for maximum level ground;
- minimise the extent of clearance of vegetation at the wellsites by staying within defined boundaries;
- avoid cutting and excavating the roots of trees where possible, so as to retain land stability;

- store topsoil in a manner to maximise its reuse in restoration, thereby reducing the long-term risk of erosion;
- install runon and runoff surface drainage systems so as to minimise soil erosion and siltation and prevent water stagnation.

Due to the wellsites being situated along the upper one-third of ridges, the potential for land slippage and slumping of the rotational type will be the most prevalent. The risk of occurrence of rotational slips and associated erosion will be highest where major cut and fill has taken place, and could arise from:

- excessive loading exerted by the drill platform;
- inadequate runon and runoff control.

The risk of land slippage and slumping and erosion will be strongly influenced by the type of soil, its water content, topography (type of degree of slopes) and type and extent of vegetation cover. Although soil and the climatic conditions are fairly similar at each site (ultisols and heavy rainfall throughout most of the year), local topography is site specific and so the potential risk of erosion and landslides varies for the sites as follows.

- At the proposed Pagoreni D and SME-A well sites the erosion risks and associated land slippage and slumping are considered to be significant. This is primarily due to a combination of existing soil types, existing vegetation cover (and the effects of its removal) and the land type. Both Pagoreni D and SME-A are located in structurally high hills with slopes occasionally in excess of 75%. Special attention will therefore be needed at the design stage to formulate a layout which minimises steep slopes and the degree of cut and fill. At the same time, runoff control systems will need to be sized and designed to cope with expected conditions at these sites.

- The remaining site at Pagoreni A has a moderate risk of erosion and associated land slippage and slumping. Although soil conditions and effects of vegetation removal will have similar effects as at Pagoreni D and SME-A, the terrain is less severe. It comprises moderately dissected low hills with slopes from 15 to 50%. Whilst careful attention will still be needed in designing layout and erosion control mechanisms, the challenges will not be as great as at Pagoreni D and SME-A.

SPDP is familiar with the steps required to minimise the risk of landslides and severe erosion in the field. The final selection and orientation of each drill site will be determined following a comprehensive topographic survey and detailed analysis of options so as to ensure that landslide risk is minimised. The risk of landslides will be further reduced and the extent of erosion minimised by the implementation of the following measures.

- Steep cut and fill will be avoided where the risk of slope failure is high.

- Where steep slopes are cut, they will be protected to minimise erosion potential using a suitable surface covering such as netting (grass, bamboo or mesh).

- Additional protection will be afforded by such means as slope design, terracing, bamboo walls, diversion drains (with diffusions methods to reduce water energy), cut-off walls, siltation traps.

- Finally, slopes will be stabilised in the longer term by appropriate bio-engineering techniques, including, but not limited to:

    - seeding;
    - planting cuttings of appropriate species (ie native ones).

Vegetation fragments in mulches and the natural seed banks in the soils will also facilitate long-term stabilisation.

The residual risk of landslides or slumping is therefore considered to be moderate to low but the consequences in the event that a landslide or slumping were to occur would be significant. The residual soil erosion impacts are likely to be moderate. This is an area of project design to which SPDP will need to give particularly detailed attention prior to the commencement of wellsite clearance and construction. In particular, runoff surface drainage systems will need to be carefully designed and made site-specific, taking full cognisance of the site-specific topographic survey. In the course of current well site construction activities (at Cashiriari) lessons have been learned in terms of the difficulties in earthworking under severe rainy conditions, runoff controls and erosion prevention. These lessons will be applied at Pagoreni and SME-A, especially in regard to design capacity of the runoff control system, and for slope stabilisation. Slope stability and erosion will require monitoring and this is provided for in the EMP.

Interruption of Subsoil and Overland Drainage Patterns

The soils present in the area surrounding each of the wellsites can be characterised as mainly within the ultisols group, which are soils having slow infiltration rates and a moderate runoff potential when thoroughly wetted. Therefore, during the wet season, surface runoff effects would be slightly higher than in the dry season due to the susceptibility of the soil to erosion when under saturated conditions.

Although cut and fill will be necessary none of the wellsites is anticipated to generate a high impact on the subsoil and overland drainage patterns since the construction of the wellsites will be on the upper part of mountain ridges. Therefore, streams and surface drainage are not anticipated to be significantly affected, although drainage characteristics may change in the short-term according to the amount of cut and fill needed. Also the areas of landtake for each well (typically around 4 ha during the construction period) are not large enough to pose significant risk of reduced subsoil infiltration, particularly because for 70% of the year these soils are already saturated, and because surface runoff is a natural phenomenon.

However, surface runoff will increase from clearance of the wellsites, and compaction, use of steel (or other) matting and laying of cement slabs on the site floor and construction of the concrete wellpad. The mitigation measures

listed above to ameliorate the risk of landslides and accelerated erosion apply in most instances equally here and focus mainly on incorporating carefully engineered, site-specific runon and runoff controls into engineering design.

Alteration of Soil Quality by Loss of Topsoil and Overburden

Loss of topsoil and overburden, either by mechanical removal or by erosion would alter the soil structure with resultant implications for revegetation.

Measures inherent in the design of the project to minimise loss of topsoil and overburden are as follows.

- Topsoil removed during site clearance will be retained where possible, stored on the edge of the wellsite. However, it must be noted that a combination of topography and minimum practical landtake leaves little room for extensive storage.
- Cut timber and vegetation will be kept at the edge of the wellsite as a seedbank, as well as being used to protect/stabilise soil surfaces on slopes (see also *Box 6.3*).
- Vegetation will not be cutback to bare soil for helicopter approaches (see *Section 3.7.3*)

On demobilisation, following removal of equipment and materials from the site, the bare earth areas will be encouraged to re-vegetate:

- compacted subsoil will be tilled;
- retained topsoil will be re-spread over these surfaces;
- seeding and plating of pioneer species will take place.

Box 6.3 ***Vegetation Clearance and Disposal***

Vegetation clearance at the wellsites will potentially give rise to the following.

- good quality timber logs from 'valuable' tree species;
- other timber products;
- other useful forest 'products' such as fruits, medicinal plants, palm leaves etc;
- small branches, twigs and other debris.

In the first instance good quality timber and useful forest products will be identified with the assistance of local people and offered to the local communities to the degree possible. In the second instance this and other timber will be used in construction on site (eg for fencing).

Cut timber (especially bamboo) will be used for erosion control measures.

These measures should help facilitate regrowth and hence retention of topsoils. Provided they are successful, the impact of drilling operations on soil quality will be insignificant. It is, however, important that these measures are monitored to ensure that they are effective. Such a monitoring programme would also be expected to provide valuable lessons for re-instatement of forest clearance during subsequent gas field development.

Soil Contamination

Wellsite design (see *Section 3.8*) incorporates the following pertinent principles.

- Fuels, lubricants (including spent lubricants) and chemicals will be stored in an area underlain with impervious plastic lining. This area will be bunded to contain at least 110% of the capacity of the largest storage container.

- Non-contaminated and potentially contaminated runoff will be kept separate. Non-contaminated runoff will be routed to offsite areas via silt traps. Potentially contaminated surface runoff will be routed to the dirty water and oil separator tank. Oil will be skimmed off, collected in drums and shippped to Nuevo Mundo for disposal. Water will be treated in the wastewater treatment system.

- Any liquids collected in the test separator will be routed to the wastewater treatment facility.

- The cuttings pit will be adequately sized, bunded, covered, and underlain with high density polyethylene.

- On completion of drilling, the cuttings pit will be dewatered and the aqueous phase will be neutralised and routed to the wastewater treatment facility. The cuttings and solid wastes (including incinerator ash) will be neutralised, solidified and buried in the sealed pit.

- SPDP will implement the drillsite waste management plan, included in the EMP, which provides for:

    - effluent from treated sewage to be discharged to the drill water make up;
    - spent lubricants and other waste or unused materials to be removed off-site as soon as is practicable (and certainly prior to leaving the site) for appropriate off-site disposal or use elsewhere;
    - an inventory to be maintained of all fuel, lubricants and chemicals stored on the site;
    - the waste management system to be subject to regular inspection.

Since fuel will be securely stored, spills in unprotected areas could only arise from a vehicle for example. During the dry season, small spills are likely to soak into the soil for a few centimetres and some may, if persistent, reach the deeper horizon at around 20-30 cm depth. During the rainy season, however, when surface soils are water saturated, pollutants are unlikely to infiltrate the soil profile; they will travel along the surface as runoff instead. Should spills occur then it is most likely they will happen in the area protected by the potentially contaminated drainage system. If containment and recovery is not immediately possible, eg due to heavy rainfall, then secondary recovery will take place in the waste water treatment and/or oily water separation systems.

The mitigation measures inherent in the design of each wellsite, together with rigorous implementation of the waste management plan are considered adequate. Significant impacts in relation to soil quality are not anticipated at any of the wellsites.

Increased Rate of River Bank Erosion or River Bank Slumping

Gravel and perhaps sand will be required for surfacing at each wellsite. It is planned that these materials will be gained from the bed of nearby rivers. Collecting gravel and sand could give rise to slumping or increased rate of erosion at the river banks. There could also be some indirect effects to river navigation from these impacts, potentially affecting transportation along the river. Disturbed sediments may temporarily affect downstream water quality for a small distance.

The significance of impact will depend on a combination of factors:

- the quantities of material to be collected;
- the location of the borrow site (ie whether on a bend, adjacent to a steep bank, etc);
- the time of year in which the excavation occurs (if in the wet season there is a higher potential for impact, due to periodical flooding of the river banks).

The quantities required are expected to be relatively small (approximately 180 m^3 per drilling site). Since extraction of the material will be mainly undertaken during the dry season and the burden will be spread along the river rather than concentrated all in one place, the scale of the impact will be minimised and should not be significant.

Summary of Residual Geophysical Impacts

All the potential geophysical impacts can be mitigated by good design and construction practice. Key aspects of mitigation will include:

- site selection to minimise the extent of earthworks, resultant steep slopes and amount of cut and fill required (recognising the inherently hilly terrain of the region);
- protection and stabilisation of bare soil surfaces, especially slopes and storage mounds, using physical and bioengineering techniques;
- installation of runon and runoff drains to both mitigate erosion of drillsite soils and to minimise wider offsite changes to drainage patterns;
- protection of soil from contamination;
- implementation of waste management plan.

Nevertheless, despite best construction practice and fit-for-purpose design there will be a residual risk of potential landslide (such a risk exists without a wellsite present). Unforeseen circumstances such as extremely high rainfall, could cause a landslide or an excessive amount of soil erosion. Since there will be a period of several months between site construction and drilling

SPDP will make regular interim site inspections to check runon and runoff controls, erosion etc.

6.2.3 *Surface Water and Groundwater Quality*

Activities Giving Rise to Surface and Groundwater Impacts

Surface and groundwater impacts could potentially be caused by the following.

- Earthworks and deforestation at each wellsite may result in changes to drainage characteristics.
- Drilling through deep groundwater aquifers.
- Potential water discharges may arise from the following sources:
    - treated domestic effluent (sewage and kitchen waste);
    - spent drilling muds, cuttings and completion fluids;
    - (potentially) contaminated stormwater drainage from the rig pad and rigwash;
    - (potentially) high sediment loads in runoff from wellsite areas;
    - any produced water and liquid hydrocarbon fractions collected in the test separator during well testing.
- Potential spills of fuel, lubricants or chemicals and leaks from engines (ie chainsaws, power generators) and liquid hydrocarbons during testing may occur.
- Waste handling and disposal, particularly spent lubricants and chemicals may give rise to accidental releases.

Identification of Potential Surface and Groundwater Impacts

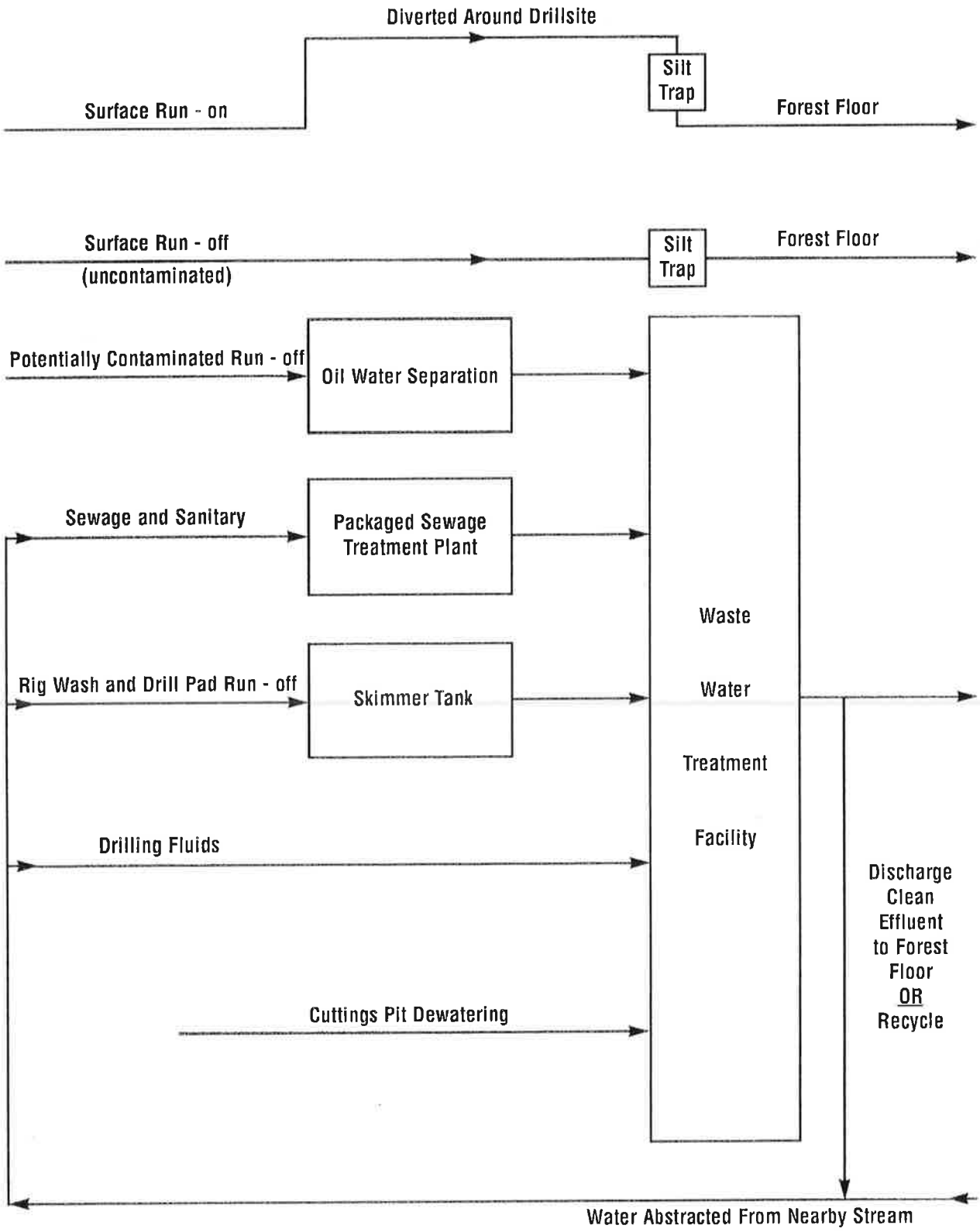
There are three categories of potential aquatic impacts anticipated:

- deterioration of surface water quality;
- deterioration of groundwater quality;
- disturbance to aquatic wildlife.

Impacts on Surface Water Quality

Wellsite design (see also *Figure 6.2*) incorporates the following relevant principles and features.

- Measures to minimise erosion and hence the load of suspended solids in catchment watercourses include:
    - minimise the extent of clearance of vegetation at the wellsites;
    - avoid cutting the roots of trees where possible, so as to retain land stability;


Diverted Around Drillsite
Silt Trap
Surface Run - on
Forest Floor
Surface Run - off
(uncontaminated)
Silt Trap
Forest Floor
Potentially Contaminated Run - off
Oil Water Separation
Sewage and Sanitary
Packaged Sewage Treatment Plant
Rig Wash and Drill Pad Run - off
Skimmer Tank
Waste Water Treatment Facility
Drilling Fluids
Discharge Clean Effluent to Forest Floor OR Recycle
Cuttings Pit Dewatering
Water Abstracted From Nearby Stream

- store topsoil (where possible) in a manner to maximise its reuse in restoration, thereby reducing the long-term risk of erosion;
- install runon and runoff surface drainage systems, which include silt traps and diffusion methods where necessary, so as to minimise soil erosion and prevent water stagnation.

- Domestic effluent will be treated in an activated sludge and chlorination package system. The treated effluent will then be directed to the drilling mud make up water and any excess will again be treated.

- Solids from spent drilling muds, completion fluids and cuttings will be routed to the lined cuttings pit, neutralised and encapsulated within the cuttings pit prior to SPDP departing from the wellsite.

- Non-contaminated runoff will be routed via a silt trap to an offsite location. Potentially contaminated runoff will be routed via the dirty water and oil separator tank to the waste water treatment system. All resultant discharges will be to a low gradient location in the forest where it will not cause erosion or stagnation; if necessary the effluent will be discharged via a diffuser to form a spray.

- The liquid hydrocarbons (condensate) will be burnt during production testing. Produced water fractions collected in the portable test separator during well testing will be routed to the waste water treatment facility.

- All fuels, lubricants and chemicals will be stored and handled within the dedicated bunded, covered storage area. Drip pans will be located under all engines.

- The cuttings pit will have a cover erected over it and will be of sufficient volume to contain the anticipated volume of dry solids (cuttings and spent, dewatered mud).

The final effluent will have a saline character due to the presence of potassium chloride. No effluents will be discharged directly into any of the rivers. Although the discharges of treated surface drainage, treated sewage effluent and treated supernatant effluent might eventually find their way into the streams, most will simply disperse into the forest. It will meet the World Health Organisation standard (for drinking water)of 250 ppm. The impact associated with these discharges is expected to be insignificant and the pristine waters of the nearby watercourses will not be placed at risk as a result of discharges from wellsites.

Noticeable impacts to water quality in nearby watercourses are more likely to occur as a result of increased suspended particle loads. During wellsite preparation, vegetation will be cleared and topsoil will be disturbed. The extent of impact to nearby forests or water courses will be a function of:

- area cleared;
- amount of rainfall in the period between clearance and laying of cement slabs (to provide a hard impervious and stabilising surface) and installation of site drainage systems to control runon and runoff;

- steepness of gradients between watercourses and drillsites;
- distance to watercourses;
- the amount and quality of intervening vegetation (especially the forest understorey) and 'filters' made from cut vegetation and mulch arising from the site clearance stage;
- how quickly runon, runoff and other controls can be installed.

Except in the most severe circumstances (such as a landslide) the latter point alone (each site is separated from the nearest watercourse by at least 300 m) will give adequate protection.

As outlined above, the project design includes several provisions to minimise erosion and it has been established that accelerated soil erosion should not be a significant impact. On demobilisation from the site some of the risks mentioned above will still apply. In the weeks leading up to demobilisation as much of the bare earth areas as possible will be allowed to revegetate.

Potential exists for accidental spillages of fuel, lubricants and chemicals to infiltrate watercourses. However, as described in *Section 6.2.2*, SPDP will ensure that on-site inventories of fuels, lubricants and chemicals (both fresh and used) are kept to a minimum. Bunds around the fuel storage area and cuttings pit together with roofing over them render the likelihood of contaminated overflow or a major spill unlikely. Finally, uncontained spills would more than likely be captured by the potentially contaminated drainage system.

Smaller spills are more likely to occur, but SPDP's site waste management plan, included within the EMP, makes provision for absorbent materials to be kept on-site to immobilise smaller spills and for their subsequent excavation and removal from site for proper disposal.

Overall, with proper implementation of the mitigation measures to which SPDP is committed, the impacts on surface water quality at all sites is likely to be insignificant.

Impacts on Groundwater Quality

Deterioration in surficial groundwater quality may result from:

- leaching from contaminated soil;
- pollution of surface runoff and soils ultimately contaminating groundwater through downwards infiltration.

The generally high clay content, together with the near year round water saturation of the soil will impede infiltration of contaminants to any great depths. Spilled material will therefore tend to run off, rather than infiltrate. Given that it has already been established that neither soil contamination and nor surface water pollution are regarded as likely areas of concern, contamination of groundwater is considered to be an insignificant impact as regards the exploratory drilling campaign.

The drilling of the exploratory wells includes penetration through a number of rock formations of different geological, structural and hydrogeological characteristics. The introduction of drilling mud to the subsurface that will be in direct contact with the geological units aforementioned implies potential for subsurface hydrological impact. The limit of the zone of invasion of the drilling additives around the drilled well will be a function of the geology and hydraulic properties of the formations encountered as well as the mud characteristics. Freshwater based non-toxic biodegradable fluids with inhibitive and encapsulative characteristics will be used, therefore minimising any long term impact on groundwater quality. Proper installation and cementing of well casing will ensure that groundwater flow between different stratigraphic horizons does not occur behind the casing.

Impacts on Aquatic Ecology

Impacts on aquatic ecology could result from:

- any deterioration of surface water quality arising from either increased sediment loads or contamination;
- excessive water abstraction.

Potential deterioration of surface water quality has been assessed above. Analysis has shown that contamination is unlikely and that suspended solids charging of nearby streams will be minimised, principally via site-specific engineering of runon and runoff control measures. Thus the potential impact is insignificant.

Water will be abstracted at a rate of up to 400 litres per minute. While the surface water bodies providing this water supply are expected to accommodate this loss, measures will be implemented to:

- minimise the use of water at the wellsite by recycling treated water;
- minimise the potential for fish and other animals to be entrained in the intake.

The abstraction inlet will be fitted with a fine mesh cage to protect aquatic fauna from entrainment.

Fish are a highly important source of protein to native communities, and are critical to their economies. Many important fish species are found in the Cashiriari and Camisea rivers particularly `doncella` (*Pseudoplatystoma fasciatum*) and `dorado` (*Brachyplatostoma filamentosum*). Fishing will be strictly prohibited.

Impacts to fish life could also potentially result from pollution of surface water, thus all mitigation measures aimed at pollution control and containment of spills will provide for fish protection.

Similarly, the likelihood of increased levels of total suspended particles (through soil mobilisation and erosion) causing indirect adverse impacts on aquatic life is low. Certainly should any 'events' occur these would probably

be within the range of those which occur naturally in terms of their extent, duration and magnitude.

It is worth emphasising that from monitoring of the existing appraisal drilling activity there has been:

- no detectable increase in dissolved metals;
- no increase in salinity;
- no detectable TPH.

Summary of Residual Aquatic Impacts

There will be no direct discharges from any of the drillsites to watercourses so the scope for impacts to surface water quality and aquatic life is limited. Water will be abstracted from the nearest suitable watercourse to each wellsite. Watercourses will be selected so that the rate of abstraction will not have a significant effect on dry weather flows. The abstraction pumps will be covered, bunded and will stand on an impervious base.

Indirect effects to water quality will be minor at most. Initially earthmoving operations will mobilise some soils and in wet weather these will be transmitted down slope towards watercourses. The nearest watercourses to the drillsites are as follows:

- Pagoreni D is approximately 500 m from the Rio Teranquiari, a tributary of the Rio Camisea;

- Pagoreni A is approximately 400 m from the Rio Sangarensiato, a tributary of the Rio Urubamba;

- SME-A is more than 1 km from two minor tributaries to the Rio Camisea.

Consequently the majority of mobilised material will be intercepted by the forest floor vegetation (acting as a natural filter), any adverse indirect effect is likely to be insignificant. As each drillsite becomes fully established then runon, runoff and drainage controls will become the prime mitigating agent and natural vegetation will provide secondary mitigation.

Groundwaters will similarly be protected against contamination by using high density poythene to underline all storage areas (used for fuels, lubricants and chemicals) and the cuttings pit. Sewage effluent will be treated in a packaged biological treatment plant and then discharged to the make up water and ultimately to the forest floor, it may contain a small level of microbial contamination (< 400 coliforms per 100 ml). However, as none of the watercourses are within 400 m of a wellsite and the fact that the intermediate forest floor will have a dispersion effect, it is not anticipated that the integrity of nearby watercourses is threatened.

On completion of drilling, all potentially contaminating materials will be removed from the wellsite. The cuttings pit will be dewatered resulting in the need to dispose of the supernatant. The dewatering process will involve

flocculation which effectively removes suspended solids and most metals will be co-precipitated with the particles. Any hydrocarbon contamination will be skimmed off. At the end of this process a relatively clean wastewater will be produced which will be tested prior to release to the surrounding forest soils.

Mud and additives will include:

- barites (tested for low cadmium and mercury contents);
- bentonite (a natural mineral);
- potassium chloride (KCl) as a weighting agent.

The resultant discharge is treated to 250 ppm chloride content, although episodes of higher concentration can occur.

To address this uncertainty SPDP will:

- seek to minimise the use of soluble salts as weighting agents in the drilling muds;
- determine an acceptable quality for the discharged supernatant;
- monitor supernatant quality and treat or dilute it to Peruvian Guidelines and IFC/World Bank standards.

6.2.4 *Air Quality*

Potential Sources of Air Quality Impacts

Sources of air emissions at the wellsites will be as follows:

- dust from earthworks;
- diesel powered generators;
- exhaust fumes from mechanical equipment (excavator, chainsaws);
- emission from flaring during well testing;
- emissions from helicopters.

Potential Impacts

Ambient air quality effects are normally assessed in relation to their potential to cause:

- health deterioration and nuisance in local communities;
- health deterioration amongst on-site workers;
- damage to vegetation.

Assessment of Air Quality Impacts

The criteria used to assess the type and magnitude of impacts are:

- constituents of emissions;
- local dispersion characteristics;
- distance of wellsites from local communities;
- presence of pollution sensitive plant species;

- amount and duration of emissions.

All emissions, other than dust arising from earthworks, arise from combustion of hydrocarbons. The pollutants of concern are NO_x, CO, particulates and unburned hydrocarbons, and SO_2.

The nearest identified meteorological recording stations are located at Sepahua and Nuevo Mundo. Sepahua is set in an environment comparable to that of the proposed wellsites, with easterly prevailing winds during summer period (January to March), and southerly/southeasterly prevailing winds during the spring and autumn periods (October to December and April to June). Despite generally windy conditions, still conditions are also often encountered in the area. The Sepahua station does not record the meteorological parameters required in order to derive Pasquil stability classes, which means that meaningful dispersion modelling could not be readily performed. SPDP's Nuevo Mundo station collects similar data to that at Sepahua.

The nearest community to the Pagoreni drillsites is Shivangoreni, which lies about 3.1 km from Pagoreni D and 6.6 km from Pagoreni A. SME-A is some 20 km to the east of Cashiriari. Emissions to atmosphere will be small scale and temporary. It is anticipated that air emissions will be dispersed within the immediate vicinity of the drillsites and will therefore not have any impact on Shivangoreni, Cashiriari or more distant communities which will be too far away to be affected. The effect of air emissions on communities will therefore be insignificant even during flaring.

The principal emissions which could influence on-site air quality (and hence workers' health) are those arising from the generators and from the flare during well testing. Both of these will be sufficiently buoyant to facilitate dispersion. Provided all equipment exhausting to atmosphere is maintained regularly to ensure effective combustion of fuels, and the generators are located so as to ensure that the stack exhausts are not subjected to downwash from the surrounding forest canopy, impacts to workers' health will be insignificant.

Vegetation can be deleteriously affected by dust blanketing and certain plants (such as sensitive species of mosses and lichens) are sensitive to NO_x levels in ambient air when exposed over a long period of time. Neither of these have proved to be demonstrable problems at the existing appraisal wellsites and are unlikely to be for the new ones.

During the short (2-3 month) site occupation period, vegetation clearance, cut and fill and other site levelling activities could generate dust particles which will be mobilised by wind and construction vehicle movements and fall within the individual wellsites' close proximity. The extent of such mobilisation is expected to be low since the soils are generally damp and the wellsite will be protected from wind effects by surrounding vegetation.

Summary of Residual Air Quality Impacts

To conclude, there will be no significant effects to air quality in the context of human health even during flaring. Similarly, effects on wildlife and flora will also be insignificant. It will be important to mitigate against dust generation since not only is it a form of soil erosion, but may also lead to degradation of habitats fringing drillsites.

The fact that existing meteorological data are inadequate to perform dispersion modelling studies is immaterial given the small scale and temporary nature of drilling activities. However, in the context of the future proposed full field development such meteorological data is now being collected by SPDP at Nuevo Mundo in the form of:

- hourly wind speeds and directions;
- atmospheric stability analysis;
- rainfall;
- wet and dry bulk air temperatures and relative humidity; ¦ cloud cover and insolation.

6.2.5 *Impacts on Flora*

Activities Giving Rise to Impacts on Flora

Impacts to flora will, or may potentially, be caused by:

- landtake (up to 4 ha per site during construction) at each drill site which will arise out of the need to provide the facilities described in *Section 3.7.1*;
- laying of the flexible water supply hose at each wellsite to the nearest stream to facilitate water supply;
- discharges of effluents to the forest environment;
- potential spillages of toxic chemicals, etc.

Besides the activities listed above, there are a number of potential impacts to other media which, if realised, would give rise to secondary impacts on flora. These, together with a reference to where they are addressed in this Report, are as follows:

- land slippage and slumping arising out of cut and fill activities to prepare the wellsites (see *Section 6.2.2*);
- erosion, siltation and water stagnation arising from runon and runoff at each wellsite (see *Section 6.2.2*);
- deterioration in ambient air quality arising out of emissions from on-site equipment (see *Section 6.2.4*).

Potential Impacts on Flora

Potential impacts to flora include the following:

- loss of species due to direct landtake;
- indirect damage offsite through dust, fire, air quality, etc;
- indirect damage offsite through soil erosion leading to siltation damage to trees etc;
- indirect damage offsite through pooling of water.

Mitigation Measures Inherent in Project Design

Wellsite design incorporates the following relevant measures which will ensure that potential impacts on flora are avoided or the significance of effects minimised.

- Each wellsite will be managed as an off-shore island with no access other than by helicopter (see *Section 3.7.9*). This will limit the geographical area impacted by wellsite installation and subsequent operation and minimise the extent of habitat and associated species affected.

- At the wellsites, the extent of vegetation clearance will be minimised by marking out the site boundary prior to commencement of clearance operations (see *Section 3.7.3*). Trees will be felled into the site.

- Helicopter approaches cleared for safety reasons will be kept to a minimum, ie a narrow approach cut to chest height (see *Section 3.7.3*). This will facilitate a rapid regeneration as the forest understorey will be retained largely intact.

- A flexible pipe will be used for water abstraction from the nearest stream at each wellsite: the pipe to be lain through the undergrowth and between trees without any need for felling of large trees. Undergrowth will be cleared along a 1 m width for access.

- Site-specific runon and runoff measures will be installed so as to minimise soil erosion and siltation and prevent water stagnation. Silt traps will also be used and the discharge will be diffused at the outlet so as not to cause erosion itself.

- If topsoil can be removed during site clearance, depending on terrain conditions it will be retained and stockpiled for subsequent reinstatement purposes.

- The flare will be sited in such a manner that, whatever the wind conditions, the flame and thermal radiation will not cause damage to vegetation.

The emissions of pollutant combustion products will have no significant impacts on flora; the amounts involved are too small.

General Assessment of Impacts to Flora

As noted above, a range of measures has been incorporated into project design to minimise the extent of forest clearance and reduce the potential for the loss of habitat and associated species. Landtake will involve

approximately up to 4 ha of complete vegetation clearance at each wellsite location. This implies a total of 12 ha of forest clearance if the option to establish all three prospective drillsites is implemented. While this might represent a very small area of the total Peruvian rainforest, any clearance of this unique and vulnerable natural resource could, in principle, be considered significant. Alternatively, with such a large resource available 12 ha could be viewed as an insignificant quantity. On the premise that the Peruvian nation requires controlled exploitation of its hydrocarbon reserves (and the Camisea gas reserves in particular) the loss of some rainforest is unavoidable. More relevant issues therefore are the extent of clearance, whether it can be avoided and if not, whether it is being minimised, whether it will recover, whether primary rainforest is implicated, is habitat disturbance extensive, does habitat fragmentation occur, and is it an important resource to local people?

It is also worth noting that habitat loss will be contained to direct wellsite landtake. Habitat loss arising from indirect impacts (such as fragmentation and severance) will not occur nor will those indirect impacts which would result in increased access by third parties since only helicopter access by authorised persons will be allowed to the wellsites. In addition, the use of a flexible hose to facilitate water supply will reduce the need for vegetation clearance between a drillsite and a nearby water source to be limited.

Another issue for consideration is that concerning duration of impacts and subsequent recovery of affected areas. Activities at any one wellsite are not anticipated to last for more than six months.

The ERM field visit undertaken in April 1996 found that the vegetation at three of the previous exploratory wells (from Shell's 1984-86 campaign) was recovering naturally in much the same way as areas rotationally used for slash and burn agriculture, with pioneer species and trees. In particular, the undergrowth had re-established at all three sites visited; however, the canopy was only established at one. Assuming similar recovery (SPDP's proposals contain significantly more measures to minimise vegetation damage including, firstly, use of pioneer and native species for erosion control; secondly planting of noble species such as, mahogany, cedro from the nursery maintained at Nuevo Mundo) it is reasonable to anticipate that the undergrowth would re-establish itself after approximately ten years with full re-establishment of the canopy after perhaps 15-20 years. It should be noted however, that, providing the drilling campaign proves successful, SPDP may use the well pads as the locations for developing cluster wells for subsequent field development. This will mean a longer duration of impact but reduced overall effects through minimisation of the number of future wellsites.

Site-specific Assessment of Impacts to Flora

A field survey of the area encompassing the wellsites has enabled the classification of habitats and the identification of indicative species mixes. Due to the heterogeneity of communities and access difficulties, particularly at San Martin, it was not practicable to prepare comprehensive and site-specific species-lists.

As noted above it is anticipated that SPDP may establish some or all of the wellsites as permanent producing wellsites. This would be a more permanent arrangement and a more extensive botanical survey would be justified to bridge the knowledge gap that presently exists with regard to species abundance and richness at, and in the vicinity of, each site. This would build upon work already commissioned by SPDP and undertaken by the Smithsonian Institution, which demonstrated that the Camisea region's floral biodiversity approaches that of the Manu National Park [1] . In addition, prior to clearance at all sites, a representative of the local community will be requested to identify any plants of value to the communities, which should either be saved once cut or, if practicable, left *in situ*.

Potential landtake impacts at the three sites are as follows.

- *Pagoreni A*: forests of this area are located on sloping (15 to 50%) lower hills in a system of 'lomadas' (small highlands). Bamboo is present but at low densities. The vegetation comprises primary forest. There is little evidence of disturbance.

  The development of the wellsite will result in the loss of 4 ha of relatively dense forest with a varied and diverse flora. Due to its location on moderately dissected lower hills, the potential for land slippage is low.

- *Pagoreni D*: forests of this area are located on the steep slopes (50-75%) of high hills. The vegetation comprises primary forest with palms present in the understorey. There is little evidence of disturbance in this area. The impact associated with landtake at this site is expected to be greater than for any of the other three wellsites. This is due to its location on a structural high hill with slopes sometimes exceeding 75%. Hence the potential for land slippage is high. In addition, the vegetation is dense and subject to little existing disturbance. Site specific mitigation measures will need to be adapted to minimise the potential for, and significance of, surface water runoff, land slippage etc.

- *San Martin*: vegetation of this area is located on sloping (15-50%) high hills. Bamboo is the dominant vegetation. Trees are present in low densities. Potential impacts associated with the installation and operation of the wellsite will be associated with the location of this area within structural high hills with some steep slopes (some >75%). The significance of landtake impacts will be reduced at San Martin, compared to Pagoreni D for example, due to the presence of bamboo, which is of less conservation value when compared with primary forest with high forest mass and tree densities.

Increase of Fire Risk

SPDP is committed to maintaining strict control over operations to ensure that no fires with risk to human life and the environment occur. In order to ensure that such impact does not arise, the wellsite will be designed to accommodate

(1) Proceedings from the Workshop on Biological and Cultural Diversity of the Lower Urubamba, Peru, 2-4 September 1996. Organised by the Biodiversity Programs of the Smithsonian Institution sponsored by SPDP.

a flare pit to house the condensate flare. Gas will be safely flared through a vertical flare. Alternatively, the flare rig will be laid out so as to ensure that the flare flame will not make contact with the forest canopy under any weather conditions. Contractors and staff will only be allowed to smoke or cook in designated areas of the site, again, well away from the forest canopy. Engines will all be diesel-type and maintained in good working order.

Other Impacts on Flora

Indirect impacts to flora could occur through the following:

- air quality impacts;
- siltation and water stagnation;
- soil erosion;
- slippage and slumping.

All are either insignificant (air quality) or subject to mitigation (see also *Sections 6.2.2, 6.2.3* and *6.2.4*).

Summary of Residual Impacts to Habitats and Flora

The main residual impacts to flora will be directly linked to landtake, approximately 4 ha at each wellsite. According to the assessment criteria given in *Section 6.1.6*, impacts will at most be insignificant to moderate and localised.

- The potential for impacts is greatest at Pagoreni D and SME-A due to their location in structural high hills with steep slopes.

- The significance of impacts at SME-A will be less than for Pagoreni D due to the predominance of bamboo which is of less nature conservation value than primary mature forest.

- The Pagoreni A wellsite is located on lower hills, of low to moderate slopes.

- Habitats at all the wellsites, although fragile, show the ability to regenerate/recover as is evidenced by the recovery, (initially) with pioneer species, since the late 1980's at Armihuari-1 and San Martin-1 wellsites.

- The sites are small 'islands' in otherwise similar habitats; they do not form ecological corridors.

In the context of the total areas of these habitat types in the study area, the loss of three, 4 ha 'islands' in the short term is an insignificant impact.

6.2.6 *Fauna*

Activities Giving Rise to Impacts on Fauna

Impacts to fauna could potentially be caused by:

- loss of habitat as a result of landtake at each drill site;
- noise disturbance, related to wellsite clearance, wellhead construction, drilling and testing;
- disturbance associated with on-site personnel presence movements involved in wellsite activities;
- illumination from night-time lighting and glare as a result of flaring during well testing activities;
- disturbance associated with helicopter movements conveying personnel and equipment to the site;
- impacts to fauna habitat and populations associated with waste management (storage/disposal);
- impacts on offsite populations due to offsite movements of personnel, hunting, trapping or taming.

Clearance of wellsites and construction of wellpads will require inherently noisy plant such as chainsaws, power generator, earthmoving equipment such as bulldozers and front-end loaders etc. These will operate for limited durations, usually about two months.

During drilling operations the main noise sources at the wellsites will include power generators, coolers, pumps, mud cleaners, degassers, centrifuges, flaring, and helicopter flights.

Besides these potential direct impacts to fauna, any impacts to flora (see *Section 6.2.5*) are likely to indirectly exert an impact on fauna.

Potential Impacts on Fauna

The activities listed above could lead to some of the following:

- loss, damage or disturbance to habitats;
- disruption of food chain as a result of loss of floral species;
- disturbance by human movement;
- poisoning, resulting from ingestion of toxic materials, plastic bags, etc;
- dependence, as a result of consuming food waste (or being fed).

Noise will especially be a source of disturbance. Vibration will not be an issue of concern; no piling is foreseen and vibration induced by drilling operations will be very local and the land affected (ie the wellsites themselves) will in any case have been subjected to forest clearance which will render the potential effects of vibration irrelevant.

Mitigation Measures Inherent in Project Design

The drilling campaign design incorporates the following relevant measures.

- Each wellsite will be managed as an off-shore island with no access other than by helicopter (see *Section 3.7.9*).
- The extent of clearance of vegetation at the wellsites will be minimised by design and staying within defined boundaries (see *Section 3.7.3*).
- Noisy equipment will be well maintained and switched off when not needed (see *Section 3.7.10*).

It is considered impractical to impose stringent noise emission limits at the wellsites when the impacts are temporary and there are no human receptors. Mitigation consists of maintaining all inherently noisy equipment in good working order, switching off idle machinery and completing the work in the shortest period practical, together with meeting those levels necessary for occupational health reasons.

The on-site power generators will be fitted with mufflers.

Assessment of Impacts

Impacts on fauna associated with landtake for the wellsites (4 ha per site) will arise from loss of habitat. Larger animals, such as mammals, are expected to move away from the area containing the wellsite. Larger mammals tend to utilise a large range, so the loss of 4 ha is not expected to have an adverse effect on behavioural patterns (as suitable alternative habitat is likely to be present within their range). Small mammals tend to have more limited (or smaller) territories. As such, the loss of range may require them to move to new areas. This effect is not assessed to be significant in relation to the large community size of these animals and their overall density within the wider area.

The range of territories occupied by arthropods tends to be more varied. Some species spend all of their lives in a very restricted area. Endemic species can occur on a very limited geographical scale. In theory, therefore, the loss of a small area of forest could result in an irreversible impact to arthropod diversity.

Many species of reptile (*eg* the snakes of the Boidae family, Corallus and Epricates and lizards of the Tropiduridae family) have territories which occupy very limited areas. Such species affected by landtake would be expected to relocate to suitable alternative local habitat.

Impacts associated with fragmentation/severance of corridors and pathways will be avoided by the exclusion of land-based access routes (access will only be permitted via helicopter) and the provision of water supply via a flexible hose (enabling retention of vegetation between wellsite and river).

The longterm effects to forest fauna of disturbance over a period of relatively short duration is not well understood. What is known is that all drilling activities and human movements will disturb wildlife.

The greatest impacts at these remote locations are likely to be during the construction phase when the local wildlife will be temporarily displaced. Birds and mammals will tend to react to construction noise by simply moving

away further into the forest. The density of vegetation will attenuate the noise rapidly such that only those habitats within a few hundred metres or less of the wellsite are likely to be impacted (see also *Appendix H*). Noise levels from the operation of the drilling equipment should generally be lower and less variable than from site preparation plant and by the time drilling commences some species of fauna will have adjusted to the new noise levels. Experience at the existing Cashiriari wellsite shows that large mammals (including tapirs and cats) are common within 1-2 km of the site after less than a year of occupation.

The wells will flare gas and condensate (depending on what is actually discovered) during testing. This is a very noisy process, typically producing levels of about 90 dB(A) at 50 m, and will probably impact animals some distance from the site. A slow build up of noise to full flaring level will help reduce the suddenness and severity of this impact. Well testing is expected to be of approximately three days duration at each horizon to be tested and could last for approximately one month.

Helicopter movements in and out of the wellsites and in the wider area will also be a source of noise disturbance. Close to the helipads noise levels in excess of 90 dB(A) may be experienced, whilst the Chinook hovering at longlining height overhead can give rise to noise levels in the same order. Even at distances of 1 km away the Bell 212 gave rise to noise levels of 50 to 60 dB(A). These levels are probably high enough to impact animals around the helipad area and in the vicinity of flight paths and especially along the angles of approach and departure. For safety reasons it will not be practical to expect loaded helicopters to adopt high approach and departure angles to reduce noise impacts, but the effects on animals could probably be reduced by ensuring the pilots keep to narrow and regular flight paths so that the affected area is minimised and sensitive local wildlife learn to avoid these areas and/or become acclimatised to the noise. To this effect, SPDP will not allow pilots conveying passengers to embark on 'game spotting' type diversions or excursions.

It is unlikely that any animals will directly suffer as a consequence of noise from the wellsites. The movement of some animals away from the new noise sources at the sites may however cause territorial conflicts, in which case indirect impacts may occur.

The fauna survey recorded a range of mammal and herpetofaunal species within the vicinity of the wellsites of nature conservation and hunting value. Of particular note, panther footprints were recorded at Pagoreni. The criteria used in assessing the degree of impacts in relation to fauna are as follows:

- amount and type of habitat at risk;
- presence of sensitive or endangered species;
- levels of noise or other disturbances.

Broadly therefore, despite the limited area of landtake proposed in construction of the three wellsites, careful attention to site clearance and appropriate on-site management, including measures to minimise habitat destruction, will be required throughout the drilling programme. Certainly

the method of clearance (ie starting at a central point and progressively clearing outwards) will facilitate evacuation of the vicinity of the wellsite by all mobile species. SPDP has also committed to maintaining strict procedures of environmental management which reflect the fact that the area is sensitive ecologically, in particular through ensuring that clearance activities are carried out sensitively and in consultation with the local communities, and ensuring that contractors and staff do not leave the site areas or hunt for food. Minimisation of night time disturbances (to the extent possible whilst still operating a drilling rig) will be of particular importance as many of the species in the local area are nocturnal.

As long as strict environmental management measures are put in place, including adequate measures for supervision of contractors and staff, negative effects on fauna will be minimised. There are, however, likely to be some residual, unavoidable, impacts, linked to the requirement to clear wellsites of vegetation to facilitate drilling activities. Monitoring will therefore be undertaken to assess the impact of drilling activities. Information obtained will be used as the basis for refining operations to reduce the long-term, adverse impacts on faunal communities.

Summary of Residual Impacts to Fauna

Residual impacts to fauna will be related to landtake and disturbance. The majority of fauna are sufficiently mobile as to avoid direct physical harm during tree felling and bush clearing. At most a small group of localised individuals would be affected. This together with the small landtake area per wellsite means that landtake impacts to fauna will be insignificant.

Disturbance impacts will result from various noise sources and human movement. The latter can be strictly controlled and an element of the former will be localised to the drillsites and immediately surrounding areas. Helicopter movements will extend the zone of impacts along their flightpaths. Strict control of helicopter flightpaths will act to limit the zone of impact. Nevertheless there is a degree of uncertainty in how different species of fauna will react to varying levels of disturbance. Some species may simply suspend feeding/foraging activity during helicopter overflights others may leave the area entirely. Experience to date at Cashiriari shows that large mammals are common within 1-2 km of the site.

Many species of fauna are expected to become habituated to the increased noise, particularly continuous sources. Such habituation has been recorded in many faunal communities located within the vicinity of development sites and industrial facilities. Nevertheless there is some uncertainty over the degree of overall disturbance impact to fauna. SPDP will indirectly monitor such effects through community consultations to:

- see if hunting areas have changed;
- see if species hunted are different.

In addition further (long-term) monitoring studies will look at fauna in the wider area.

6.2.7 *Landuse*

Introduction

As stated in *Chapter 5*, traditional and sustainable land uses in the Study Area concern mainly agriculture and cattle grazing, hunting, logging and cultural patterns (medical uses).

There are four potential landuse impacts to be considered:

- loss of potential (ie as yet undeveloped or underdeveloped) agricultural land (both crops and livestock);
- loss of areas suitable for logging and for extraction of timber products (eg palm);
- loss of hunting areas and/or displacement of species of economic importance for the villagers;
- loss of areas used for cultural purposes (ie areas used for collecting medical plants, sacred areas).

Loss of Agricultural Lands/Forest Resources

Activities which could potentially contribute to loss of agricultural land primarily comprise landtake for drilling pads and ancillary facilities.

None of the three wellsites is located sufficiently close to a populated area or fields presently used for agriculture or to areas which could conceivably be used in the near future for such purposes; there will not be any direct loss of agricultural land as a result of the drilling campaign.

Loss of Areas Suitable for Logging

The main criteria to assess impacts relating to loss of areas suitable for logging are:

- amount of land at risk;
- presence of sensitive/valuable/slow growing species.

It is estimated that up to 4 ha of land will be required for each of the wellsites, therefore a total of 12 ha is anticipated to be required for the entire drilling programme.

The tree species which are normally logged by the communities and hence termed 'Valuable' are:

- 'Cedro': *Cedrella odorata;*
- 'Tornillo': *Cedrelinga catenaeformis;*
- 'Caoba': *Swietenia macrophylla;*
- 'Moena': *Aniba sp., Ocotea sp.*

Any economically valuable species of tree which are required to be felled will in the first instance be offered to the local communities for their use. Bearing in mind the distances involved it would not be practical to make all timber

available. In the second instance these resources will be used constructively on site for construction of buildings, for erosion protection and slope stabilisation.

SPDP has committed to ensuring that logging activities are contained within the site, and that trees are logged in such a way as to ensure that they fall into the site area, rather than outwards onto other surrounding trees.

During the consultation programme, it was stated by certain villagers, particularly in Cashiriari Community, that because methods of tree felling are still largely primitive (using hand cutting techniques plus transport by hand to the river) trees are generally felled near the rivers to minimise the requirement for manual handling. Thus the wellsites (which are largely inaccessible) will not be in conflict with existing logging areas.

Bamboo was dominant at SME-A, whereas the two Pagoreni sites contained a number of forest tree species and palms. It is likely that the two Pagoreni sites will contain species of use to the local communities.

Effects on Hunting Areas

Factors which could contribute to effects on hunting areas include:

- landtake for wellsites;
- waste handling and disposal;
- site activities and movements;
- site noise and helicopter noise;
- poaching.

The impacts on fauna have been addressed in *Section 6.2.6* and on aquatic resources in *Section 6.2.3*.

Main assessment criteria which have been used for the effects on hunting areas are:

- presence of valuable species;
- amount of hunting area at risk.

SPDP has implemented a policy strictly prohibiting hunting, trapping or taming of any animals or the keeping of pets or the handling of trophies, hides or birds' eggs by contractors or staff. This policy has been effective and will continue. SPDP's waste management practices, discussed in *Section 6.2.2*, will ensure that all ecotoxic waste material will be removed from location by helicopter, thereby ensuring that it cannot be ingested by any animals. Therefore, the only impact which may arise is from displacement of hunted species and disturbance from noise (especially helicopter movements), worker movements and illuminations from site lighting and flaring. These issues have all been discussed in *Section 6.2.7* and *6.2.8*.

Overall, given the small areas of land to be taken for development of the drillsites, SPDP's commitment to ensuring that contractors and staff do not hunt or trap, and the fact that there will only be displacement rather than loss

of animals from the site works, the impact on availability of hunting areas has been assessed as insignificant.

Loss of Areas Used for Cultural Purposes

During interviews with the villagers of the potentially affected communities, it was ascertained that none of the proposed wellsite areas are regarded as sacred or likely to exclusively contain forest species of particular medicinal value.

Plants which are recognised as useful for medical purposes are 'huito' (species not determined) used by the villagers to protect themselves (particularly children), against insect bites, and 'Cat claws' *(Uncaria tomentosa)*, and 'palo-sangre' (species not determined) used for disinfecting wounds (in the same manner as iodine is used in standard medical practice).

However, there are likely to be many more species which are used by the villagers, which are only known to them. Villagers, however, stated that areas of collection are normally close to the communities, therefore major impacts are not expected to arise from temporary loss of these species at the wellsites. However, SPDP's commitment to allow villagers to survey the wellsites prior to felling, so as to allow them time to identify and collect any species which they would wish to receive, will further mitigate any impact which may arise.

Summary of Residual Land Use Impacts

There will be no direct land use impacts since the wellsites are remote from the local communities and relatively inaccessible. Nevertheless they have potential land use value and may contain resources which are useful to the communities and therefore an appropriate level of compensation will be agreed (see also *Section 6.4.5*).

6.2.8 *Other Impacts on Resources and Infrastructure*

Introduction

As highlighted in *Section 5.12*, infrastructure is very scarce in the Study Area, especially in the vicinity of the three drillsites. Wellsite preparation and drilling operations could conceivably affect the following infrastructure:

- water supply system;
- river navigation;
- existing trails.

Gravel extraction from rivers has been addressed in *Section 6.2.2*.

Community Water Supply in Relation to Wellsites

Water supply is only available to the Camisea community through a well which was built by the Swiss Mission in 1994. This well is 10 m deep and draws on the water table located at a depth of 5-7 m below ground. However, Segakiato and Shivangoreni communities use springs directly fed by

groundwater resources. The assessment of impacts to groundwater indicates that none of these resources is at risk.

Loss of Trails Due to Interference

There are no formal records of existing trails around the wellsites, although there may be trails which the local villagers use, and keep secret to avoid encroachment. The only recorded track is the old road leading from the old SEPP Camisea base camp to San Martin-2 and Armihuari-1 via Cashiriari 1 and 2. This track is not in use and has been taken over by vegetation.

No trails were identified during the field trip, but data collected by the socio-anthropological team show the existence of trails connecting the communities together. These trails are not constantly used, but appear to be maintained on a regular basis. These tracks, well used by the local populations for hunting and for access to huts, are hidden in the undergrowth. Their existence is kept secret by the Machiguengas who do not want others to encroach on the area.

SPDP has committed to maintaining strict control over the encroachment of contractors and staff into forest areas. Workers will be accommodated in workcamps at the wellsites, and prohibited from entering the surrounding forest for their own safety and security, as well as to prevent damage to the surrounding environment.

With strict adherence to these mitigation measures the level of impact on existing trails is likely to be insignificant.

Glare from Flaring

During well testing, flaring will take place continuously over an approximate three day period per horizon tested, during which time the pressure of gas will be increased. This activity will cause a significant change in the background levels of light in the local vicinity of the site, especially during the night, and is also likely to affect the background levels at further distance to some degree. This will have the effect of changing the appearance of the sky. However, as the communities are a long distance away from the wellsites (ie more than 3 km), there will be little immediate impact from the glare of the flare on the communities (as long as they have adequate forewarning), although there could be a more profound effect on any nomadic persons in the vicinity. There will be some impact on the surrounding fauna whose living patterns will be disturbed, potentially significantly, during the flare testing. Given that the duration of the flare testing will be relatively short, it is anticipated that the impact will be of a largely temporary nature. Nevertheless, SPDP will forewarn the communities in advance of well testing. Alternatively SPDP is investigating cutting edge technology. This would involve a fully enclosed flare, which if it proved feasible to use would produce no glare and therefore no impacts. Glare impacts from the condensate ground flare (if used) would be smaller and of much shorter duration (and could be run only during the day).

6.3 SOCIO-CULTURAL IMPACTS

6.3.1 *Introduction*

In discussing potential socio-cultural impacts, it is difficult to isolate those potential impacts associated with the exploratory drilling programme from the ongoing Appraisal Drilling campaign, and indeed from those of the future ultimate full field development.

In order to establish a meaningful discussion of potential impacts associated with the exploratory drilling programme it is therefore necessary to consider issues which have arisen as a result of the ongoing work in the project area in the context of the extent to which these may become moderate or significant impacts at a later stage and thus require additional controls to be put in place now. It is apparent from experiences to date that in some areas the controls put in place for the Appraisal Drilling Campaign have been a success, whilst others will require further attention. The remainder of this section focuses on such matters.

6.3.2 *Range of Impacts Considered*

Potential impacts which need to be considered as a direct or indirect result of project activities are as follows:

- unwanted access;
- direct loss of economic resources (timber, other forest products, food etc);
- landtake of productive lands (agriculture, pasture, hunting and fishing areas);
- general community disturbance;
- protection of drinking water supplies;
- human health impacts;
- loss or damage to archaeological sites;
- increase in employment and income generation;
- provision of health and education services.

There is also the question of how the above effects may have cumulative, and profound changes on a way of life that has more or less prevailed for thousands of years.

6.3.3 *Unwanted Access*

One of the most severe social impacts associated with petroleum development activity in rainforest regions is associated with the in-migration that often follows the penetration of remote areas. The extent to which in-migration is an issue typically depends on the size of the workforce, the level of associated infrastructure development and basic service provision and, most importantly, on the nature and degree to which the project augments access to and within the project area. Where substantial infrastructure development is involved (such as the construction of new access roads and airstrips, for example), the consequences for traditional community life may be serious and far-reaching. In the longer term, and as an overall consequence of project presence, communities may undergo cultural change

and new (uninhabited or sparsely populated) areas become targets for inward migration.

In order to minimise unwanted in-migration for the Appraisal Drilling Campaign SPDP proposed not to initiate any new means of access to the Camisea area or within it.

- The existing airstrip at Nuevo Mundo has been improved.
- The Logistic Centre at Nuevo Mundo is under SPDP control. SPDP has not and will not employ any individuals applying for work locally, other than members of the local communities.
- Barges, aircraft and helicopters do not and will not carry any unauthorised/third party passengers.
- Each of the three drillsites will be installed and managed as an off-shore wellsite, ie the only access to wellsites will be by helicopter. No access roads will be constructed.

These are all important measures since not only do they limit the means by which individuals can enter the area, they also act to severely limit the attractiveness of the area to opportunistic colonisers.

These measures were implemented and have been successful. There has been no resultant 'colonisation' or associated adverse effects (such as 'boomtowns'). These issues will be discussed no further.

6.3.4 *Direct Loss of Economic Resources*

Installation of the three proposed drillsites will inevitably result in some vegetation clearance. Clearance will lead to some direct loss of timber and non-timber forest products, some of which will be of commercial or conservation value.

Timber is of fundamental importance to the Machiguenga and is used for the construction of houses and other temporary dwellings. In addition to timber, some fruit-bearing trees also provide a food source for a wide range of fauna and form the focus of seasonal Machiguenga hunting activities. The disappearance of fruit trees from some locations may lead to the relocation of hunting activities which may, in turn, disrupt the established hunting equilibrium.

Limited forest clearance and the associated loss of forest resources is an unavoidable impact. However, the economic significance of the impact for communities will be reduced through the provision of direct compensation for forest resources lost. This will entail the identification of valuable species and estimation of volumes (or basal area or number of species) to be lost.

In addition, preference will be given to the communities themselves to carry out vegetation clearance activities; a number of Machiguenga (from Nueva Luz to Kirigueti) are competent in the use of power-driven saws.

A summary of mitigation measures for the protection of economic resources and enhancement of economic recovery is presented in *Box 6.4*.

Box 6.4 ***Mitigation Measures: Loss of Economic Resources***

Issue	Recommended Mitigation Measures
Depletion of forest (timber) resources	• Depletion of forest (timber) resources SPDP and local communities (in collaboration with a forester) shall establish the exact area, volume and types of tree species to be removed with a view to developing appropriate compensation. • Local communities shall be consulted to establish the most appropriate form of compensation (eg financial, provision of services etc).
Degradation of fauna resources.	• SPDP will implement an awareness training programme amongst its workers to increase general awareness of the conservation value of forest fauna.
Degradation of vegetation resources	• Prior to vegetation clearance (for the installation of wellsites), members of the Machiguenga communities will be recruited to visit each site together with a third party expert in the applications of local fauna. The purpose of the visits to locate useful trees and other plants as outlined below: • furnishing palms used for roofs of housing; these are rare and therefore very precious in the region of the Camisea (as emphasised at Shivangoreni and Segakiato); • edible cogollo palms (hearts of palm); • palm trees furnishing fruits or traditionally used building material; • marketable tree essences, either in order to recover them, or to use them in situ; • lianas, climbing plants and other plants used as building material, in therapies or in traditional rites. • Removal or damage of agricultural or horticultural crops shall be prohibited.

To summarise, the construction and installation of the three drillsites will entail the direct loss of some economic resources such as timber, edible plants and fruits, albeit on a small scale. It should be noted that, due to their remoteness and inaccessibility, the drillsites can at best be regarded as only a potential resource. The impact on local communities will not be significant and will be mitigated through the development of an appropriate compensation plan which is transparent, equitable and agreed by all directly and indirectly affected parties. These activities are best conducted by the Machiguenga whose local knowledge of forest species will be invaluable.

6.3.5 *Landtake of Productive Lands*

General

As a population, the Machiguenga are closely dependent on the productive capacity of the lands which they occupy. Small agricultural plots, known as

chacras, are worked by each family group and are used to produce a wide range of subsistence crops on a rotational basis.

While the drilling programme might involve very limited landtake of forest, which is potentially of commercial value, at the drillsites adequate compensation will be agreed with the affected communities. To prevent unnecessary conflicts and inter-community disputes, an equitable system of land compensation will be established prior to land clearance. SPDP is in the process of getting advice from an environmental lawyer on drafting a model of agreement, which will then be discussed further in consultation with the local communities. Shivangoreni is most likely to be more directly affected by landtake; certain other communities (ie Camisea) could claim to be affected indirectly.

Mitigation: Loss of Productive Lands

The directly affected community will be compensated for direct landtake. Other communities will also receive some compensation as is appropriate.

Compensation for the use/change in use of productive lands associated with the project is a complex issue. Approximately 4 ha of forested land at each wellsite will be required by the project. Attaching a specific value to these lands is complicated and will need to be discussed between the developer and the communities on the same basis as has been used or the existing appraisal wellsites.

6.3.6 *Community Disturbance*

General

Community disturbance during the drilling campaign may arise through the following activities:

- use of helicopters;
- use and movement of construction plant;
- drilling activities (see *also Section 6.2*);
- flaring (see also *Section 6.2.8*).

These activities will produce noise disturbance, and with it possible interruptions to daily village life. Helicopter and construction vehicle movements may also cause some disturbance to forest fauna, animal and bird nesting and reproductive activities although it is difficult to predict the extent of these effects. These effects may have implications for the Machiguenga who rely on hunting as a significant source of animal protein for food.

Noise Effects

The findings of the noise assessment are contained in *Appendix H*, and summarised below.

Baseline noise levels were measured in two native communities, Shivangoreni and Nuevo Mundo. From these baseline measurements, together with

internationally accepted standards (eg World Health Organisation), noise assessment criteria relevant to the Camisea region were developed. At the same time noise levels due to drilling, river vessels and aircraft movements were quantified.

On the basis of the above measurements, and in applying the to the proposed exploratory wells, the following conclusions can be drawn.

- Impacts due to drillsite construction and operation are very unlikely to occur.

- River vessels give rise to noise impacts subject to their distance from the receptor. Hovercraft noise causes the highest disturbance levels but it will not be used for the proposed exploratory drilling programme. The impact is a transient one as the vessel passes.

- Helicopter movements give rise to noise disturbance and nuisance in the communities. Sound levels inside dwellings and speech interruption in the open can both be significantly affected. The impact is relatively transient, but repetition adds to its severity.

It should be noted that helicopters provide a positive function - ie their extensive use removes the need for access roads. The most effective way to mitigate noise nuisance and disturbance from helicopters is to maximise, taking full cognisance of navigational safety, the distance between flight paths and the communities.

Other Effects

In addition to foreseeable disturbance, there will also be some risk of accidents or accidental damage to properties and infrastructure through, for example, vortex effects of aircraft, fire etc. To this effect, SPDP will locate helipad sites away from dwellings both to reduce downwash effects and minimise noise disturbance.

Box 6.5 summarises proposed good practice measures for the mitigation of community effects.

Box 6.5 Mitigation Measures: Community Disturbance

Issue	Recommended Mitigation Measures
Noise disturbance to humans	• Night-time working will be avoided at Nuevo Mundo which is the only project work site close to native communities. • Fixed flight paths will be used for both helicopters and fixed wing aircraft when serving the wellsites or the various logistics sites. These paths will be agreed with the communities.
Interruptions to day-to-day activities	• No unauthorised entry by Contractors, Sub-Contractors or other project personnel shall be permitted into communities. • Helicopter landing and takeoff areas on the runway will be located as far away as possible from temporary and permanent dwellings; helicopter landings and take off shall be controlled to reduce the risk to properties and people; overflight will not be permitted.

Issue	Recommended Mitigation Measures
Visual intrusion	• Maximum use shall be made of natural vegetation barriers to screen intrusive activities.

6.3.7 *Protection of Drinking Water Supplies*

Shivangoreni and Segakiato have asked for guarantees with respect to the preservation of the water of the Camisea River itself, used by half the villagers in each village. The same applies at Cashiriari, where two thirds of the village take their supplies directly from the river. Protection of water quality is an absolute necessity for the sustainability of the project and will be achieved through the adoption of good working practices and the enforcement of strict controls on domestic, sanitary and other waste disposal.

Specific mitigation measures for the prevention of the contamination of drinking water supplies are presented in *Box 6.6* and have been described in detail in *Section 6.2.3*.

6.3.8 *Human Health Impacts*

The adverse health effects of new developments in previously isolated areas have the potential to present serious problems for native populations and attract intense attention (whether warranted or unwarranted).

In addition the local communities make clear links between the perceived environmental quality and their own health. The fact is that the majority of poor health condition in the area is attributable to nutritional status, sanitation and the prevalence of endemic diseases and parasites. However, the perception is that illness is something that strikes from outside not just the body but also the immediate community (1) . Thus if there is a perception that SPDP is polluting the atmosphere or the rivers then this will be perceived as a direct threat to the individual's and community's health above and beyond the usual (and more real) threats. This in turn can lead to a general level of anxiety, which the communities also effectively regard as an illness - *"the mind should be without anxieties"* (see Health Baseline Study). In perceiving such threats to health, distinctions are not made over the level of 'pollution' causing it. Small changes to river turbidity or minor emissions of exhaust gases from a handful of vehicles can be perceived as health threats.

From its previous experience of undertaking similar developments in Peru and other remote tropical regions, SPDP is acutely aware of the potential for health problems and has already committed to a number of measures to reduce the likelihood of adverse effects. The most important of these relates to the use and enforcement of 'Health Passes'. All visitors, whatever the purpose and duration of their visit, must be able to demonstrate in advance that they have been inoculated against the non-endemic diseases (ie those from outside the area) that are a threat to the health of the local communities.

Box 6.6 summarises mitigation measures for the prevention of adverse health impacts. The risks of disease transmission will be reduced through the

(1) A Health Baseline Study in the Camisea Area, Lower Urubamba, Peru.

adoption of these measures and the provision of improved health care facilities, medical personnel and medical provisions.

Box 6.6 *Mitigation Measures: Impacts on Human Health*

Issue	Recommended Mitigation Measures
Disease transmission	• All workers shall undergo medical screening for communicable disease prior to commencing work (particular attention will be paid to malaria, influenza and sexually transmitted diseases (STDs)), and vaccinations provided. • Prophylaxis (for the prevention of malaria) shall be made available to the entire workforce. • Compulsory inoculation shall be introduced for the entire workforce (see list of Do's and Don'ts in EMP). • The creation of bodies of standing or stagnant water shall be avoided to prevent the creation of additional breeding grounds for disease vectors (eg mosquitoes). • Any worker developing or showing signs of malaria, dengue or other fevers shall report to the site supervisor and doctor immediately.
Increasing demand for health services	• All workers shall be trained to be aware of SPDP policy and actions with regard to medical emergencies. • Workers will be required to use toilet and sanitation facilities provided at the wellsites and at the logistics camps. • There will be on-site medical provision through a SPDP doctor, who will also work closely with the local community to facilitate the early detection of any problems. • Measures shall be undertaken to prevent the uncontrolled interaction of workforce during downtime and vacation periods with local communities. • All measures shall be taken to raise health awareness (particularly of STDs and malaria) and train workers in emergency evacuation procedures. • SPDP shall provide access for the local community to emergency medical care facilities (including MEDEVAC).

However, although SPDP has put in place all the necessary measures to protect surface and groundwater supplies and air quality impacts are negligible the means of adequately demonstrating these matters to the local community will need to be sought. Simple monitoring of indicators, whilst necessary, will not be enough. Explanation through consultation will be needed to allay community fears. At present the local communities see changes to their environment and perceive some of them as threats to their health. SPDP will implement a programme, combined with monitoring, to explain the true consequences of what are generally minor changes. The programme will educate the communities in such matters as the levels at which the pollutants are known to cause adverse effects and the corresponding levels that urban communities tolerate.

6.3.9 *Employment and Income Generation*

The community activities (some of which are related to income generation) within the project area are concentrated along the Urubamba River and diminishes with increasing distance from it. Cashiriari is located at the end of the employment chain with weak economic development and the majority of activities focused on subsistence production (horticulture, fishing, hunting and gathering).

The presence of the SPDP project at the geographical end of the Urubamba River valley 'employment chain' can have two potential effects on the existing pattern of employment:

- the direct provision of employment opportunities associated with project activities;
- longer term effects on income distribution in the area.

Limited employment opportunities will arise on the project even though with exploratory drilling SPDP's presence in the area will be extended. The number of workers overall to be contracted during the drilling campaign will continue to be in the tens rather than the hundreds. There will continue to be a need for local guides, foresters, environmental studies and logistics support. Despite the above, employment expectations are likely to outweigh the actual number of positions available. Longer term employment benefits may also arise indirectly within the health and education sector but will be small scale.

Several communities (eg Nuevo Mundo) expressed employment creation as an overriding concern and reflected the serious negative consequences that imported labour could produce. However, notwithstanding this, it is clear that skilled drilling rig workers and SPDP logistics contractors will need to be used.

The positive employment opportunities presented by the SPDP project will be enhanced through a proactive approach to local community participation. Depending on the exact type of employment, the communities have suggested that a 'concentric' employment strategy is adopted whereby priority is given to the communities directly affected or closest to the project sites passing to the more distant communities as appropriate. Once this approach has been formally adopted, it could be administered by the communities. During consultation Shivangoreni community expressed the wish that since exploratory drilling would be so close to their village, they should be given preference in the award of employment over other communities.

These measures will continue to have a small positive effect on the local economy, reduce the present sense of economic marginalisation from more developed areas felt by the Machiguenga and reduce any potential enmity between the project and local people.

Further positive impacts will arise through the generation of additional income resulting from:

- direct income from the provision of labour by indigenous groups;
- local trade (particularly in the sustainable sale of agricultural produce from indigenous and other groups).

The project may also result in some secondary stimulation of local trade and markets which will benefit indigenous populations through an increase in demand for local goods, an increase in trade activities and the demand for manufactured goods such as clothing, tools and food.

However, it is also possible to predict a number of negative impacts on the socio-economic status of the area through increases in inflation associated with higher levels of monetary circulation. Inflation impacts will be particularly acute if there is no parallel increase in the level of production of agricultural and other basic produce and discrepancies between the prices paid for local and imported produce. Access to higher income levels may have a negative effect on the traditional lifestyle of indigenous communities, particularly through changes in consumption patterns and a shift in emphasis from subsistence production to a greater focus on exotic produce, and a monetary economy. To date such effects have not been observed, nor have they been reported in local consultations.

Employment and income generation opportunities will be enhanced through the adoption of the measures outlined below in *Box 6.7*.

Box 6.7 ***Mitigation Measures: Employment and Income Generation***

Issue	Recommended Mitigation Measures
Short and long term employment opportunities	• Measures will be taken to maximise opportunities for the involvement of locals in skilled and semi-skilled work (for example tree felling and sawing). • Technical training shall be provided for local employees where possible (although this is really a long-term activity). • SPDP shall ensure that wages for native workers are equivalent to what would have been paid to workers from outside the region doing similar work. • SPDP shall encourage over time the purchase of local produce. • In all circumstances, the full regional price shall be paid for local produce; the system of pricing shall be transparent and implemented village-wide. • Existing agricultural activities shall be enhanced through the provision of agricultural extension and training in conservation practice through, for example, agroforestry, subject to long term presence.

As reflected during the community consultation process, the communities have raised expectations of employment and have expressed preference for the following types of employment:

- as motorists and prow-men;

- as lumberjacks and timber merchants;
- as suppliers of agricultural products, poultry and fishing products at the regional price.

However, it should be noted that fish appears to be the major protein source to the communities and that fishing is an important cultural activity. SPDP therefore has a policy to ensure that in purchasing fish especially (but also many other local produces) the local food economy is not upset, in a way that could have possible consequences to the nutritional status of the local communities.

The positive effects of new employment opportunities should be maximised by continuing an overt policy of sensible recruitment of local labour. This will diminish existing tensions between the communities and developers and provide a sense of economic liberalisation of the Machiguenga.

6.3.10 *Public Services*

Several communities have indicated that they regard the overall Camisea development project as a potential source of revenue for the support of educational facilities and other public services; in many cases, children within the communities have been excluded from secondary education due to a lack of financial resources. The villagers have suggested that, with SPDP's help, appeals could be made to the Peruvian government for the rediversion of some percentage of taxes to educational support in the form of:

- financial provisions for fees;
- financial provisions for journeys (some schools are very remote);
- boarding fees for secondary schools;
- provision of grants and scholarships;
- provision of educational resources;
- teacher training;
- agropastoral training;
- education in nature conservation;
- technical training in competent jobs linked to gas production.

It is important to realise that as for the appraisal drilling currently underway, the proposed exploratory drilling campaign entails a very focused programme of short duration which will in itself provide little direct potential for delivering the facilities (or the revenue to support the facilities) listed above. However, longer term planning and dialogue with community leaders as part of the Social Capital Programme is ongoing to initiate a sustainable programme for promoting social capital within the local populations as the development and production phases occur.

6.3.11 *Interactions with Communities*

The presence of a new workforce and its associated employees in a previously remote,area may lead to unwanted interactions between the imported workforce and the permanent population. These interactions may, in the medium-term, lead to disputes between the project and local villages and cause unnecessary aggravation. Unwanted interactions may be avoided

through the introduction (into contractual documentation) of social behaviour obligations on the workforce. *Box 6.8* below summarises good practice measures for the avoidance of unwanted interactions and to date these have been successfully applied in the appraisal drilling campaign.

Box 6.8 ***Mitigation Measures: Unwanted Interactions***

Issue	Recommended Mitigation Measures
Unwanted interactions with local residents	• All construction areas/work camps shall be located away from village communities. • All SPDP and Contractor employees shall adhere to a code of social conduct to govern interactions with the local community, to be put in place prior to project commencement. • No unauthorised entry into villages shall be permitted. • SPDP shall enforce strict penalties to any employee found guilty of misconduct (eg brawling, drunkenness). A policy of local hiring shall be adopted as a contractual obligation.

6.3.12 Cultural Change

The potential for cultural change is typically dependent on the interplay of a number of factors as follows:

- the strength of existing kinship ties, marriage ties and existing social structures within the affected population;
- the traditional modes of land division, food production and food consumption;
- the duration of project presence in an area.

In the case of the Machiguenga, kinship and other social ties are very strong; as a people, the Machiguenga have survived a cyclical process of transition, adaption and reconstruction. Cultural identity has remained intact despite the force of external pressures. In addition, the Machiguenga have thrived on the concept of communal ownership of the land and its resources. Individual land ownership is discouraged and the belief that the land is the common inheritance of future generations is shared by all.

Introduction of the Camisea project could affect the cultural integrity of the Machiguenga in the following ways:

- through raised expectations of local development, access to higher education and an increased awareness of modern economic relationships;
- through the introduction of a 'capital orientated' economic influence into a non-capitalist society;
- through the provision of individual, as opposed to communal, access to the means of production;
- provision of salaried work to some and not all;
- the introduction of a class structure as opposed to a reciprocal arrangement for the division of work based on sex;
- accumulation of capital in place of redistribution of excess production;

- through the prolonged absence of the heads of families and older sons (male absenteeism) and associated increase in workload of the women;
- increases in the rate of alcoholism;
- increasing interrelationships and possibly marriages between local women and migrant populations/workers.

In terms of susceptibility to cultural change, the Machiguenga are considered to be more resilient in comparison to certain other sub-Andean groups due to their growing numbers and long experience of politics. Moreover, owing to the short duration of the drilling campaign the current state of affairs is unlikely to be dramatically changed.

However, the project may reinforce the Machiguenga's sense of isolation and marginalisation from other Andean and sub-Andean groups depending on the degree to which the Machiguenga feel that they have been actively or passively involved in the project. The equity of local/outsider project participation and general respect shown by the contract workforce to local residents will be crucial in these terms. By tradition, the Machiguenga are unlikely to display either anger or rancour immediately; any grudge, disagreement or aggravation will be borne by them long term and will be difficult to remove. This is evidenced by regular reference back to the experience of SPDP's activities in the 1980's rather than by reference to the results of SPDP's initiatives now.

It is difficult to predict with any degree of accuracy the longer term effects of the project on the cultural integrity of the Machiguenga, however, it is more than likely that some changes will take place to the existing balance of resource consumption, resource ownership and traditional customs. Although some of these effects may not be negative, it is important that measures are taken to avoid the loss of tradition and customs, especially since these can lead to secondary impacts on the sustainable use of the natural environment. In fact, some communities have expressed the desire for certain changes (eg in regard to health, education). Whether potential change is wanted or unwanted, the key factor is its management. The most effective form of protection against unwanted change will be to restrict the interplay of project-related activities and day-to-day activities of the communities. *Box 6.9* below summarises the proposed measures for the prevention of loss of cultural integrity.

Box 6.9 *Mitigation Measures: Cultural Change*

Issue	Recommended Mitigation Measures
Loss of traditional customs	All measures shall be taken to avoid interference with the day-to-day activities of the Machiguenga. • All local customs and traditions shall be respected and upheld by the workforce. • SPDP shall develop and enforce, as a contractual obligation, a code of social conduct for the behaviour of the workforce. • Employees shall not be allowed to spend downtimes or leave periods in the Machiguenga villages.
Introduction of private ownership Capitalization of the economy Change in the traditional balance of labour	

It is important to note that the exploratory programme will lead to a decision on how these sites fit into the full field development over the next year or so. SPDP will continue to make full and valuable use of this period to monitor interactions between SPDP and the communities, to discuss problems and development solutions jointly. In addition an objective of the FFDP EIA will be to identify some of the tangible and less tangible indicators of social-cultural identity so that these can be closely monitored in the long-term in much the same way that water and air quality will be measured.

6.3.13 *Loss or Damage to Archaeological or Cultural Remains*

While no significant cultural remains were identified in the surface survey undertaken to support this EIA, the exploratory well sites are located near areas that have some potential for past temporary human habitation.

To ensure the protection of archaeological finds during the installation of the wellsites, it will be necessary to engage the help of the local population to identify sites for registration and protection. Contractors and Sub-contractors to the project will also need to participate in this activity. The provision of information on potential finds and the archaeological history of the area will enhance preservation activities and increase the chances of finds recognition. *Box 6.10* below summarises proposed measures for the protection of the archaeological heritage of the project area.

Box 6.10 *Mitigation Measures: Loss of Economic Resources*

Issue	Recommended Mitigation Measures
Damage or disturbance to cultural sites	• Throughout the appraisal programme, Machiguenga shall be employed to identify and confirm findings during excavations. • Contractors must inform the SPDP representative of the discovery of any archaeological, cultural or religious site or find. Guidance must then be sought before any further progress is made. • All care must be taken to ensure that ancient monuments (anything of historical, archaeological or artistic interest) are not damaged. • Under no circumstances shall the Contractor remove any artefacts from a working area until the SPDP representative has been informed and appropriate instructions have been issued. • All finds shall be registered with the relevant authorities. • SPDP shall provide information and educate workforce in the archaeological and cultural heritage of the project area. • To ensure the long-term protection of archaeological sites, all finds and archaeological evidence shall be notified to the authorities and recorded on maps at an appropriate scale.

6.3.14 *Summary of Residual Socio-Cultural Impacts*

The local communities will be exposed to various types of impact some of which can be regarded as direct (eg landtake, construction disturbance) and some of which may lead to profound changes in socio-cultural characteristics (eg increase in income generation).

Direct impacts such as landtake, loss of forestry resource and accidental damage, are all ones that can readily be 'quantified' and compensated. Others such as noise and general disturbance effects can be managed as best as possible. Further direct impacts, which may be perceived as likely to occur by the local communities, could include adverse effects on drinking water quality, air quality, hunting, fishing etc. All of these will be avoided by strictly applied mitigation measures and this will be clearly explained to the local communities through a programme of consultation, which will place especial emphasis on environmental quality parameters and their perceived and actual relationship to human health.

A further type of potential direct impact is that on human health through diseases spreading from the workforce to the local community. This too will be carefully monitored and strictly managed.

The main residual impacts are likely to stem from two main areas:

- general 'disturbance', especially from noisy activities;
- changes to existing economic activity through the presence of SPDP;

- changes to the existing culture due to the presence of SPDP.

Drillsite noise during construction and drilling itself is sufficiently manageable and far away from communities as to be unlikely to cause impact or nuisance. Of greater concern is noise due to helicopter and river craft movements, both of which are inevitable. On the rivers, the hovercraft was a significant cause of noise and the 'scaring away of fish' has been attributed to it. The hovercraft will not be used for the exploratory drilling programme. The effects of river traffic are in part mitigated by the fact that noise from them is a passing phenomenon to a stationary observer, quite rapidly diminishing with distance and the screening effects of river bends and intervening vegetation. The overall zone of influence is also limited.

Helicopters are another matter. They comprise a louder noise source; their use is spread over a wider geographic area; and their noise influence affects an even wider area. Helicopters flying near to communities are a regular source of noise disturbance (Shivangoreni community has cited '20 movements in a day') and causes disruption to village life. This is unsurprising once it is appreciated how quiet these villages are: average noise levels in the communities show them to be noisier at night (due to the influence of forest life) than during the day - a direct inversion of the normal experience in urban and even rural areas.

Helicopters have also been cited as the main cause of 'scaring away game' with the result that villagers have to hunt for longer and further away (although this could equally be attributable to population growth and over-exploitation). Nevertheless it also has to be recognised that the helicopters provide a significant positive function - their use negates the need for a road and isolates the drillsite workforce from the communities. However impacts will need to be managed more firmly. In the course of this EIA noise levels have been quantified and avoidance distances (based on widely accepted noise impact criteria and modelling) will be put forward for helicopter activity. These will be developed further in consultation with the affected communities so that clearly defined flight paths (supported by navigational beacons) are set out that go as far as possible to meet the needs of both the communities and SPDP. These will then be published to the communities and all helicopter contractors/pilots and strictly adhered to.

Changes to existing economic activity will be, and are being, managed to some extent by:

- maximising opportunities for the involvement of locals in skilled and semi-skilled work coupled with training where appropriate;
- giving preference to the most affected local communities for recruitment;
- encouraging over time the purchase of local produce, so as to avoid inflation and/or unsustainable harvesting of agricultural resources.

However, it is important to note that even the positive effects, such as local employment, can have negative impacts, such as income disparities. It is reasonable to state that greater benefits will accrue to the communities through the provision of communal facilities (education, health,

communication devices etc) rather than monetary gain to a limited number of individuals.

Changes in cultural characteristics may be profound and subtle and are very difficult to predict in terms of their significance. SPDP's presence is not the only factor of change in the area; religious missions are also present and active since the 1950s. It is worth noting that there have been no noticeable cultural changes resulting from SPDP's previous presence in the Camisea region or to date from the appraisal drilling campaign. However SPDP's presence this time may be substantially less 'temporary' than previously and the potential for initiating significant cultural change could be greater.

For this reason, SPDP will not only apply the strictest of measures to manage interactions with the local communities, together with a programme of ongoing consultations, but will also initiate a programme of monitoring the results of the interactions that do occur. This monitoring will not only monitor obvious matters such as health, complaints of construction nuisance etc, it will also keep track of indicators of more profound socio-cultural change, including, but not limited to:

- prices of local produce;
- income and income disparities;
- demographic change;
- increasing agricultural and domestic workloads for women.

Understanding theses changes and formulating means, in association with the local communities, for dealing with them will be a key activity during the drilling campaign in leading in to the potential Full Field Development.

Furthermore the FFDP will bring some benefits to the local communities and the region as a whole. A major component of SPDP's community affairs strategy has been aimed at determining ways of harmonising the project with the provision of overall benefit (ie increasing 'social and human capital') to the local people of the Region. SPDP will maintain on-going dialogue with the communities, seeking to develop the means and protocols by which this can be achieved.

Chapter 7

Conclusions

7 CONCLUSIONS

An EIA has been conducted to Peruvian and international standards. The EIA has covered the drilling of up to four exploratory wells at up to three sites together with the relevant aspects of the logistical programme to support this activity.

The EIA has been an iterative process with both SPDP and primary and secondary stakeholders feeding information and concerns into it.

SPDP has designed the proposed 1998 Pagoreni and San Martin East exploratory drilling campaign along the lines of the current Appraisal Drilling Campaign ie in a way which has sought to minimise the scope for impacts (eg no access roads, running wellsites as 'remote wellsite', a single self-contained logistics centre). To this has been added carefully thought out mitigation (such as drilling fluid treatment and recirculation, wellsite run-on/run-off control, general waste management, codes of conduct for personnel, health monitoring of workers entering the area and strict employment procedures). In addition, lessons have been learned during appraisal drilling to date and these too will be applied to the proposed exploratory drilling campaign.

The EIA has identified the key environmental sensitivities of the project area; both in terms of the natural environment and the socio-cultural character. This has been done based on a literature study, remote imagery and field surveys by Peruvian specialists. In addition, technical information on air quality and noise has been collected. Consultations have provided important input to this process. The local communities ('primary stakeholders') and Peruvian and international NGO's ('secondary stakeholders') have all been provided with information on the project and have responded with their concerns, identifying what they view as key environmental sensitivities and important potential impacts of the project.

As far as is reasonably practicable, the EIA has taken all the information collected, plus all these concerns into consideration. The significance of impacts has been assessed by applying appropriate methodologies. The findings of the EIA demonstrate that the overall impacts associated with the proposed exploratory drilling programme can be maintained within acceptable levels by applying both the mitigation measures proposed by SPDP and those resulting from the assessment process. These measures are described in this EIA as well as being set out as firm commitments in the accompanying (separately bound) *Environmental Management Plan (EMP).*

Nevertheless the key to successful environmental management will be to ensure that the commitments in the EMP (and indeed in project design) are properly implemented and that they achieve their intent. To this end a fundamental part of the EMP is a programme of monitoring, inspection and audit. This will cover the full range of activities including, but not limited to, such matters as:

- effluent quality;
- noise and air traffic movement;
- workers' and community health;
- disturbance effects on fauna;
- contingency planning for spills, emergencies etc.

The monitoring part of the process will also be applied to areas of uncertainty in the EIA. These are especially critical in regard to potential socio-cultural impacts. Whilst SPDP can exert control over direct interactions, potential indirect effects (such as Machiguenga in-migration to the area, subtle changes in economic activity and resource use) would be outside of SPDP's control. A combination of monitoring and close liaison with the local communities will ensure an understanding of such changes and the means to remedy them can be discussed.

Whilst it is not expected that the exploratory drilling campaign would in itself lead to profound local socio-cultural changes, the proposed future Full Field Development Programme could be seen as a potential stimulus to such change. The two year project feasibility determination period currently anticipated for FFDP will therefore continue to provide an opportunity for both SPDP and the local communities to gain an understanding of potential future changes and develop the means to ensure that adverse impacts are identified and minimised, and that the pace of any other changes is controlled and steered in a positive direction. It will also provide opportunities for lessons to be learned, be they related to the management of social issues or to the difficulties of working in harsh environmental conditions and difficult terrain.

List of Appendices

Appendix A	SPDP's HSE Policy
Appendix B	Key Legislation and Institutions (B1 - B2)
Appendix C	Briefing Papers 7 and 8
Appendix D	Field Survey Diary
Appendix E	Vegetation and Soils Classification and Land Use Potential (E1 - E4)
Appendix F	Water Quality Data (F1 - F4)
Appendix G	Evaluation Methods for Mammals, Herpetofauna and Arthropods (G1 - G2)
Appendix H	Noise Study
Appendix I	Methodology for the Archaeological Survey (I1 - I2)
Appendix J	Participatory Maps
Appendix K	Photo Log

Appendix A

SPDP's HSE Policy

Shell Prospecting and Development (Perú) B.V.

SPDP
HEALTH, SAFETY, AND ENVIRONMENT POLICY

Shell Prospecting and Development (Peru) will conduct its activities to take foremost account of the health and safety of employees and of other persons who may be affected by our activities and to give proper regard to the conservation of the natural environment. In implementing this policy Shell Prospecting and Development (Peru) -SPDP- will not only comply with the requirements of all relevant Peruvian legislation and international agreements but will also promote initiatives which can protect and benefit the health, safety and the environment of all who may be affected directly or indirectly by our activities with particular attention to indigenous persons.

Principles

In adhering to this policy SPDP will maintain a Health, Safety and Environmental Management System that will allow it to meet the following principles:

Health

We will conduct our activities in a way that avoids harm to the health of our employees and neighbours.
We will actively promote the health of our employees and neighbours.

Safety

We believe that all injuries can be prevented.
We will actively promote high standards of safety consciousness and discipline.
We will design all our activities and operations to minimise risk to employees, contractors and third parties.

Environment

We will maintain a consultation process with our neighbours and other stakeholders.
We will design operations to avoid impact where possible and minimise impact where inevitable.
We will rehabilitate land after the completion of operations.
We will control our use of natural resources.
We will limit our access and intrusion into sensitive environments.
We will pursue in our operations progressive reductions of emissions, effluents and discharges of waste materials that are known to have a negative impact to the natural environment.
We will promote protection of the natural, physical and social environment which may be affected by SPDP activities, and seek continuous improvement in efficiency of the use of natural resources and energy.

Alan Hunt
General Manager

Date: October 16, 1996

Implementing the HSE Policy

The HSE Policy will be implemented through a Company Health, Safety and Environmental Management System

In executing this policy SPDP will:

- Reduce the HSE risk to a level as low as reasonably practical (ALARP).
- Establish HSE practices and procedures in all operations and strive for an incident free operation.
- Recognise the importance of HSE objectives in relation to other main business objectives.
- Recognise the unique social and societal structure surrounding SPDP activities and the importance of community health.
- Carry out assessments (EIAs) before commencing new activities or changes to existing facilities.
- Listen and respond to the concerns expressed by any company shareholders, employees and society on HSE matters and to provide to them relevant information on company policies and procedures.
- Provide HSE training to all staff (and contracters).
- Undertake HSE awareness and education campaigns.
- Conduct or support research which can improve HSE practices in the upper Amazon area of Peru.
- Facilitate the transfer of experience and technology in HSE areas to Peruvians.
- Require contractors to apply HSE standards which are fully compatible with those of SPDP.
- Develop and maintain contingency procedures and measures to minimise the consequence of any accident.
- Promote amongst all those associated with its activities a high standard of HSE awareness, motivation and discipline and to provide the necessary education and training to achieve this standard.

Appendix B

Key Legislation and Institutions

TableB1 Legislation for Regulation of the Petroleum Industry

1	Law N° 26221, dated 08/19/93	National Oil Law, regulates hydrocarbons activities throughout Peru.
2	Supreme Decree N° 046/93/EM, dated 11/10/93	Regulations for environmental protection with respect to hydrocarbons activities.
3	Supreme Decree N° 055-93/EM, dated 11/17/93	Regulations for hydrocarbons exploration and extraction activities.
4	Directoral Resolution N° 030/96/EM/DGAA, dated 11/04/96	Approves maximum permissible levels for liquid effluents coming from extraction and commercialisation activities of liquid hydrocarbons and by-products.
5	Decree Law N° 25763, dated 10/01/92	Stipulates that compliance with obligations related to mining, energy and hydrocarbons activities could be controlled by qualified auditing and inspection companies.
6	Ministerial Resolution N° 335-96-EM/SG, dated 07/25/96	Approves regulations for public participation by means of public hearings in the Environmental Impact Studies approval process.
7	Supreme Decree N° 010-94-EM, dated 03/01/94	Unified provisions for administrative procedures of the Ministry of Energy and Mines.

Table B2 Legislation for Overall Environmental Protection

1	Decree Law N°613, dated 09/07/90	Environmental and Natural Resources Code.
2	Decree Law N° 17752, dated 07/24/69	General Water Law. Protection of water resources.
3	Decree Law N° 21147, dated 05/13/75	Forestry and Wildlife Fauna Law: addresses the conservation of forests and wildlife resources, establishes relevant legislation regarding use of their by-products.
4	Decree Law N° 757, dated 11/08/91	This decree law is the framework for the private investment growth.
5	Supreme Decree N° 010/90/A6, dated 03/20/90	Establishes the National System of Natural Areas protected by the Government.
6	Decree Law N° 635, dated 03/04/97	Criminal Code, Second Book, Section XIII, Sole Chapter: Identifies offences against Natural Resources and the Environment.
7	Law N° 26786, dated 05/12/97	Establishes and details Environmental Impact Assessment Law.

Table B3 Laws Covering Indigenous Peoples

1	Peruvian Political Constitution, promulgated on 12/29/93	States that Native Communities have legal existence and are juridical persons.
2	Decree Law N° 295, dated 07/24/84	Promulgates the Civil Code. Book 1, 4th Section deals with Rural and Native Communities.
3	Decree Law N° 22175, dated 05/09/78	Law of Native Communities and Agrarian Development in Forest and Timberline Regions. It states that the Government guarantees the integrity of the native communities' territorial property and must grant them land title documents.
4	Law N° 26505, dated 07/17/95	Private Investment Law for the Development of Economic Activities in National Territory and Rural and Native Communities lands.
5	Supreme Decree N° 011-97-AG, dated 06/12/97	Approves regulations of Law 26505.
6	Covenant N° 169/ILO (International Labor Organisation), dated June 1989	Covenant on Indigenous and Tribal Peoples from Independent Countries. It was approved and ratified by Peru and is part of the national law.

TableB4 Provisions on Public Organisations Responsible for Verifying or Approving the EIAs related to Hydrocarbons Activities

1	Decree Law N° 25962, dated 12/12/92	Organic Law of the Energy and Mines Sector.
2	Law N° 26734, dated 12/29/96	Creates OSINERG (Investment on Energy Supervising Organisation).
3	Supreme Decree N° 027-93-EM, dated 06/19/93	Approves the Ministry of Energy and Mines structure and organisation and the Ministry's functions.
4	Supreme Decree N° 005-97-EM, dated 04/17/97	Regulations of OSINERG's Law (Investment on Energy Supervising Organisation).
5	Supreme Decree N° 055-92-AG, dated 12/22/92	Approves the INRENA's organisation and functions.

Appendix B2

Role and Function of Key Institutions of Direct Relevance to the Exploratory Wells Drilling Campaign

Table B8 Ecclesiastic Institutions

Name	Activity
Misión Católica de Sepahua	• The presence of this institution in Sepahua dates back many years. It works with native peoples of the area, supporting them in a variety of activities such as education.
Instituto Lingüístico de Verano - ILV	• ILV is a religious (protestant) institution with head offices in the USA, which has been working in the Amazon area for a long time. It used to work with the Ministry of Education in developing educative activities for native (and other) people living in these areas. At present it has no major project in the Urubamba valley.

Table B9 Institutions Grouping Together Native Communities and Female Organisations

Name	Activities
Central de Comunidades Nativas Machiguenga - CECONAMA (Centre for the Native Machiguenga Communities)	• CECONAMA is an organisation representing a group of Native Communities of the Inca region. In periodical meetings they deal with, discuss and analyse, matters of interest for their members. They are the official "spokespersons" of the communities belonging to this institution.
Federación de Comunidades Nativas Yine Yami-Piro del río Urubamba - FECONAYY (Federation for the Yine Yami-Piro Native Communities of the Urubamba river)	• This institution assembles a group of Native Communities of the Urubamba river. Likewise, in periodical meetings they deal with matters of interest for the federated communities. They are the official "spokespersons" of the communities belonging to this federation.
Consejo Machiguenga del río Urubamba - COMARU (Council for the Machiguenga People of the Urubamba River)	• COMARU assembles a large number of native communities and is their official "spokesperson". In periodical meetings they also analyse and discuss matters of interest for their members.
Various Mothers' Clubs	• Mothers' Clubs operate in a variety of native communities and are institutions grouping together mothers and women in general. These clubs are progressively gaining an important role in promoting woman and obtaining female representation in communal organisations.

Appendix C

Briefing Papers 7 and 8

The Camisea Project, Peru
Shell Prospecting and Development (Peru) B.V. Briefing Paper 7
May 13, 1997

Update

We enclose the latest information about the appraisal phase of the Camisea Project. This is followed by a briefing on the process by which the design and the studies for the full field development (the production of gas and condensate (liquid) and transportation via pipeline to Lima) will be undertaken.

Accident

Firstly, we regret to inform you of a tragedy at the San Martin well site (the second Camisea appraisal location). Just before 8 a.m. on April 25 Mr. Teodoro Rudas Ramos, a 49 year old Peruvian operator of a compactor / roller on contract to COSAPI, died as a result of injuries sustained when he entered an unsafe area. An investigation is currently underway. The investigation is carried out by Shell Prospecting and Development Peru and the contractor (COSAPI). A second independent investigation is undertaken by a government appointed auditor. Our deepest sympathies go out to the Rudas family.

Visit by President Fujimore to the Camisea Area

The President of Peru, Alberto Fujimori, visited the Camisea area with Daniel Hokama, Minister of the Presidency, senior Shell management and media on Wednesday, April 30. He traveled to Nuevo Mundo by presidential aircraft and then flew by helicopter to the Cashiriari 2 well site and the communities of Cashiriari and Nuevo Mundo. At the well he inspected progress and talked to staff. In the communities he inaugurated the new health posts which have been provided as part of agreements for the use of land for Camisea operations. In Cashiriari a woman sought help from the President for health care for her 4 year old son. The president supported this request and the boy (and his father) traveled back to Lima with the Presidential party. He is to receive an operation.

In Nuevo Mundo the President gave a speech and discussed the sustainable needs of the community with the community president. Mr Fujimori committed to assist through the provision of agricultural advisors and the supply of appropriate technology (e.g. solar panels, agricultural implements).

Smithsonian Biodiversity Studies at Well Site

A combined effort by the Smithsonian Institution Man and Biodiversity program and experts from the University of San Marcos, University of Cusco~San

Antonio Abad, University of Ricardo Palma and the University of Trujillo is entering its 5th month of activity at the San Martin site. Two test plots have been established during which time flora and fauna have been extensively sampled and analyzed by botanists, biologists, avian specialists, and experts on amphibians and reptiles. The plots are GPS (Global Positioning System) located so that return visits may be made to the same locations in future years. The results will be used to both understand the biodiversity and to assist in the development of a long term indicator species monitoring program that will indicate the impact of the drilling activities. The program will continue with the identification of test plots at the Cashiriari 2 well site and at the future construction site at Cashiriari 3. Additional testing and sampling will be undertaken between the well sites and the Urubamba river along the Camisea River. The program is expected to complete this phase by the end of the year. A report will be made available. Species that are taken are shared equally with the Peruvian National Museum and with the Smithsonian in Washington under permit requirements of INRENA - the national parks institute. Cross training is occurring between Smithsonian and Peruvian scientists. Of particular interest is the inclusion of 2 Yaminahua and 4 Machiguenga who are being trained as technical assistants.

Social Diagnostic Study and Social Capital Program

As part of SPDP's commitment to deliver a net benefit to the local communities, SPDP is developing long-term partnerships with the local communities, the government and NGOs in an effort to deliver social capital and achieve local sustainable development. Pro-Natura, an international NGO, has been providing in-house assistance to SPDP in developing this social capital program and strategy.

Achieving sustainable development depends on understanding the local socio-economic reality before taking actions to improve the situation. This scientific understanding is as important as stakeholder cooperation. Therefore, as mentioned in Briefing Paper #6, SPDP requested that the regional government and NGOs work in the local communities to conduct a socio-economic and ecological diagnostic of the region. The diagnostic covers education and training, women's issues, resource use, business development and other economic issues and will propose initiatives to promote regional sustainable development. The diagnostic is a partnership between Region Inca, IMA (Instituto Medioambiente) and SPDP. The technical team includes representatives of FPCN (Pro Naturaleza), CBC (Centro Bartolome de las Casas), ADARI (Asociation Derecho Ambiental Region Inca), INANDES (Instituto Andino de Ecologia y Desarrollo) and IMA. This diagnostic relies on both secondary information and current information which will be uncovered at a series of village workshops.

Because sustainable development depends on the entire region the diagnostic the eventual programs its proposes will go beyond the three or four communities where SPDP has current operations. It intends to cover the lower Urubamba watershed from the Pongo de Mainique to Sepahua. The diagnostic should last from May to August. After the diagnostic is complete, a series of workshops with all the key stakeholders

will discuss the results and determine what programs should be established and their priorities.

In the interim period before the diagnostic process delivers its recommendations on long-term action, SPDP will give limited short-term support to small community led pilot projects that advance the development of social capital. SPDP will encourage the participation of the local federations, communities and regionally active NGOs in proposing initiatives.

All of these activities follow an internal SPDP strategy towards promoting regional sustainable development that is being developed with the advice of Pro-Natura. When this strategy is completed it will become a public document.

Discussion with Montetoni and Serhali about Nomadic People in the State "Reserva"

During the week of April 7 the SPDP Community Liaison Adviser and a Community Liaison Officer visited two distant communities on the borders of Block 75. Montetoni is on the eastern border at the upper reaches of the Camisea River. This community was founded by the Kugapakori (isolated Machiguenga) about 8 years ago through their own self determination. They have entered into contact with other native communities through the travel by village leaders, health promoters and teachers down the Camisea. The village was included as part of the Ministry of Health vaccination program which started in October 1996. The Serjali community is Nahua in origin and lies on the Mishagua River, close to the mouth of the Serjali river. This community also was founded about 8 years ago and maintains regular communication and trade with Sepahua. In discussions with the leaders of these communities information was conveyed to us which strongly indicated that no nomadic peoples live in the Camisea area of the 'reserva'. The Nahua indicated their village represented all of the Nahua in the region. The Kugapakori observed that persons are continuing to join the village from a more isolated life style from the upper Timpia river at the south of Block 75. The isolated Machiguengas or Kugapakori lie to the east and south of Montetoni - the opposite direction form Camisea. While these findings indicate a reduction of risk for contacts SPDP will continue with the policies of protection already in place.

Appraisal Well Progress

As indicated in BP 6 drilling at the first well site, Cashiriari 2 (originally called Armihuari) commenced in early March. This was a late start largely due to weather, first not enough rain to raise the river levels to permit equipment to be delivered by barge to Nuevo Mundo. This was followed by excess rain that hampered construction at the Cashiriari site. However since that time progress has been steady. One of the reservoirs has been penetrated and cores of solid rock taken. These cores will be analysed in Peru and Europe to determine key properties that will assist in the design of the means to extract natural gas and condensate from within the porous rock of the reservoir. Deeper hydrocarbon bearing horizons still need to be penetrated (drilled),

followed by production testing over the various horizons. During this testing a newly developed vertical enclosed flare system will be used to burn the gas whereby the amount of noise and light will be drastically reduced. Burning of the condensates produced with the gas will be through a horizontal flare over an open pit. Upon completion the full rig will be disassembled and removed by helicopter to the second drill location at San Martin 3. It is expected the site will be used for the drilling of more wells during the development phase. This is termed cluster drilling and assists in reducing the overall land take for the project.

As Cashiriari 2 was the first site particular lessons were learned. Environmental controls for waste management worked well with most wastes segregated and returned to Nuevo Mundo for disposal. The on site sewage treatment plant has performed well but needs tuning to fully meet specifications. The effluent in any event is being recycled into the feed water for the drilling process. However, the intensity of rain in the area was underestimated. Consequently, there was a greater loss of soil and more gullying on the periphery of the site than anticipated. An action plan has been developed to restore the areas affected. This plan will be implemented during the course of the next 3 months. As a result of this learning extensive erosion control devices have been built into the design and construction at San Martin 3. During late season rains these improvements are already showing to be effective. They will be supplemented by further planting and greening of the site.

Furthermore the heavy rains affected transport of the cuttings to the proposed treatment and burial area of the well site. The cuttings are made up of the rock which is ground up during the drilling process. These cuttings are removed during the drilling by the drilling mud which is circulated through the drill bit. Separation of cuttings and other solids from the mud is achieved through vibrating screens and centrifuges. Whilst the cuttings are largely inert the commitment has been made to place in a lined pit and solidify before covering. The cuttings have now been stockpiled in a temporary holding area. The final site for cuttings disposal has been located and preparations are being made to seal the burial pit prior to starting the treatment and solidification process.

Block 75 and the 1988 Drilling Program

With the signing of a license agreement for Block 75 the search for hydrocarbons in the region is set to continue. Based on the block boundary the search will extend to the west and north of the existing finds. SPDP is required to drill at least one exploration well as part of the agreement. It has been determined that the most likely location for this exploration well will be into the 'Pagoreni' structure extending some 2500 to 4000 meters below the surface. Part of the Pagoreni field lies below lands where the community of Shivangoreni has land title. Following a trip by SPDP staff to the community agreement was reached for a team to access the area to undertake field studies in relation to the environment and social conditions. It was agreed that members of the community would participate. The site visits were completed during the week of May 5.

The field visits and community consultation is part of the Environmental Impact Assessment (EIA) and will be the second EIA prepared by the consulting company of ERM (with experts based in Lima and London working on the project). The EIA will be completed and filed by the end of July. The results of the studies will be shared with the community and with all other interested parties. Dialogue is already taking place on community concerns and wishes in relation to the well location. The well site will be served - as are the existing wells - from the supply base at Nuevo Mundo. An agreement with the community is necessary before the final location is determined and before any construction can begin.

The scoping document for the EIA was distributed on April 11 to all stakeholders.

Third Party Monitoring

SPDP has come to an agreement with Red Ambiental Peruana (RAP), a Peruvian social and environmental network comprising 35 NGOs, to conduct independent third party monitoring of the social and environmental performance of the project. The agreement enables teams, comprising three members nominated by RAP, to monitor Camisea activities in any way they choose. Teams are expected to visit the area on a quarterly basis. The agreement was signed by Eric Cardich, President of RAP (member of Sociedad Pachamama), Charles de Weck, Executive Secretary of RAP (member of DESCO) and Victor Nomberto, Vice President of RAP (Director CEDRE) and Murray Jones, SPDP Health Safety and Environment Manager. The first visit to the area occurred at the end of April.

Power Plant Option

Shell International Gas and Mobil have chosen International Generating Company Inc. (InterGen) to join in developing a thermoelectric power plant fueled with Camisea gas. The equity participants in the venture will consist of InterGen, Shell International Gas and Mobil Power Inc. The decision follows the February 12 announcement that the consortium comprising InterGen and Community Energy Alternatives Inc (CEA) had informed Shell and Mobil that they had chosen to dissolve the consortium formed last August due to internal disagreements on how best to progress the proposed development. At the same time both companies informed the Shell / Mobil consortium that they retained a strong interest in developing the plant. Shell and Mobil also received expressions of interest from four other independent power producers (IPPs) following the February 12 announcement. InterGen was selected based on its strong international experience, good knowledge of the Camisea project and complementary skills to work effectively with Shell and Mobil. Environmental Impact Assessment (EIA) work, technical studies and consultation will continue to help determine the nature of the development. All EIAs will be made publicly available. The choice of plant location, together with the routing of the necessary gas pipeline and transmission lines, will reflect the views expressed in environmental and social consultations and studies, enabling disruption to be minimised and to support the Camisea consortium's aim to actively promote sustainable development.

A 300 megawatt power plant is currently under consideration which would supply power to the south of Peru where there is strong growth in electricity demand, primarily driven by demand from energy intensive industries such as the mining sector. A 600 megawatt plant was originally under consideration but significantly lower than expected electricity growth in the Central North Interconnected transmission system in 1996 prompted the parties to consider a smaller plant with the capacity to upgrade to serve the northern system should demand increase or to serve further southern growth. Shell and Mobil remain committed to the objective of serving the markets of southern Peru with power from Peruvian natural gas.

Medical Passports

Mobil has informed us that they will be adopting the medical passport concept used in the Camisea Project for its operations in Peru. SPDP seeks best practice from other operators and will adopt ideas wherever they are appropriate. We welcome ideas and suggestions.

CAMISEA PROJECT - FULL FIELD DEVELOPMENT

Through the license agreement with Perupetro, Shell and Mobil are committed to advise Perupetro on a decision to proceed with the development by 16/4/98 or to request a six month extension. Key commercial considerations in making this decision are to obtain sufficient long term sales commitments from potential gas users, as well as establishing the quality and size of reserves required to support the large investments required.

As described in our November 1st Briefing Paper 1996 two consortia, one comprising of Bechtel, Cosapi and Odebrecht, and the other Fluor Daniel, Gran y Montero, and Technit, started conceptual design of the Camisea development. Both consortia submitted their plans on 1st May, these are currently being evaluated.

Both consortia were given challenges and principles to take into account in their bid submissions, and both were encouraged to develop innovative solutions, and to provide their preferred technical solution, integrating all relevant issues such as costs, logistics, health, safety and environment and technical design.

The key environmental challenges given were as follows:

- No permanent access roads
- Minimise permanent infield roads
- Corridor used to connect well sites & production sites to be restricted in width with natural ground cover
- No off site waste disposal
- All emissions controlled to highest standards
- No noise intrusion into communities from operating facilities
- No permanent flaring or venting

- Ring fenced operations, using off shore concept,
- Contingency plans in advance of operations,
- All areas designated for temporary occupation will implement an abandonment or restoration plan
- Demonstrate where the choice of technology will deliver improved environmental protection
- Demonstrate how the technology employed will reduce resource consumption and, or provide a contribution to sustainable development

The evaluation process now being undertaken within SPDP aims to choose the consortium which has demonstrated the best proposal, and the best capabilities and attitude to carry out the detailed engineering, procurement, construction, and commissioning for the Camisea development. The contract, which will be based on alliance principles is expected to be awarded in August 1997. Such principles are focused on SPDP and the Contractor sharing both Successes and risks in realising the contract objectives.

Outline of the Camisea project

The scope of the Camisea project is to produce gas and condensate from the San Martin and Cashiriari reservoirs, transport the hydrocarbons by pipeline over the Andes to the coast and deliver to the market.

Camisea Area

The wells will be drilled in clusters to minimise land take. This means the placing of 4 - 8 wells at a single 2 hectare location with locations separated by up to 6 - 8 km to minimise land take. Produced products will be transported from these clusters to a production plant in the proximity of the two fields. The location of the plant has yet to be determined. Options exist that would see the plant close to the area of production or more distant. The factors effecting location include the need to be able to deliver equipment to the construction site, the need to be able to re-inject gas back into the reservoir by high pressure pipeline and the need to be sensitive to the native communities. Plant design and construction methodologies will be such as to minimise environmental and social impact. Due considerations will also be given to minimising the environmental and social impact from operational activities during the total lifetime of the field (such as minimising number of field staff required, and plans for abandonment). Logistics remains a key challenge to the project. For example variable water levels in the rivers play an important role even in the rainy season; and several staging areas will be required for intermediate material storage and transfer.

Pipelines

Gas and condensates will be transported by two separate parallel pipelines. Whilst the route of the lines is still undecided, much design effort is already being spent on minimising landtake during construction (especially in the rainforest), community safety, erosion control and design to allow crossing of the Andes through high altitude terrain and with the potential for seismic activity carefully in mind. Routes leaving Camisea in an arc towards the North and West as well as to the South and West are being considered. In principle pipelines will be buried.

Coastal facilities

The pipelines will 'land' at a location in the coastal area North or South of Lima. From here the gas will be distributed to local consumers in and around the Lima area. The condensates will feed into a fractionation plant which separates the propane, butane and condensates. These products will be stored before local dispatch and loading into ships for transport to world markets.

Consultation & Environmental Impact Assessment

An environmental impact assessment scoping document, which includes the consultation program for the Camisea development, has recently been developed and will shortly be distributed for comment.

The consultation program provides plans for individual consultation discussions, and also will adopt the use of workshops, which have proved so successful in the social capital and biodiversity projects. The form of the workshops can consider the geographical location of the facilities, the particular interests of stakeholders and the subject matter under discussion. The program is being designed to provide an effective means of integrating into the Camisea project the needs and expectations of you - our consultees, to earn and maintain your trust, and reflect SPDP's core values of honesty, integrity and respect for people.

The scoping report also provides information regarding the environmental impact assessment process and execution program. It describes how options will be narrowed down during conceptual design, consultation, and during the environmental impact process itself.

For further information and / or to provide direct feedback please contact:

Murray G. Jones
Health Safety and Environment Manager
Shell Prospecting and Development Peru (B.V.)
Av. Nicolas Arriola 740
Lima 13
PERU

tel 51 - 1 - 225 3213 fax 51 - 1 - 224 2937

Stephen Macklin
Safety and Environment Adviser
Shell Prospecting and Development Peru B. V.
Raamweg 27
2596 HL The Hague
Netherlands

tel 31 - 70 - 377 2298 fax 31 - 70 - 377 4904

BRIEFING Paper # 8
CAMISEA PROJECT - FULL FIELD DEVELOPMENT AND OPERATIONS UPDATE

July 31, 1997

This Briefing Paper provides information on both the decision making toward full field development and on the current actions taking place related to the appraisal well and exploration well programs.

As described in our May13th, 1997 Briefing Paper, two industrial consortium, one comprising of Bechtel, Cosapi and Odebrecht, and the other Fluor Daniel, Grana y Montero and Techint, have undertaken conceptual (or preliminary) design for the total Camisea development. Both submitted their plans on 1st May and evaluation of both plans by SPDP was successfully completed in early July 1997. Discussions to clarify the proposals with both consortium have been initiated, and it is envisaged that contract award to the winning consortium will take place in Lima during September 1997. This stepped approach is an important sequence in making such a key decision on our long term construction and operating partnership.

Pipeline route selection process

The total project consists of well sites at the San Martin and Cashiriari reservoirs, which lie on either side of the Camisea River. The produced gas and condensate will flow by gathering system to a central gas plant. This plant will feed two pipelines that end on the Pacific coast and feed a fractionation plant and terminal. Products will flow to Lima, to local consumers and international markets.

A key part of the Camisea project is therefore the transportation of the gas and condensates, by two parallel pipelines over the Andes to the coast.

Both consortium, as part of their bid submissions, were encouraged to address all technical alternatives for the pipelines, develop innovative solutions, and provide their preferred technical solution within the challenges set by SPDP. These challenges included the need to address the environment and social issues as described in the May 13th, 1996 Briefing Paper. Much design effort was spent on considering alternatives and addressing these challenges.

Routes leaving Camisea, in an arc towards the North and West the "Northern Route" as well as to the South and West the "Southern Route", have been proposed. During early July technical experts from SPDP flew both routes by helicopter to gain further information on construction, logistics, health, safety, environmental and social issues.

An internal workshop was held in Lima on the 7th July, which aimed to agree to a decision methodology to evaluate options for the pipeline route. A further aim was to undertake a first pass at using this methodology to derive the preferred option, taking note of both the strengths and weaknesses of both options. Those in SPDP with a specific interest in the outcome of this methodology participated including experts from marketing, technical, health, safety, environment and security.

The decision methodology utilised was a structured "decision tree" made up of "criteria" that addressed all of the issues associated with making the choice. The decision tree and a list of

the criteria developed for the pipeline route selection is attached to this document. Comments are invited on the completeness of the criteria.

The workshop concluded that the southern option was preferred on most criteria.

The southern route heads south from Camisea following the Rio Urubamba. Once south of the Pongo Manique (a canyon that allows the Urubamba River passage through an East West ridge as it flows from the Upper Urubamba region) it turns West through the cloud forest to the altiplano, passing south of Ayacucho and then on to the coast north of the Pisco area. The selection of a pipeline route influences the location of the fractionation facility and coastal terminal. The latter will allow the shipment , by sea, of products to foreign and domestic markets. These will be the subject of a separate briefing paper. Wherever the pipeline meets the coast it must then be extended from the facility to Lima to meet Lima markets.

The northern route heads north west from Camisea to Rio Tambo, through various valleys to the altiplano, across the altiplano south of Lake Junin and down to the coast North of Lima. The pipeline route selection influences the selection of the coastal facilities, and a pipeline along the coast to meet southern markets are linked to this option.

Local, national and international stakeholder participation will now be sought on the decision methodology, issues relevant to the pipeline route selection, and the preferred Southern corridor. Views, needs, concerns and expectations of interested parties will be integrated into the project, with the aim of confirming the southern corridor by the end of the year. It is emphasised that the Northern corridor will be kept as a fallback option should there prove to be any "showstoppers" (areas of unresolvable concern) of the Southern route corridor.

Having confirmed the corridor the actual pipeline location within the corridor could be subject to local variations several kilometers in either direction. This will be subject to further more detailed investigation and stakeholder participation, leading to an exact route definition towards the middle of next year.

Health, safety, environmental and social issues, and more specifically issues arising from both studies and consultation will be integrated into the pipeline design, location choice and planned construction activities as part of the Environmental Impact Assessment process. A scoping document describing this process has been made available. The pipelines will be buried in most areas (about 1 -2 meters deep), creating the need to access land up to 20 meters wide for the length of the pipeline, in order to dig a trench, and lay and bury the pipe. Special construction techniques will be employed to reduce this land take in sensitive areas. Furthermore, within forested areas steps will be taken to completely reestablish forest cover after pipeline construction (temporary access roads along the pipeline route will be removed).

Key environmental and social issues include:

- working with local landowners and tenants to ensure safe, temporary access through their property and to agree to fair compensation
- ensuring that pipeline construction activities and rights of way do not create open access to private lands along the route and particularly to prevent access to the Lower Urubamba
- protecting community health and safety during both construction and operation
- minimising land take during pipeline construction, particularly in the rainforest area, focusing on the width of the pipeline right of way

- optimising designs to minimise erosion control and potential for accidents and their consequence
- minimising waste arising from construction activities and observing relevant national or international standards for waste disposal, whichever is the highest
- ensuring measures taken to re-instate land which was accessed for pipeline construction, including top soil storage, planting and erosion control techniques.

It is anticipated that the overall approach described above, including the decision methodology, will be adopted for other key decisions SPDP will make during the development of the Camisea project (e.g. the location of the plant site in the Camisea area which will be initiated later this year). Comments on our approach would be very welcome and particularly timely. The methodology itself will be a subject of our planned Stakeholder workshops. These will take place in November and will be a subject of a separate briefing paper and specific invitations.

Other Developments

Power Plant

In mid June Intergen, Shell International Gas and Mobil Power Inc. signed a Memorandum of Understanding forming a new company to develop a gas-fired power plant of up to a 600 megawatts to be fuelled with Camisea natural gas. The new company, called **EnerPeru** S.R.L., plans to build, own and operate the new power facility. Initial plans are to construct a 300 megawatt plant as this would be sufficient for current demands.

EnerPeru is currently negotiating commercial power purchase agreements with industrial customers in the south of Peru (e.g. mining companies which need energy to power expansion plans).

Whilst a location for the plant has yet to be determined EnerPeru has confirmed to SPDP that it has ruled out the possibility of constructing the plant in the Camisea area (see attached letter). EnerPeru has also confirmed that it will base its location decision on a combination of technical (primarily logistically based), environmental, social, marketing and financial criteria. EnerPeru plans to issue its first briefing paper in the near future. EnerPeru will complete Environmental Impact Assessment studies prior to construction which will be made public.

Determining whether the power plant is a viable project, including a decision about its location, has taken longer than originally anticipated. Initial uncertainties about the provision of an "interconnector" (see briefing paper 7) and market growth, together with the break-up of the power consortium, have contributed significantly to the delay that occurred from the consultation round, starting with our Briefing Paper 4, in October/November of 1996 until this recent decision was taken.

Operations Activities in Appraisal Drilling

The first well, Cashiriari-2, commenced drilling in March 1997 with American contractor Helmerich and Paine. Operational progress was slow due to the difficulty of drilling and taking core samples (a series of 9 meter long samples of rock taken from the hole) in difficult geologic conditions. These samples were necessary to provide detailed geological information on the reservoirs. At a depth of 2953 m, some 130m from the planned total depth of the well the drill string became stuck. This fact and the discovery of the poor

condition of the 7" liner (the steel pipe inserted and cemented in the hole to allow for the controlled flow of gas and condensate) necessitated terminating the well. At time of release of this Briefing Paper the hole was being plugged (sealed off with cement according to international standards). The plan is to re-drill the lower section of the well starting at 1100 meters depth via a new track and proceeding into two of the reservoirs with an ultimate depth of about 3100 meters. Extensive data has been gathered in the original drilling and coring process and will be supplemented by production testing of the new hole. These data and the testing of the gas bearing reservoirs are essential to the more detailed design of the extraction system and to ultimate project decision making.

The San Martin -3 location construction was completed in early July and is ready for drilling operations. The site construction design has adopted innovative erosion control techniques to avoid the erosion that was experienced due to the heavy rains at the Cashiriari-2 well site. The erosion control will be supplemented with planting of local pioneer species to enhance the natural revegetation.

Construction activities are on-going at the 3rd location, Cashiriari - 3. The well site construction is expected to be completed at the end of August. Similar anti erosion control techniques to those used in San Martin will be utilised.

For information, pictures of the Cashiriari- 2 and San Martin wells sites are included.

On the logistics side of the business a decision has been reached to release the hovercraft from Camisea service due to the lack of current need as well as the possibility of alternatives. The hovercraft contract was the first signed by SPDP and enabled early delivery of equipment and fuels up the Urubamba river during the prolonged dry season of 1996. Once the supply base was established delivery in the rainy season focused on barge transport and alternate means such as air. In addition specially designed smaller transport boats are now being investigated. While providing numerous benefits the hovercraft also created some concerns amongst the local population. Initially it was a totally new concept never before seen and thus local information sessions were required. The noise was greater that desired for continuous operations and the stern wake proved to be somewhat higher than expected. Nonetheless the wake is still lower than Push Tug / barge convoy or boats with outboard engines. The difference being that the path and speed of a boat is easier to control than the wake of the Hovercraft. While many boaters on the river learned how to adapt there were a number of cases of swamped canoes for which the company compensated the owners. If there is to be a return to hovercraft use specific design criteria will be developed based on the past experience.

RAP Independent Monitoring

An agreement with Red Ambiental Peruana (RAP) was signed in March 1997 for the independent monitoring of the Camisea project. RAP is a national umbrella organization that coordinates communications between about 35 of Peru's NGOs dedicated to environmental and social concerns.

A visit was carried out in April by three representatives of RAP. During this visit the RAP team reviewed well sites and the logistic base at Nuevo Mundo and visited a number of Native Communities for specific interviews.

The report produced recognised the efforts of SPDP to meet highest environmental standards and fair approach to the Native Communities through openness and transparency. No major

complaints were raised during the interviews. However, it is recognised in the report that noise caused by logistic transport (helicopter, hovercraft) is one of the main concerns. A copy of the report is available upon request.

Under the terms of the agreement a second visit will be held in August (in keeping with the terms of reference for quarterly reviews).

Pro-Natura International Involvement

Pro-Natura International, an international NGO founded in Brazil, is dedicated to the conservation of natural resources through community-based sustainable development. It has been involved in the Camisea Project since 1995. The initial focus of Pro-Natura's effort was to help build SPDP's understanding and involvement in regional community-based sustainable development. It now participates in a number of related issues as an independent part of the Camisea team. However, its main activity centers on developing SPDP's long-term corporate role in promoting the company, community, NGO, government, and multilateral partnerships that are required to deliver sustainable net benefits to local communities. This strategy is being developed with the input and participation of the local people and other stakeholders.

Pro-Natura also works to promote the adoption and refinement of Camisea's experiences for use in other parts of the Royal Dutch / Shell Group of companies.

Meeting of Federation Presidents with SPDP

In June 8 eight persons representing the three regional federations met with SPDP near Lima for a two day workshop. The Federations represented were COMARU, CECONAMA and FECONAYY. The event had an open agenda but was designed for general exchange of information and to chart a joint course for the future. The discussions focused around the current and intended SPDP activities and the expectations of the Federations to work with SPDP. It was clear that capacity building within the Federations and communities would be an area for early attention. The Federation leaders agreed to start the process of capacity building by informing their respective communities of the meeting, their learning's from SPDP and to seek issues and concerns of the communities. It was also agreed that SPDP would undertake some additional means to improve communication with communities such as installing a dedicated radio at the SPDP base such that communities could communicate directly with Community Liaison Officers (CLOs), producing more papers in Machiguenga and producing papers that supplement the Briefing Papers but are designed for Native Communities. SPDP has acted on all these requests. The Federations in turn suggested that an Indigenous Commission could be formed to act on behalf of the Federations collectively, not in decision making, but in assisting in key areas of discussion, capacity building and information dissemination. The Federation leaders agreed to host the next workshop in Sepahua.

Compensation to Communities

One area of continuing interest of many stakeholders is the way in which agreements are reached with communities and the resulting terms of compensation.

The native communities require certain formalities within which information is received and decisions are reached. Formal notice of visitation is required. Community meetings are held and lead to joint decision-making. Agreements must be formalised and often are signed by

the full community. This process is repeated for each community visited. While currently we are visiting about 8 communities this number will expand to reflect all communities within our exploration license block and others outside that lie along the pipeline route - approaching 30 in all.

For the rights to use community lands an agreement must be reached with the community itself. We have already established agreements with the Native Communities of Nuevo Mundo and Cashiriari and at time of writing are negotiating with Shivankoreni for the right to locate an exploration well.

Our goal is to base our agreements on fairness to both parties and on providing compensation that reflects community needs. In principle compensation should be durable, sustainable, useful to the whole community and in keeping with our commitment to net long term benefit. Within this criteria fall such items as improvements to health posts, medical supplies, solar refrigeration for vaccines, solar radio for communication, water wells for improved health, improvements to schools, equipment for mothers clubs, specific training programs, development of waste management and village planning and scholarships to higher education.

In addition to the individual areas of compensation we are committed to the development of regional programs that will meet our commitment of net benefit to the communities. These will take longer to establish but should reflect the rights of the Lower Urubamba region to see benefits from the project. In the long run this will improve social capital (the abilities of the people to manage their own futures) and minimise inequities between communities. These programs start with baseline studies such as the Health Baseline Study (1996) and Regional Social Diagnostic (1997). The resultant initiatives will cover such areas as health care, drinking water, training, education, understanding of small business economics, enhancing women's abilities and agriculture.

EIA Block75

Following the signature with the Peruvian Government (Perupetro) for the exploration of Block 75, an EIA was commissioned under the direction of an independent environmental consultancy company (ERM Peru, S.A.). The EIA started in March 1997 and addressed four potential locations in the land of Shivankoreni Native Community, on a geologic field named Pagoreni, as well as one more location to the eastern end of the San Martin field named San Martin East. The possible Pagoreni fields were identified from seismic results obtained during the 80s. These have been recently re-assessed. San Martin East has been selected to evaluate a possible extension of the San Martin gas field towards the East.

Following an agreement with Shivankoreni Native Community a field team visited the area during two weeks in May assessing the socio-economic and ecological baseline data. One location was eliminated based on community input. A preferred location for the first well was jointly identified. While the surface location is within Block 88B through deviated drilling (i.e. starting with a vertical hole and then turning the drill stem to move laterally for a distance and then returning it to a vertical profile again some distance away from the original location) the final subsurface location will be within Block 75. This offset reduces community impact and still meets with government requirements as specified by Perupetro. The EIA will be presented in early August to the Peruvian Authorities.

A number of field studies are underway which have provided input to the Pagoreni/EIA and will be used for the Full Field Development EIA. These are:

Air Quality: a number of diffusion tubes has been installed in communities, logistic and remote sites. These tubes are measuring SO2, NOx and Volatile Organic Compounds (VOCs) and are replaced every month and will continue for 6 - 9 months.
Water quality and soils: A detailed surface water and soil sampling program was completed for the Pagoreni/San Martin East EIA
Noise: a noise baseline survey was carried out in some communities and logistic plus remote locations. Baseline measurements were made as well as recording of barges, helicopters, hovercraft and canoes as well as drilling equipment and helicopter long-lining. Measurements were made in the communities to assess the impact of noise, in the jungle to assess the effects of noise attenuation and at the sources to assess the potential human health impact.
Flora and fauna has also been part of the field studies but is also tied with the biodiversity program that the Smithsonian Institution is carrying out in the area.

The first phase of the Exploration Well EIA was to prepare a scoping report which was distributed to stakeholders. Discussions were held with the affected Native Community. Apart from certain minor works related to topographical surveying, no construction will start until an approval from Director General of Hydrocarbons and agreement with the native community. A visitation by a delegation of community chiefs including Shivankoreni was made to Cashiriari-2 and San Martin-3 to show current operations and how sites are constructed for the future.

All comments received during the consultation exercise on the Pagoreni/San Martin East Scoping report, will be addressed in the final EIA. Following is a brief summary of the main comments:

- Increasing presence on the Nahua-Kugapakori reserve area due to the activity at the proposed San Martin East location
- Disturbance to wildlife and Native Communities due to increasing logistics (Barges, helicopter)
- Principle of fairness on reaching an agreement with the Shivankoreni Community for the use of their land
- Protecting indigenous rights
- More involvement of Native communities in the EIA process

With regards to the concern for the Nahua Kugapakori Reserve we will maintain our offshore policy at the proposed SME-A exploration well. In addition it has been determined that the presence of uncontacted natives close to the area of the well sites is unlikely. This conclusion was reached after a recent study by the SPDP Community Liaison Adviser to the Communities of Serjali and Montetoni. These two communities, existing for more than 6 years, are located inside the Nahua Kugapakori reserve and are representative of both tribes. Guidelines in case of contact with isolated people will still be operational and workers will receive full training on its application. SPDP recognises that the reserve is a temporary designation, allowing drilling operations, pending application of the villages for status as Native Communities. SPDSP would be pleased to see such an application and would then work directly with the established Community to develop a land use agreement.

Disturbance to wildlife and people due to logistics is a primary concern to SPDP. Flying path corrections have been undertaken during current operations. During the activities related to the new Pagoreni/San Martin East exploration wells flying path selection will be assessed in

detail in order to avoid, as much as possible, disturbance to Shivankoreni which is about 3 km form the wellsite.

Disturbance to wildlife is an impact which is difficult to assess in the short term. SPDP is consulting experts within scientific institutions and NGOs. What is clear from current biodiversity studies is that large mammals continue to be present around our well sites, (reforestation workers have also confirmed the presence of large wild animals along the base camp runway in Nuevo Mundo).

On the issue of native rights and involvement SPDP will continue to work with Shivankoreni encouraging participation of community members in EIA review, in attendance at public hearings in Lima, in working on the site and in monitoring .

Note of apology

In the report produced by the Smithsonian Institution on the Biodiversity Workshop held in late 1996 Mr. Caesar Sarasara Head of the Indigenous group CONAP was inadvertently referred to as the President of the Indigenous Commission. Mr. Sarasara was not president and acted only as a facilitator to provide assistance to the Federations having an interest in the Commission at that time. The Indigenous Commission as then proposed was not moved forward until more recent agreement by the three federations as noted in this Briefing Paper.

For further information and / or to provide direct feedback please contact:

Murray G. Jones
Health Safety and Environment Manager
Shell Prospecting and Development Peru (B.V.)
Av. Nicolas Arriola 740
Lima 13
PERU
tel 51 - 1 - 225 3212 fax 51 - 1 - 224 2037

Stephen Macklin
Safety and Environment Adviser
Shell Prospecting and Development Peru B. V.
Raamweg 27
2596 HL The Hague
Netherlands
tel 31 - 70 - 377 2298 fax 31 - 70 - 377 4904

Criteria used in decision model

The following criteria were developed specifically for a decision methodology to choose a preferred pipeline corridor North vs South. The criteria therefore should address all the issues associated with making the "macro", or generic, choice of North or South. The 'micro" scale process of defining the actual route itself, with local variation options and more detailed environmental surveys and stakeholder participation, will be initiated on the preferred option. These more detailed investigations and consultations will lead to an exact route definition by the middle of 1998.

The criteria selected were used in a simple comparison process, giving strengths and weaknesses of both options, and obtaining team agreement of which corridor presented the best overall solution. During the EIA process the correct technology and mitigation measures would then be applied to minimise risks and impacts.

The criteria, evaluated in a tiered or stepped process as shown in the following decision tree, are defined as:

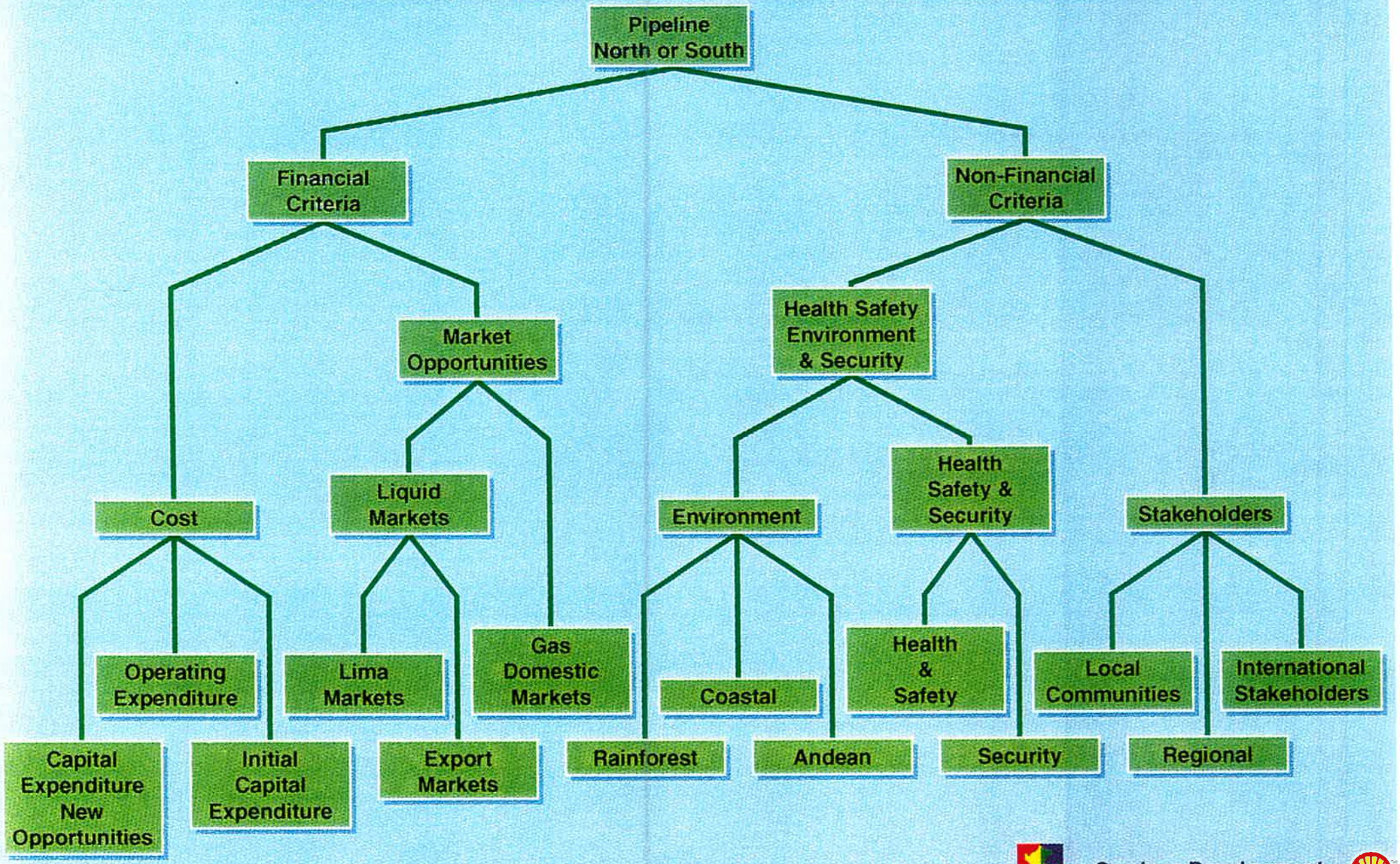
- **Choice to be made: the preferred option of the pipeline corridor - North or South bearing in mind there may be local variations, also that the pipeline route and coastal terminal should be considered in combination.**
- **Combined criteria: non financial:** essentially a bringing together of the criteria quantified by risk or potential impact, but also includes added value issues such as increasing need for local jobs in areas where this is much needed.
- **Combined HSE& S criteria:** a bringing together of the health, safety, environment and security criteria.
- **Environment:** overall judgment of total environmental risk or potential impact, which corridor presents the best practicable environmental option
- **Rainforest environment:** total environmental risk or impact to rainforest environment, particular focus on: size of land take, erosion potential, amount and size of rivers and their sensitivity, pipeline operating failure consequence, ecology of the area land use designations, logistics and the potential need for roads, the potential for archeological finds.
- **Andean environment:** total environmental risk or potential impact in Andean environment, particular focus on: size of land take, amount and size of rivers/lakes and their sensitivity, operating failure consequence, ecology of the area, potential for archeological finds.
- **Coastal environment:** proximity to environmentally sensitive areas - operating risk & consequence, fisheries, loading failure consequence, marine & shipping issues, potential for archeological finds.
- **HS&S:** total health, safety and security risks and potential consequences.
- **H&S:** construction health and safety: narrow right of way, steep slopes, logistics such as the need for helicopters, working at high altitudes; operational health and safety: proximity to local communities and population centers, transiting through Lima, emergency response access, potential for earth quakes and land slides.
- **Security:** risks to people and assets associated with possible terrorists and drug traffickers.

- **Combined criteria stakeholders:** total risk and potential impact to communities and individuals local to the pipeline; issues which have the potential to breakdown both trust and confidence of interested parties, and potential to add value in a sustainable way.
- **Local communities:** rainforest: location of communities, reserves and sanctuaries, and risk of access. General: land acquisition issues including crops and compensation; expectations for local jobs and services and potential to meet these expectations, access created by pipeline right of way.
- **International stakeholders:** issues of concern in rainforest - access to Camisea from outside, pipeline right of way, potential need for roads, proximity to isolated persons and total risk and potential impact on local communities.

- **Combined criteria financial:** criteria characterised by cost and project value.
- **Combined criteria cost:** total life cycle cost in terms of capital expenditure and operating expenditure.
- **Initial capital expenditure:** capital expenditure of the pipeline, including off-loading at coastal facility.
- **Capital expenditure opportunities:** synergy with opportunities such as further block 75 exploration.
- **Operating expenditure:** cost of operations over lifetime of the project.

- **Combined level criteria markets:** total anticipated liquids and gas sales.
- **Liquid markets:** total anticipated liquid sales.
- **Lima liquid markets:** total anticipated sales to Lima market, LPG and condensate.
- **Export liquids market:** total liquid sales internationally.
- **Gas domestic markets:** total anticipated gas sales to Peruvian markets, including coastal and pipeline en-route markets.

Pipeline Decision Methodology



CAMISEA

Camisea Development

Cashiriari 2
Drilling operations underway



San Martin 3
Construction nearing completion



Dirección Provisional
Daniel Oleachea y Oleachea 199
Jesús María
Lima-11 PERU

Tlf.: (51-1) 463-8227
Fax.: (51-1) 463-8723

EnerPerú

Lima, July 22, 1997

Mr. Alan Hunt
General Manager
Shell Prospecting and Development (Perú) B.V.
Av. Nicolás Arriola No. 740
Lima-13

Dear Alan,

As you are no doubt aware, we have made much progress since EnerPerú was formed earlier this year. Discussions with industrial customers in the south of Perú are going well and there is great interest amongst them about the provision of a gas-fired power plant which will satisfy their growing energy needs and enable expansion plans to proceed.

Over the past few months we have conducted and reviewed a number of technical, commercial and environmental studies regarding the proposed plant and the siting of it. We have been especially interested in the written and verbal feedback which Murray Jones, HSE Manager, received from Camisea stakeholders following the publication of SPDP's fourth briefing paper ("Power from Camisea Gas").

In light of the serious concerns expressed by so many Camisea stakeholders to SPDP about the effect that a Camisea-based thermal power plant might have, backed by the serious and strong concerns expressed by yourselves and your shareholders, as well as our own misgivings about such a location, I confirm that we have now ruled out the possibility of locating a power plant in the Camisea region itself.

We continue to explore alternative locations - currently stretching from Atalaya and Quillabamba to the coast - and will base our decision on a combination of technical (primarily logistically based), environmental, social, marketing and financial criteria. The preferred route for the Camisea - Lima pipeline together with the timing and routing of the proposed "interconnector" transmission system are key. We look forward to receiving information about these developments. We will advise you of developments on our part.

We will shortly be issuing our own briefing paper and at the same time will assume responsibility for consultation with stakeholders regarding the plant. If you feel the need to explain to others our progress to date please feel free to do so.

We share your vision regarding socially and environmentally sustainable development. We hope that you might regard this move as going some way towards demonstrating this.

Sincerely,

J. M. Driscoll

James M. Driscoll
General Manager

Appendix D

Field Survey Diary

APPENDIX D FIELD SURVEY DIARY

D1 *THURSDAY APRIL 24, 1997*

The field team met at Mr.Kapila's apartment for an initial briefing meeting to discuss field work preparations. The discussions were concerned with the following:

- The proposed work plan was presented to SPDP and was discussed in terms of the main goals that were to be achieved during the inspection of the Pagoreni and San Martin East well locations.

- The roles of each team member were presented and discussed.

- The team leader (Jorge Briceno) indicated the need to maximize the use of the time spent in the field. This was of particular importance because accessing the well locations by foot would account for a large percentage of the field time.

D2 *TUESDAY APRIL 29, 1997*

The trip to Camisea:

- The field team met at Lima National Airport at 07:00 to catch the ATSA flight to Nuevo Mundo. The flight departed at 09:00 arriving at the Logistic Base Camp in Nuevo Mundo at 10:00. The field team included the logistic coordinator and support personnel from CSM PERU (former Latchmoor S.A).

- Upon arrival the team cleared their health passports with the medical officer and then attended a brief meeting with SPDP Community Liaison Officers; Mr. Victor Grande and Ms. Martha Rojas. At the meeting ERM presented their work plan and logistical requirements.

- Food supplies for the field trip were delayed in Lima awaiting a cargo plane, due to arrive in Nuevo Mundo at 17:30. 4 boats from Sepahua were available to leave Nuevo Mundo at 13:45 so it was decided that the field team proceed to Camisea, arriving in Camisea at 17:50. A cargo boat and its four crew members remained in Nuevo Mundo to rendezvous with the cargo plane.

- Upon arrival at Camisea the ERM field team leader and SPDP CLO requested permission from the President Mr. Ramon Díaz Zapata to contact the Medical Post to radio Nuevo Mundo to confirm that the food supplies had arrived. Unfortunately although the cargo had arrived, traveling by river to Camisea was postponed until the next morning.

- SPDP CLO and the team leader made a short visit to Shivangoreni, 12 minutes from Camisea by boat, to confirm the arrival of the team and to request a formal meeting for the next day. The meeting would introduce the field team to the Shivangoreni community and outline the objective of

the visit. The Community treasurer Mr. Esteban Italiano welcomed the visit and agreed to the meeting.

- After consultation with the CSM PERU Logistic Supervisor, it was decided that the team leader would remain in Camisea Village and wait for the arrival of the supply boat. Accommodation and dinner arrangements were offered by the Health Post to the team.

D3 *WEDNESDAY APRIL 30, 1997*

The Shivangoreni Community meeting:

- The field team travelled to the Shivangoreni Community leaving Camisea at 08:00.

- At 09:30 the community members began to assemble and in total there were about 40 attendants. The meeting was directed by Mr. Esteban Italiano in place of the President who was travelling back from a meeting with COMARU in Quillabamba.

- The team leader presented the community with copies of the EWEIA Scoping Report and circulated photographs of the project areas in Armihuari and San Martin to illustrate SPDP's plans to drill an additional well in the vicinity of Shivangoreni. The explanation given to the community included details of the project description and procedures in order to obtain the required permit to utilize Shivangoreni title land.

- The team leader expanded on the role of the environmental experts in gathering baseline information for the Environmental Impact Study. Each team member had the opportunity to explain their role and specialty within the team. After the first round of presentations a copy of the Appraisal Wells EIA conducted in the region was donated to the Community library to allow the leaders to have a closer look at the type of document required by Peruvian environmental regulations.

- A question and answer session followed the presentations and the main issues raised related to; waste management, water quality, contractual details, type of negotiation with the company, hunting and fishing, timing of the project, noise. In response the team leader emphasized that the purpose of the trip was to gather a comprehensive baseline for the current environment against which a monitoring program would be designed.

- In general the outcome of the meeting was positive and the community leaders expressed their views and expectations on the possibility of negotiating directly with SPDP. They expressed cautious optimism of the project reminding the team leader that the legacy of waste from the 1980s campaign was still fresh in their minds. The treasurer indicated that the community has formed a committee to guard against potential environmental impacts in the area. The community also expressed concerned about the potential drop of cargo on their village since the helicopter flight path is close by.

- The meeting was adjourned at 12:00 and the logistics supervisor and the team leader proceeded with the community leaders to make the necessary arrangements for the field group. The team leader expressed the need for at least four guides from the community to reach specific areas where SPDP had exploratory interest. The community offered the medical post as a suitable location for the field team. Agreements on proper daily compensation were settled with the community and the order to establish camp was given to the CMS PERU crew. All supplies were off loaded from the boats and placed in their proper locations.

- After the meeting the sociologist Prof. Martha Rodriguez and CLO Martha Rojas met with the "Club de Madres del Vaso de Leche" to carry out activity mapping and land use mapping of the community. Interviews with the local teacher and the elders were also conducted.

The Pagoreni C1 well site:

- The team leader made the necessary preparation to mobilize the team to the well site located less than three kilometers from the community of Shivangoreni. Access was via the north side of the Camisea River and was led by the team surveyor using a GPS receiver, compass and topographic maps of the area to establish the most direct bearing to the specified coordinates.

- In order to reach the area the guides had to open an access trail cutting through the dense vegetation along the river bank. After a few minutes the team crossed the old road used in the 1980's to access the Armihuari well location. At this point the road runs along the river bank and it was possible to recognize the gravel bed laid to stabilize the road. Beyond the road a steep hill with a slope over 70% came into view. This corresponded to a high terrace with an altitude of over 420 meters and the team reached the top of this terrace in two hours. Observations of wildlife, vegetation, soil conditions, and topography were conducted along the trail and the well site was reached at 17:00.

- The well site presented a dense vegetation corresponding to primary forest without signs of any perturbation. High trees dominated, mixed within the dense regrowth of the younger vegetation; they did not hamper access into the forest. The relief was characterized by rolling hills of up to 200 meters combined with deeper drainage areas where small creeks were found at the bottom of the valley.

- After conducting the field assessment the team returned to base camp arriving at 18:45 in Shivangoreni. Samples of vegetation, insects, amphibians and water collected during the trip were processed and prepared.

D4 *THURSDAY MAY 1, 1997*

- The field team departed for Pagoreni 'A' location arriving at 09:00. The available maps located the proposed well location close to the Urubamba river approximately 5 km downstream from the confluence of the Camisea and the Urubamba rivers.

- Access was via a small tributary known as Curiosari Creek. The field crew followed the course of the creek to a point closer to the UTM coordinates indicated on the map. The team surveyor indicated a bearing 78° East which the crew followed for 3 hours before beginning the climb toward the well location. Along the trail through the banks of the creek wildlife experts indicated the abundant evidence of animal tracks, including large mammals such as Tapir, Deer, and large cat.

- Once the climb towards the well site began the forest and soil members of the field team started to collect information on tree density, soil structure characteristic, type and coloration. The archeologist scoped the area for any visible evidence of cultural remains while the wildlife team conducted a reconnaissance survey of the hill top. The area was characterized by steep rolling hills with slopes over 80%, mature vegetation representing primary forest, high tree density, especially at the crest of the hill, and smaller trees (diameter breast height < 30 cm) toward the bottom of the hills. Abundant drainage was noticed in the valleys which is feeding the surface water system that surrounds the mountains. The wildlife team made the return trip to the creek early in order to make further observations of birds, mammals, and insects without the noise caused by the local guides clearing the access. At 16:00 the remainder of the team started the trip back after completing sample collection of vegetation and soils.

- On rendezvous with the boat the wildlife party informed the rest of the team of a direct contact with a red deer (Mazana americana) while it was crossing the Urubamba River. This direct observation indicates the wide spatial range of this species and the presence during daylight hours. Most of the wildlife is active at night.

- After sorting all field equipment the field group started the trip back to base camp at 18:45 arriving at Shivangoreni at 17:45.

- At 20:30 the team leader conducted a briefing meeting to exchange group information. This was beneficial as the sociological and noise experts where conducting activities apart from the main field group. The meeting agenda included; field reports and observations by each team member; upcoming activities and logistic requirements; noise recording and baseline levels inside villages and during normal village activities. The team leader reviewed the environmental impact process followed during the previous campaign in the Camisea region. He indicated the importance of addressing cumulative impacts and the abandonment plan in the Pagoreni Study, as the proposed project will add to already active mobilization and demobilization in the area.

- The team sociologist reported the general feeling in Shivangoreni was positive with regard to the opportunity for direct negotiations with SPDP. The community is very aware of the experiences in Nuevo Mundo and Cashiriari and there is expectation of potential benefits as a result of having drilling activities within the community. The team leader conveyed his impression that the benefits of future relations must be balanced with a clear understanding of the scope of the project for the Full Field

Development Programme (FFDP). There will also have to be periodic updates of clear, concise information to avoid misinterpretation.

- The sociologist also indicated that Shivangoreni community leaders are worried about the frequent flights of the helicopters (up to 20 per day) with regards to possible accidents. The community would also like more contact with the CLOs since to date it has been very sporadic.

- The meeting was finally adjourned at 23:30.

D5 *FRIDAY MAY 2, 1997*

Site inspection of Pagoreni D well site:

- A site inspection was conducted at the proposed well location of Pagoreni 'D' located upstream (less than 30 minutes by boat) of the Camisea River. The field team departed Shivangoreni at 07:00 and began their hike at 08:00. As with the previous inspection the team had to walk through a small creek which surrounded the hill where the site was located. The site corresponded to a high terrace with an average altitude of 450 meters. The walk along the Yopoato creek was led by the guides and allowed direct observation of the riparian vegetation and rock formations of the creek.

- The creek was very distinctive in that the substrate was dominated by sandstone with clayish appearance and covered with moss and lichen. The stream was a reddish colour indicating a high suspended solid content as a result of the intense runoff from the steep banks of the creek. After a 4 hour walk the team began the ascent to the well site.

- The climb was slow reaching the 420 meter contour in 1.5 hours. At this point the team conducted test plots for vegetation and collected soil samples. The vegetation community was similar to the Pagoreni A well site with a luscious primary forest dominated by large trees (> 30 cm dbh) and abundant regrowth in the lower levels of the forest. The relief was dominated by rolling hills and numerous valleys. A rich organic layer of fallen leaf and debris blanketed the soil. There were noticeable populations of insects and amphibians in the area. Archeological observations conducted at the site and during the walk did not suggest any cultural remains.

- Samples of plants, soils, insects, and direct observations of birds and wildlife tracks were taken before the return to base camp was at 16:45. Water and sediment samples were also collected on the return journey to the rendezvous location at Camisea river.

Pagoreni C2 well site:

- On the return trip to base camp a detour was made to look at Pagoreni well site C2 because of the proximity. The field team did a brief inspection of this location. The proposed well site was located at approximately 300 meters from the Camisea river bank on a medium terrace with an altitude of 400 meters. After climbing a hill with 45% slope the well location was identified and investigated to evaluate soil, vegetation and wildlife. Even

though it is very close to the river bank the forest corresponds to a primary mature plant community characterized by large trees (> 30 cm dbh) and abundant regrowth of smaller trees facilitating the access to the area.

- The field team returned to base camp at 18:45 and the team leader contacted Nuevo Mundo to confirm the availability of the helicopter to transport the field team to San Martin East 'A' location the next day. At the same time, and with the support of SPDP CLO, steps were taken to send part of the team; the noise expert and the water technician, to conduct sampling in Armihuari, San Martin and Nuevo Mundo. These requests were confirmed and it was agreed that an helicopter (Helisur) would transport a party of 10 to San Martin East, and on the way back would take two passengers to Nuevo Mundo in the afternoon.

D6 *SATURDAY MAY 3, 1997*

- The departure from the Shivangoreni soccer field was scheduled for 09:45. The pilots agreed that the helicopter would fly east to predetermined coordinates corresponding to the proposed site in San Martin East 'A'. Along the route visual observations of the Pagoreni location were made to verify the information collected on the previous days. In addition, it was an excellent opportunity to verify the physiographic map of the region since the flight path followed the Camisea river all the way to the headwaters.

- 15 minutes into the flight the helicopter pilot indicated the GPS location. Visual observation of the site indicated that the dominant vegetation corresponded to a dense bamboo forest (Guadua sp). It was apparent that there was no appropriate site near this spot to land the Bell 212 and deposit the field team. After inspection of the surrounding area it was decided that the closest location to land safely was the Camisea river. This drop site would placed the team about 5 km away from the exact location, however the area was homogeneous and gave the opportunity to examine a different vegetation type.

- A pick up time and location for the field team were confirmed before the helicopter departed. The field crew included two Shivangoreni natives to help open the trail. As soon as the guides started opening the trail it was evident that it would be a very slow process owing to the thickness of the Bamboo forest. After 3 hours the field group began the ascent to get closer to the well area, but were still several kilometers from the actual GPS reading. Along the trail it was obvious that there were no major changes in the vegetation type so the team leader decided to conduct sampling plots as representative of the area.

- During the site evaluation it was evident that the area was completed dominated by the Bamboo which weaves a thick mat of stem and debris that choke other plant species. Few trees gain access to the light and it was noted that the tree density was very low in this environment. A relatively higher tree density tended to occur at the summit of the hills, but other than this sporadic cluster of hardwood vegetation the rest was completely covered with Bamboo.

- Samples of plant species were collected and the soil described at the site. The wild life experts conducted site observation and sampling of insects and reptiles. Along the Camisea river bank visual observations of small mammals were recorded; a Huron and a Peccary (wild pig) were observed crossing the river. In the headwaters of the Camisea the river is narrower and the waters are crystal clear. The river is also shallower and the wild life can easily overcome the current to reach either bank of the river.

- The field team returned to the rendezvous location at 16:00 to await collection. Aerial observations of the location were conducted to confirm the field notes with regard to relief and vegetation communities in San Martin East 'A' location. The helicopter flight pattern toward Shivangoreni was similar to the one taken during the morning. The field team was dropped at Shivangoreni at approximately 16:30. The noise and water sampling team members left for Nuevo Mundo as planned.

D7 *SUNDAY MAY 4, 1997*

Review of progress to date:

- The team leader conducted a coordination meeting to review the past two days of activities and to discuss field reporting procedures. The meeting began at 09:00 with all but two of the team members (the noise expert and freshwater technician).

- The meeting was dedicated to the format for field reporting. The Table of Contents was presented and commented on. It was agreed that the final report must present a clear field methodology with all the results from direct field notes or laboratory analysis and appropriate references.

- The team leader discussed the impact matrix analysis to indicate the assessment criteria that were used in the previous years study. Since the proposed exploratory and appraisal project is similar to the one conducted in the previous year the key impacts identified will be similar, but the team leader emphasized the additional importance of cumulative impact analysis. Questions regarding the criteria to assess cumulative impacts were addressed and discussed illustrating with examples which type of impacts will be exacerbated when the Pagoreni project starts next year (ie possible additional helicopter flights in the region).

- The importance of the abandonment plan was discussed in light of the mobilization and demobilization cycle of the construction activity. This plan must address all aspects of physical clean up to complete reclamation activities where deemed necessary by the team leader. Forestry and soil group members had several questions regarding this topic, mainly to clarify the level of detail that such a plan would require. It was indicated that the plan should be a working tool that can be easily incorporated into the environmental management plan. It should provide clear actions and if possible methodologies to achieve and meet environmental regulations at national and international levels. It was agreed to use Armihuari as a case study to prepare the abandonment plan.

- The meeting also addressed ERM's demobilization schedule for the field team indicating that after completion of the site inspections at all proposed well locations the return to Nuevo Mundo would be scheduled for Monday May 5, 1997.

- The remainder of Sunday was open to each group to make the necessary arrangements for equipment and samples. The meeting was adjourned at 12:00.

- The team leader and the CSM Peru logistics supervisor completed financial arrangements for the field personnel, including fees and rental of premises. The community was presented with 90 gallons of fuel oil and 5 of motor oil as a gesture of thanks to the Shivangoreni community. Mr. Mario Italiano Peña as President received the donation and verified the condition of the tanks before accepting the gift.

- The forestry, soil and wildlife members of the field team requested permission to conduct a brief inspection of a terrace along the west bank of the Urubamba in order to review the physiographic map and determine the nature of the terrace on the opposite side of the river. The request was granted and they departed with a boat at 15:00 returning three hours later with soil and vegetation samples.

D8 *MONDAY MAY 5, 1997*

Demobilization:

- Demobilization activities commenced early in the morning. All canned food (two large boxes) remaining in the kitchen was donated to the Mothers Club through her President Mrs. Marlene Piñareal Serrano and the Secretary Mrs. Teodora Vicente Aladin. The donation also included sugar, salt and rice that was requested to be distributed to the club members. The health post, where the field team lodged, was given left over alcohol, paper, notebooks and the agreed monetary compensation.

- Before leaving the area the team stopped in the village of Camisea to present the community President Mr. Ramon Díaz Zapata with a 55 gallon drum of fuel and a five gallon drum of outboard motor oil as a gesture of thanks for the support and openness shown towards the field team. The donation was clearly appreciated and wishes of good will exchanged between the President and the team leader.

- At 10:00 the field team with the logistic support group started the trip back to Nuevo Mundo arriving at the SPDP docking area by 12:00.

- After lunch in Nuevo Mundo, discussions with SPDP CLO were conducted to finalize ERM's return. It was apparent that two contingency days had been allowed for in the schedule meaning that return would be on Wednesday May 7, 1997. Poor communication from Shivangoreni meant that it was not possible to update the schedule in time. After several inquiries it was decided that only two ERM pesonnel could depart for Lima; the rest waiting in Nuevo Mundo for a flight the next day. It was decided that the sociologist and the forestry expert should leave for Lima

with samples that were scheduled to arrive in laboratories. SPDP CLO made the necessary arrangements to lodge the rest of the team until the next day.

D9 *TUESDAY MAY 6, 1997*

- The extra time in Nuevo Mundo for the remainder of the team was dedicated to packing and reviewing sampling sites for the air monitoring passive devices. Briefings for the Field Manager, HSE supervisor and CLOs were conducted summarizing the main findings of the field work in the Pagoreni and San Martin East locations.

- At 15:00 the field team assembled in Nuevo Mundo airport for the return flight to Lima arriving at 17:15. This ended the field trip for the EWEIA EIAand the observations for the FFDP EIA.

D10 *MONDAY MAY 12, 1997*

Noise and water sampling:

- In order to complete sampling for noise and water monitoring at the well site locations a second short visit to the field was scheduled and coordinated with SPDP Operation. This field trip was considered as an extension of the Pagoreni EWEIA and geared to gather field data on noise produced by; hovercraft; normal drilling operations; and construction activities in San Martin. The field team monitored water quality in San Martin and Nuevo Mundo and inspected the water supply to Armihuari.

- The team departed Lima at 09:00 arriving in Nuevo Mundo by 10:00. The two person field team were transported directly to Armihuari (by 12:00) to begin the noise monitoring at the rig site during normal drilling operations. Measurements were recorded at 40 meters intervals around the drilling island perimeter. After finalizing the readings the team continued on walking down the hill of the old access road leading to the location of the fresh water pumping station. The water supply system was inspected noting in particular that the pond designed to hold the water was effective although the two main streams that feed into the pond had very low flow due to the lack of rain in the area. These streams could easily dry out if the water demand from the drill site increased.

- After collecting the noise samples and conducting the field inspection the team departed to San Martin on the afternoon helicopter flight arriving in San Martin at 16:20.

- In San Martin the field team sampled the stream near the camp which was in much better condition in terms of water flow than the river at Armihuari. Crystal clear water and a good flow of water were the main features of San Martin. Water quality samples for hydrocarbons, water chemistry and sediment were collected at two stations in the San Martin creek.

- In the evening the team leader had the opportunity to visit the Smithsonian Field Laboratory at San Martin holding discussions with the visiting

experts in different fields of biological sciences; mammalogy, entomology, parasitology and herpetology. Through the informal visit the team leader was informed of all major findings in this area of high biodiversity.

D11 *TUESDAY MAY 13, 1997*

- Noise recordings of normal construction activity at the site were collected. Mr. Cristobal Carpancho, HSE officer in San Martin, indicated to the field team the control and supervising system in place at the construction site. He also introduced the initiative to decrease erosion problems using a terrace system to spread the unused soil. Noise measurements were also registered from the long lining operations in San Martin before and after the dropping of supplies.

- Transportation arrived at 12:00 and the team departed for Nuevo Mundo via Armihuari. They arrived in Nuevo Mundo at 13:00 and began coordinating the noise readings of the hovercraft which was scheduled to arrive from Atalaya at about 16:30. The field team proceeded to find accomodation and to prepare for deployment of the noise sensor at a suitable location on the bank of the Urubamba river close to the community of Nuevo Mundo.

- The Manta (SPDP) hovercraft traveled down the river allowing clear recording of the noise produced by the vessel. Additional recordings of other river transportation outboard motors were also recorded to compare noise levels.

- The field team was picked up from Nuevo Mundo at 17:50 to return to the SPDP logistic base.

D12 *WEDNESDAY MAY 14, 1997*

- In the early hours of the morning, readings of the Manta leaving the docking area in Nuevo Mundo were conducted to close the operational sequence of this vessel in the area. The noise data will be analyzed to compare with predictions estimated by a noise model and to compare with other sources in the area.

- With the assistance of Mr. Jorge Borda, HSE officer in Nuevo Mundo, water samples from the waste water plant were collected to estimate the performance level of the unit and potential discharge levels of key parameters; BOD, Total and Fecal Coliform, and general inorganic characteristic of the waste water. The unit was only just operational in Nuevo Mundo and the discharge point into the river did not have discharge water. As a result the sample was collected directly from the outflow section of the plant to provide a worst case example.

- Due to the short duration of the BOD and Coliform samples (less than 24 hours) the actual sampling was delayed until a few hours before departing for Lima. The Lima flight was scheduled for 15:00 and despite the persistent rain the plane departed on time arriving in Lima at 17:00 after one stop in the Pucallpa Airport.

Appendix E

Vegetation and Soils Classification and Land Use Potential

Appendix E1

Vegetation Units: Pagoreni

E1.1 FOREST OF LOW TERRACES (BT)

This vegetation unit covers an area of 1165.70 which is equivalent to the 7.64% of the assessed area. This unit encompasses low, medium and high terrace forests.

The forests of low terraces are developed on flat or gently undulating alluvial-origin surfaces, varying between 5 and 10 m in height, located on the banks of the Camisea and Urubamba rivers of Block 75 (Shivangoreni Community). In high rainfall seasons, this forest tends to be flooded.

Most of the common vegetation of these areas corresponds to mature secondary forests, with some occurring in a more recent, pioneer stage, called "purmas".

The forestry species developed in these forests are : *Inga* sp, Shimbillo; *Porouma* sp, uvilla; *Cecropia* sp, cetico; *horisia integrifolia*, lupuna; *Guarea* sp, requia; *Inga* sp, Pashaco; *Ficus* sp, ojé; *Sapium* sp, caucho masha; *Ochroma pyramidale*, topa and shrublike vegetation along the banks of the rivers such as *Gynerium sagittatum*, *Heliconia* sp., *Calliandra* sp., *Alchornea* sp.

On medium terraces, forests are developed on flat, sub-recent and dissected alluvial terraces. They are located at both banks of Urubamba river. This forest shows gentle slopes (0 to 6%), and the dissected terraces forests represent a second erosive process caused by intense rainfall.

In some cases, these units are found as mature secondary forests and other younger forests in a pioneer stage, called "purmas". The trees reach from 15 to 20 m. in height.

The forestry species present in this unit are: *Guarea* sp, requia; *Inga* sp, shimbillo; *Cecropia* sp, cetico; *Ficus* sp, ojé de altura.

The high terrace forests are developed in flat, wavy and dissected areas, having an ancient alluvial origin, with a drainage from moderate to good. The forests of this unit are deemed as primary forests in dynamic balance, with defined strata in their vertical structure, and with a stable wooded structure.

It is characterised by dominant trees, reaching 35 m height with variable diameters. The species found in this kind of forests are: *Ficus* sp, ojé; *Bixa* sp, achiote; *Matisia cordata*, sapote, and palms such as *Iriarthea deltoidea huacrapona*; *Astrocaryum* sp, huicungo, *Jessenia* sp.

E1.2 FOREST WITH PACAS IN TERRACES (BPT)

This unit occupies an area of 558.56 ha, representing 3.66% of the total assessed area. These forests are developed on recent alluvial soils, with slopes varying from 4 to 8%. The shrublike vegetation is mixed with wild bamboo the so-called paca (Guadua sp), where the canes are very dense, having thorn-shape buds, which sometimes makes access difficult.

Among the forestry species present in association with the paca, includes: *Ficus* sp, *Bixa* sp, *Guarea glabra, Pentagonia parvifolia, Endlicheria dysodantha, Inga* sp, *Pouruoma* sp.

The volume estimated from the assessment of a medium terrace (Capironshiapiari river), corresponding to a secondary Forest mixed with pacales, was 71 m^3/ha and 65 trees/ha, with diameters greater than 20 cm at chest height.

E1.3 *FOREST OF LOW HILLS (BCB)*

This unit occupies an area of approximately 4082.18, representing 26.76% of the total assessed area. They are in the northern and southern part of the studied zone, having a physiography of "lomadas" (small highlands) and hills with a different degree of dissection, and slopes between 10 to 70%, and elevations reaching up to 80m above Camisea and Urubamba rivers level.

The forests of this unit are deemed as primary and as being in a dynamic balance, without having any disturbances or human activity. Pacalaes (Guada sp) are found there, but in low concentrations, the vegetation being dominated by tree mass. Trees reach up to 30 m. and indicate the following species: *Perebea* sp, *Aspidosperma* sp, *Matisia cordata, Inga* sp, *Aniba* sp/*Ocotea, Sapium* sp, *Guatteria* sp

E1.4 *FORESTS WITH PACA IN LOW HILLS (BPCB)*

This unit occupies an area of approximately 1,509.46 ha, corresponding to, 9.90% of the total assessed area. They are found on reliefs with a moderate dissection, jointly originating slopes between 25 to 50%.

The vegetation covering this kind of forest is characterised by shorter trees of smaller diameters, being more obvious the understory and dominated in some places by paca (*Guadua* sp), resulting in the scarce presence of trees.

The forestry species found are: *Inga* sp, *Sapium marmieri, Pouruoma* sp, *Shizolobium* sp, *Aniba/Ocotea* sp. The volume estimated by ONERN (1990) for these forests varies from 90 to 95 m^3/ha and from 60 to 80 trees/ha.

E1.5 *FORESTS OF HIGH HILLS*

This unit occupies an area of 1,662.92 has, corresponding to 10.90% of the total assessed area. They are present on hilly zones located between 80 to 300m

above the river levels, with slopes from 30 to 70%, giving place to a very varied topography of deep to moderately deep soils, of drainage from good to moderate.

The forest of this unit is in a primary stage, without human disturbance due to its difficult access.

It has dominating trees reaching up to 35 m. height, with defined strata, an understory with "lianas" (woody veins), bromeliaceas and "bejucos", and some shrublike species such as *Miconia* sp, *Cyathea* spp, some tree ferns, and communities of irapay *Lepidocaryum tessmannii* in some areas.

These forests dominate the project area, being deemed as primary, where the following tree species can be found: *Perebea* sp, *Virola* sp, *Inga* sp, *Cedralinga catanaeformis, Hura crepitans, Chorisia integrifolia, Calycophylum* sp. *Jacaratia digitata.* Likewise, some palms such as *Iriarthea deltoidea,* and *Astrocaryum* sp can be found.

According to reports of ONERN (1990), the estimated volumes vary from 90 to 93 m^3/ha, and from 71 to 80 trees/ha.

E1.6 FOREST WITH HIGH HILL "PACAS" (BPCA)

This unit occupies approximately 3,841.74 ha corresponding to 22.82% of the total assessed area. It is primarily located on high hills with slopes that vary from 30 to 70%. The soils are shallow and of good drainage.

The floristic composition of this unit is the paca (*Guadua* sp), having less developed trees, both in terms of height and diameter. The forestry species in this type of association are *Shizolobium* sp, *Tabebuia capitata, Aspidosperma* sp, *Inga* sp, *Brosimun* sp, *Tabebuia serratifolia, Pouteria* sp and some palms such as *Iriathea* sp, *Astrocaryum* spp.

The estimated volumes for this association as reported in ONERN (1990) vary from 35 to 40 m^3/ha, and from 23 to 32 trees/ha with trees assessed from 25cm diameter at chest height.

E1.7 PACAL (P)

The proportion of paca found in this association varies between 70 to 100%. This unit occupies an area of 1,406.37 ha, which corresponds to 9.22% of the total area assessed.

The cane communities are smaller than the trees. Generally they reach a maximum average height of 20 m., and a maximum diameter of 10 cm. The tree species are rather scattered, and tend to be thin and deformed, probably due to the competition from the paca for soil nutrients.

According to INRENA (1996), in the forestry inventories performed in dense pacal zones, up to 4,000 canes/ha and up to 10 trees/ha were found. Likewise, from 600 to 1,000 canes/ha, with an average of 50 trees/ha from 10 cm. diameter at chest height, were estimated in the zones where there is balance between canes and trees.

The species growing under these conditions are: *Inga* sp, *Guarea* sp, *Perebea* sp, *Pourouma* sp, *Poulsenia* sp.

E1.8 *WOODED AREAS AND RIVERS (AP)*

This unit occupies an area of approximately 516.01 ha corresponding to 3.38% of the total assessed area.

This unit is located on non-flooding areas, usually on medium terraces, at both banks of Camisea and Urubamba rivers. It includes areas inhabited by Machiguengas communities of Camisea and Shivangoreni, agriculture farms, and abandoned roads.

In the agricultural areas, the following crops are cultivated:

- *Manihot esculenta* (Yucca);
- *Musa* spp (Banana);
- *Ananas sativus* (Pineapple);
- *Sacharum officinarum* (sugar cane);
- *Theobroma cacao* (Cacao);
- *Arachis hypogaea* (Peanut);
- *Bixa orellana* (Achiote);
- *Chrysophyllum* (caimitocaimito);
- *Annona* sp (anona);
- *Lonchocarpus* sp (Barbasco).

E1.9 *ISLANDS AND SANDBARS (IS, PY)*

Islands and sandbars, formed along the Camisea and Urubamba rivers, jointly occupy an area of 251.38, which represents 1.65% of the total area assessed. In some cases, a river shrublike vegetation, dominated by *Gynerium* sp (caña brava), and in others by *Crotalaria* sp and *Sapium* sp, is found.

Appendix E2

Soil Units within the Pagoreni Study Area

APPENDIX E2 SOIL UNITS WITHIN THE PAGORENI STUDY AREA

E2.1 SOIL: HUITIRICAYA (HU) TYPIC TROPOFLUVENTS

This unit occupies 151.88 ha (equivalent to 0.99% of the total assessed area). The unit is located in low terraces with slopes from 0 to 4%. They are formed from recent alluvial sediments. These soils are without genetic development, having an AC profile with ochric epipedon and without diagnostic horizons. They are moderately deep, having a medium to coarse texture and a brown to yellowish dark brown colour. Natural drainage is good and permeability is moderate. Temporary flood may occur. Soil reaction is neutral, presenting a high base saturation (90-100%), and having an catiotic exchange capacity from 10 to 22 cmol (p+) / kg of soil. They have a medium natural fertility.

E2.2 SOIL: SENSA (SE) TYPIC TROPOFLUVENTS

This unit occupies 462.67 ha (3.03% of the total assessed area). Located in low terraces, with slopes varying from 0 to 4%. They are formed from recent alluvial sediments. These are soils without genetic development, AC profile with ochric epipedon and without sub-surface for diagnostic. They are deep, having a medium texture and of a brown to yellowish brown colour. Natural drainage is good and permeability is moderate. There is no significant flood risk. Soil reaction is slightly acid to moderately alkaline, with a salt saturation greater than 50%, and a cationic exchange capacity from 10 to 20 cmol (p+)/Kg of soil. Soils with a low natural fertility.

E2.3 SOIL: MASHINTERI (MA) TYPIC TROPOFLUVENTS

This unit occupies 111.02 ha, (0.73% of the total assessed area). Located in low terraces having flooding risk, with slopes from 0 to 2%. They are formed from recent alluvial sediments, and without genetic development. They have an AC profile with ochric epipedon and without diagnostic horizons. They are deep soils, having a medium texture and a yellowish brown colour. Natural drainage is good to slightly excessive, and permeability is moderate. Their reaction is slightly acid to neutral, having a base saturation of 50%, with a cationic exchange capacity from 10 to 30 cmol (p+) / Kg of soil. Natural fertility is medium.

E2.4 SOIL: MIARIA (MI) FLUVENTIC DYSTROPEPTS

This unit occupies 1761.28 ha, equivalent to 11.54% of the total assessed area. Located in medium and high terraces, and in Small Highlands (Lomadas). The slopes vary from 0 to 25%. They are formed from sub-recent alluvial sediments.

The soils have genetic development, ABC profile with ochric epipedon and cambric horizon. They are deep, having a moderately fine to fine texture and a brown to yellowish brown colour. Natural drainage is good and permeability is moderate.

The acid reaction goes from extreme to very strong, having a base saturation from 20 to 40%. Its cationic exchange capacity is between 11 to 18 cmol (p+)/kg of soil. Aluminium saturation varies from 30 to 75%. Natural fertility is low

E2.5 ***SOIL: PISHITE (PI) FLUVENTIC DYSTROPEPTS***

This unit occupies 457.45 ha (3.00% of the total assessed area). Located in medium terraces with slopes from 0 to 4%. This soil may appear as edaphic inclusions to Huacaroya soil (ONERN, 1990). It is formed from sub-recent sediments.

The soils have genetic development, ABC profile with ochric epipedon and cambric??? horizon. They are moderately deep to deep, having a coarse to moderately fine texture and a brown to yellowish brown colour. Natural drainage is good and permeability is moderate. The acid reaction goes from very strong to moderate, having a base saturation from 20 to 70%. Its cationic exchange capacity is between 11 to 24 cmol (p+)/kg of soil. Natural fertility is low. They include the soil described upo test-pit (C - 6), sampled at the right bank of Capironshianpiari river.

E2.6 ***SOIL: HUACAROYA (HC) FLUVENTIC DYSTROPEPTS***

This unit occupies 162.85 ha (1.07% of the total assessed area). Located in medium and high terraces, with slopes between 0 to 8%. This edaphic unit may include Cumarillo and Paureni soils (ONERN, 1990). It is formed from sub-recent alluvial sediments. The soils have genetic development, ABC profile with ochric epipedon and cambric horizon. They are deep, having a medium texture and a brown to yellowish brown colour. Natural drainage is good and permeability is moderate.

The acid reaction goes from very strong to strong, having a base saturation from 20 to 60%. Its cationic exchange capacity is between 10 to 20 cmol (p+)/kg of soil. Exchangeable aluminium saturation varies from 30 to 70%. Natural fertility is low.

E2.7 ***SOIL: CHILICHILEJA (CL) TYPIC DYSTROPEPTS***

This unit occupies 3175.67 ha (20.85% of the total assessed area). Located in low hills with slopes from 8 to 50%. This soil may include Charapa and Shell soils (ONERN, 1990). They are formed from ancient alluvial sediments. The soils have genetic development, ABC profile with ochric epipedon and cambric horizon. They are deep, having a medium to moderately fine texture,

and a brown to yellowish brown on yellowish red colour. Natural drainage is somewhat excessive, and permeability is moderate to moderately fast.

The acid reaction goes from extreme to strong, having a base saturation from 10 to 30%. Its cationic exchange capacity is between 7 to 24 cmol (p+)/kg of soil. Aluminium saturation varies from 50 to 80%. Natural fertility is low. It includes the soil described in test-pit (C - 3), sampled in a slightly dissected bare low hill.

E2.8 *SOIL: CHENI (CH) TYPIC DYSTROPEPTS*

This unit occupies 2453.11 ha (16.08% of the total assessed area). Located in low hills with slopes from 15 to 50%. They are formed from tertiary rock edaphization. The soils have genetic development, ABC profile with ochric epipedon and cambric horizon. They are deep, having a moderately fine to fine texture and a brown to reddish colour. Natural drainage is good to moderate and permeability is from slow to very slow. The acid reaction goes from extreme to strong, having a base saturation less than 50%. Its cationic exchange capacity is between 10 to 40 cmol (p+)/kg of soil. Aluminium saturation varies from 40 to 90%. Natural fertility is low. It corresponds to the soil described in test-pit C - 2, sampled on a moderately dissected bare low hill.

E2.9 *SOIL: PAGORENI (PG) TYPIC DYSTROPEPTS*

This unit occupies 244.36 ha (1.6% of the total assessed area). Located in dissected high terraces, with slopes varying from 4 to 25%, and located on the central southern part of the area.. They are formed from ancient alluvial material.

The soils have genetic development, ABC profile with ochric epipedon and cambric horizon. They are deep, having a medium to moderately coarse texture with rolling stones, and a yellowish red to dark brown colour. Natural drainage is good and permeability is moderate or moderately fast.

The acid reaction goes from extreme to strong, having a base saturation from 20 to 40%. Its cationic exchange capacity is between 18 to 29 cmol (p+)/kg of soil. Aluminium saturation varies from 20 to 75%. Natural fertility is low. It corresponds to the soil described in test-pit (C-4). Two soil associations have been identified in the area:

- *Soil: Cheni-Maingo Typic Troportents.* This unit occupies 678.83 ha, (4.46% of the total assessed area). Located in low and high hills, with slopes varying from 25 to 75%. They are formed from Cheni soils (60%), and Maingo soils (40%). Maingo soils covers 3765.38 has, equivalent to the 24.68 of the area. Formed from tertiary sandy and argillaceous rock edafization. They are soils without genetic development, showing an AC profile with ochric epipedon and without diagnostic sub surface. They are shallow, having a medium to moderately coarse texture and a brown to yellowish brown

colour. Natural drainage is good to excessive, and permeability is moderately fast. They have an extremely acid reaction, and a base saturation from 10 to 24%. Aluminium saturation may reach 50%. Natural fertility is low. It includes the soil described in Test-Pit 1 (C-1), sampled on a structural high hill.

Soil: Maingo- Miscellaneous Area. Covers 4 622.19 has, equivalent to 30.30% of the assessed area. Formed by Maingo soil (70%) and lithic outcrops (30%). It is located in structural high hills with slopes varying from 50 to 75% or more.

- *Miscellaneous Area (M).* Miscellaneous areas occupy 1585.72 ha, (equivalent to 10.49% of the total assessed area). It includes the consolidated and non-consolidated materials croping-out in the structural high hills, and in the sandbars. They are deemed as non-edaphic units due to unfavourable factors regarding its capacity for bearing any kind of vegetation. Due to its edaphic characteristics and limitations, they are considered as protection lands.

Appendix E3

Soil Units in the San Martin Este Study Area

APPENDIX E3 SOIL UNITS IN THE SAN MARTIN ESTE STUDY AREA

E3.1 SOIL: CHENI (CH) DYSTROPEPTS

This unit occupies 1312.13 ha, (54.21% of the total assessed area). Located in relict sites, "lomadas" (small highlands), bare low and high hills, structural low hills, mountain sides, etc. They are deep to moderately deep, formed from sub-recent or ancient sediments (sandstones, shales, clays). The soils have genetic development, ABC profile with ochric epipedon and cambric??? horizon. They have a medium to fine texture and a yellowish red to yellowish brown colour. Natural drainage is good to moderate, and permeability is moderate. The soil acid reaction goes from extreme to strong, having a base saturation less than 50% (ammonium acetate). Natural fertility is low.

E3.2 SOIL: MAINGO (MG) TROPORTHENTS

This unit occupies 839.12 ha, (34.43% of the total assessed area). Located in "lomadas" (small highlands), bare low to high hills, structural low and high hills, mountains. They are formed from sub-recent or ancient colluvial-alluvial deposits or from residual material. They are deep to moderately deep soils, without genetic development. They have an AC profile with ochric epipedon and without diagnostic subsuperficial horizon. They have a moderately coarse to moderately fine texture, and a yellowish brown to dark yellowish brown colour. Drainage is good to slightly excessive. The acid reaction goes from extreme to strong. Natural fertility is low.

E3.3 MISCELLANEOUS AREAS (M)

Miscellaneous Areas occupy 248.76 ha, (10.21% of the total assessed area). They are deemed as non-edaphic units and in this case, they are mainly formed from lithic outcrops.

Appendix E4

Description of Land According to Potential Primary Use: Pagoreni

APPENDIX E4 DESCRIPTION OF LAND ACCORDING TO POTENTAIL PRIMARY USE: PAGORENI

E4.1 POTENTIAL LAND USE FOR CLEAN CULTIVATION(A)

Covers 758.75 ha, equivalent to 4.97% of the total assessed area. The classified encompasses lands with the best environmental and edaphic conditions of the zone for the establishment of annual crops or of short vegetative period crops, adapted to the ecologic conditions of the zone. They are located in low terraces and islands, and in some medium terraces from flat to slightly inclined topography. The following classes A2 and A3 have been identified:

- *Class A2* Covers 262,90 ha, equivalent to 1.72% of the area. These lands are suitable for agriculture, having a medium agricultural quality, so moderate practices of soil management and preservation are required. A sub-class was established upon its edaphic limitations and flooding risk:

    - *Sub-class A2si.* Deep soils having a medium to moderately coarse texture. Their reaction is slightly acid to moderately alkaline. Drainage is good to slightly excessive and permeability is moderated. Their limitations are referred to a shortage of nutrients (edaphic factor) and to the risk of temporary fluvial flood inundability). From time to time, they may show side erosion undermining). The suitable use and management of these soils involve the use of organic fertilisers, in order to meet the shortage of nutrients upon the requirements of the crop to be cultivated. In accordance with their edaphic characteristics and environment, the recommended species for cultivation are yellow corn, kidney beans, yucca, rice, peanuts, sweet potato, sugar cane, banana, among others. They are found in islands and low terraces, and include Mashinteri and Huitiricaya soils. Only one phase by slope has been identified: 0 to 4%. Flat, slightly inclined.

- *Class A3.* Covers an area of 495.85 ha, equivalent to the 3.25% of the total assessed area. These lands differ from class A2 for their low agricultural quality, requiring intensive practices of management to achieve their suitable agricultural exploitation. Based on the predominant identified limitation, the following sub-class is found:

- *Sub-Class A3s.* The main limitation is referred to the edaphic factor. Their natural fertility is low. These are deep soils, with a medium texture and good drainage, with a slightly acid to strongly acid reaction. A management program of the soil resource in accordance with the requirements of the crop, is very important and strongly advisable.

Located in low and medium terraces, and included Sensa and Miaría soils. Only one phase by slope has been identified: 0 to 4%. Flat to slightly inclined.

E4.2 POTENTIAL LAND USE FOR PERMANENT CULTIVATION (C)

Covers 1057.31 ha, equivalent to 6.93% of the total assessed area. Includes lands presenting some edaphic or topographic limitations prevents to consider them as lands suitable for clean cultivation, and install intensive agriculture.

- *Class C3.* Formed by lands suitable for a permanent-tupe agriculture, with a low agricultural quality, so requiring adequate and intensive practices of soil management and preservation. The limitations of these soils let us identify a sub-class.

    - *Sub-class C3s.* These are soils of a moderately coarse to moderately fine texture, having a drainage from moderate to good. The acid reaction is from very strong to moderate. The shortage of nutrients leads to consider the edaphic factor as a powerful restricting factor. In order to improve the low natural fertility of these soils, suitable agricultural practices and the use of native species are required. These are in medium and high terraces, including Pishite, Miaría and Huacaroya soils. Only one phase by slope has been identified: 0 to 4%. Flat, slightly inclined.

E4.2 *POTENTIAL LAND USE FOR PASTURE (P)*

Covers 1542.76 ha, equivalent to 10.11% of the total assessed area. Includes lands with edaphic limitations and limitations of relief, prevents to consider them as lands suitable for intensive or permanent crops, but allowing the instalment of native and improved pasture, adaptable to the zone. The following sub-class was identified:

- *Class P3.* Referred to as lands suitable for grazing, but having a low agricultural quality, so intensive practices for soil management and preservation are required. Based on their limitations, two sub-classes have been identified:

    - *Sub-class P3s.* Covers 738.80 ha, equivalent to 4.84% of the total assessed area. Formed by moderately deep to deep soils, having a moderately fine to moderately coarse structure, with a good to moderate drainage . It has an extreme to very strong acid reaction. Its main limitations are the edaphic factor, a low natural fertility, low nutritional levels, and a high content of changeable aluminium. For a suitable cattle raising, the instalment of gramineae associated with native and exogenous leguminous plants adapted to the zone are required.

They are found in medium and high terraces, and include Mairía soil. Two phases by slope have been identified:

- 0 to 4%. Flat to slightly inclined;
- 4 to 8%. Moderately inclined.

- *Sub-class P3se.* Covers 803.96 ha, equivalent to 5.27% of the total assessed area. Includes deep soils, having a medium to moderately fine texture and a drainage from moderate to good. Due to its relief, use limitations are edaphic and erosional, increasing so erosional risk (loss of soil). The suitable use and management is oriented to soil preservation practices, and to the instalment of pastures adapted to the ecological and edafic conditions of the zone. They are found in medium terraces, wavy high and dissected terraces, and include Miaría and Pagoreni soils. The following phases by physiography have been identified:

    - 4 to 15%. Moderately to strongly inclined
    - 8 to 15%. Strongly inclined
    - 4 to 25%. Moderately inclined to moderately steep
    -

E4.4 *POTENTIAL LAND USE FOR FORESTRY (F)*

Covers 5860.98 ha, equivalent to 38.42% of the total assessed area. The very severe edaphic and topographic limitations of these lands restrict their use to forestry, without considering them for intensive agriculture, permanent cultivation or grazing. The following classes have been identified.

- *Class F1.* Covers 526.51 ha, equivalent to 3.45% of the total assessed area. These lands suitable for forestry have a high agricultural quality. Based on their limitations, the following sub-class has been identified.

    - *Sub-class F1se.* The limitations are referred to the edaphic factor and the erosional factor, facilitated by the moderately steep slopes increasing the hydro-erosional risk. These are moderately deep to deep soils, having a moderately coarse to moderately fine texture.

The forestry exploitation must be performed upon a plan of a rational use and management of the resource, emphasising on the reforestation, especially of profitable and commercial species. They are found in small highlands (lomadas) and slightly dissected low hills, and includes Chilichileja soil. One phase by slope has been identified:

- 8 to 25%. Moderately steep;
- 15 to 50%. Steep.

- *Class F2.* Covers 5334.47 ha, equivalent to 34.97% of the assessed area. They are lands with a medium agricultural quality regarding forestry. A sub-class has been identified:

    - *Sub-class F2se.* Formed by deep soils, having a moderately coarse to moderately fine texture. Its chemical reaction is extremely to strongly acid, and having a low natural fertility. Presents edaphic limitations and erosional limitations, due to excessive slope, conditioning its use for forestry exploitation through forestry management systems simultaneously with the preservation of the

edaphic resource. Found in slightly and moderately dissected bare low hills, and includes Chilichileja and Cheni soils. Only one phase by slope has been identified:

- 15 to 50%. Steep.

E4.5 PROTECTION LANDS (X)

Cover 55,188 ha, equivalent to 36.18% of the total assessed area. They are formed by lands without the edaphic, topographic, and environmental conditions required to be considered within the aforementioned purposes. They are mainly used for protecting the hydrographic basins, wild life, scenic and recreational values, etc. Based upon their limitations affecting use, the following sub-class has been identified.

- *Sub-class Xse*. Superficial soils having a medium to moderately coarse texture, and a good to excessive drainage. The reaction is extremely to very strongly acid. It also includes lithic outcropings or miscellaneous areas, and is found in structural high hills, inter-hilly small valleys, talus, and even in sandbars. It includes Chilichileja and Maingo soils. The following phases by slope have been identified:

  - 8 to 25%. Moderately steep;
  - 25 to 50%. Steep;
  - 50 to 75% or more. Very steep to extremely steep.

Appendix F

Water Quality Data

Appendix F1

Water Quality Parameters Measured in the Field

Appendix F1 Water Quality Parameters Measured in the Field

Water Sample, Sediment and Benthos in Camisea from April 29 to May 5, 1997:
Sample spots, field analysis, environmental conditions, physic characteristics of water and sediment.

Site Specific Information		In Situ Determinants					
Station No.	GS Position	T C Air	T C Water	pH	Conductivity	Dissolved Oxygen	Comments and incidental observations
1	0726727 - 8704656	26	24.4	8.07	128	8.7	Clear sky, clear water without observed discharges into the Camisea river. Clayish sediment at low stream level.
2	PENDING	26	24.4	7.96	152	8.13	Clear sky, clear water, river at low level. Only water samples were taken.
3	0726200 - 870525	26	24.2	7.97	182	8.16	Clear sky, clear water, stream of 2mt. wide, minimum flow of water, clayish sediment. Samples for Benthos taken.
4	0725867 - 8704413	26	24.7	8.02	152.1	8.17	Clear sky, clear water, river at low level. Only water sample is taken at this spot.
5	PENDING	26	22.9	8	167.8	8.75	Clear sky, lightly turbid water, river at regular level, strong water flow at sample spot. Only water sample is taken.
6	0718124 - 8708230	28	23.3	8.02	166.6	8.8	Clear sky, river at low level, lightly turbid water. Strong water flow at sample spot due to stones at channel bottom. Only water sample.
7	0719692 - 8708039	28	23.4	8.01	165.1	8.85	Clear sky, river at low level, lightly turbid water. Strong water flow at sample spot. Only water sample is taken.
8	PENDING	29	27.6	7.45	62.9	9.04	Clear sky, clear water, stream at low level, abundant stones at the mouth of the stream. Sediment taken at shore, basically clay. Benthos sample.
9	0718684 - 8708281	28	27.8	7.97	265.5	8.5	Clear sky, clear water, plainy stones at sample spot. Low water flow, stream of 2.5mts. wide, clayish sediment. Samples for Benthos
10	0727406 - 8703902	28	26	7.93	166	8.01	Clear sky, narrow stream with fine stones at the sample spot with adhered algae. Abundant vegetation at shores with sandy sediment.
11	0725766 - 8704579	26	25.3	6.18	80.4	1.06	Coloured water, dense vegetation at sample spot, water practicly stagnated. Shivankoreni inhabitants throw garbage, clayish sediment, roots presence
12	0756684 - 8689955	29	28.6	8.02	204.2	8.6	Clear water, sampled by Jorge Briceño. Sediment mainly sandy.
13	PENDING	25	24.5	7.84	153.2	8.44	Sky lightly clear, stream with scarce water flow. Abundant tree branches on the stream, sandy sediment. Stream provides water for Armihuari camp.
14	PENDING	26	25	8.05	198	8.1	Sky lightly clear, stream with scarce water flow. Clear water. Stream provides water for Armihuari camp.
15	PENDING	28	26	7.98	166.5	7.93	Clear sky, lightly turbid water, river at low level. Sample taken before Shell loading station (port).
16	PENDING	28	26	7.99	166.9	7.91	Sample taken in front of Nuevo Mundo community. Clear sky, river at low level, water lightly turbid.

SAMPLE	CODE
Kumasinaroato stream	01
Camisea river- 500m before K. stream	02
Stream w/o name	03
Camisea river in front Camisea town	04
Urubamba river in front Camisea town	05
In front Pagoreni - A (Urubamba river)	06
Curve before Pagoreni - A (Urubamba river)	07
Capironshanpiari stream	08
Pagoreni stream - A (Curiosiari)	09
Yopoato stream (near Pagoreni D)	10
Shivankoreni stream	11
San Martin East (stream)	12
Arminhuari stream - 1	13
Arminhuari stream - 2	14
500m before Shell base (Urubamba river)	15
Nuevo Mundo community (Urubamba river)	16

Appendix F2

Water Quality Results

Appendix F2 Pagoreni Water Quality

SURFACE WATER

	Chlorides mg/L	T.D.S. mg/L	T.S.S. mg/L	Nit. Am. mg/L	Phosphates mg/L	N - Nitrate mg/L	Silicates mg/L	Mercury mg/L	Barium mg/L	Cadmium mg/L	Lead mg/L	Copper mg/L	Zinc mg/L	T.P.H. mg/Kg	Dis. Ox. mg/L	onductivit uS/cm	pH
SAMPLE																	
01	2	72	52	N.D.	0.07	N.D.	16.23	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	8.7	128	8.07
02	2	136	72	N.D.	0.03	0.15	9.38	N.D.	N.D.	N.D.	N.D.	N.D.	0.08	N.D.	8.13	152	7.96
03	2	152	N.D.	0.01	0.08	0.18	17.36	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	8.16	182	7.97
04	N.D.	136	40	0.01	0.03	0.12	9.38	N.D.	N.D.	N.D.	N.D.	N.D.	0.01	N.D.	8.17	152.1	8.02
05	10	N.D.	240	0.01	0.08	0.17	19.55	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	8.75	167.8	8
06	9	168	72	N.D.	0.09	0.13	14.02	N.D.	N.D.	N.D.	N.D.	N.D.	0.04	N.D.	8.8	166.6	8.02
07	9	180	72	N.D.	0.09	0.13	13.23	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	8.85	165.1	8.01
08	2	108	N.D.	N.D.	0.05	N.D.	25.23	N.D.	N.D.	N.D.	N.D.	N.D.	0.13	N.D.	9.04	62.9	7.45
09	N.D.	164	48	0.01	0.07	N.D.	15.42	N.D.	N.D.	N.D.	N.D.	N.D.	0.01	N.D.	8.5	265.5	7.97
10	N.D.	144	40	N.D.	0.13	0.23	16.6	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	8.01	166	7.93
11	2	92	60	0.01	0.02	N.D.	13.54	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	1.06	80.4	6.18
12	N.D.	164	20	N.D.	N.D.	0.12	12.33	N.D.	N.D.	N.D.	N.D.	N.D.	0.01	N.D.	8.6	204.2	8.02
13	N.D.	140	N.D.	0.01	0.07	N.D.	18.99	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	8.44	153.2	7.84
14	N.D.	172	N.D.	0.01	0.07	N.D.	14.83	N.D.	N.D.	N.D.	N.D.	N.D.	0.02	N.D.	8.1	198	8.05
15	8	152	184	N.D.	0.15	0.15	13.82	N.D.	N.D.	N.D.	N.D.	N.D.	0.04	N.D.	7.93	166.5	7.98
16	9	168	164	N.D.	0.14	0.18	14.02	N.D.	N.D.	N.D.	N.D.	N.D.	0.03	N.D.	7.91	166.9	7.99
17	2	92	20	N.D.	0.07	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.01	2	8	157	7.3
18	2	84	36	N.D.	0.09	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.01	0.5	8	159	7.3
19																	

SEDIMENT

	Mercury mg/Kg	Barium mg/Kg	Cadmiu mg/Kg	Lead mg/Kg	Copper mg/Kg	Zinc mg/Kg	luminiu mg/Kg	Iron mg/Kg	Rd. Pot. mv	Org. Mat. %	T. P. H. mg/Kg
SAMPLE											
01	N.D.	N.D.	N.D.	N.D.	N.D.	30	5240	15450	-59	2.68	N.D.
02											
03	N.D.	N.D.	N.D.	N.D.	N.D.	30	4775	20225	-137	2.35	50
04											
05											
06											
07											
08	N.D.	N.D.	N.D.	N.D.	N.D.	30	5200	13550	-136	2.36	N.D.
09	N.D.	N.D.	N.D.	N.D.	17.5	49	7750	23750	-127	1.51	N.D.
10	N.D.	N.D.	N.D.	N.D.	N.D.	39	5500	20700	+30	0.07	
11	N.D.	N.D.	N.D.	N.D.	N.D.	37	7250	13900	-83	1.81	30
12	N.D.	N.D.	N.D.	N.D.	N.D.	34	5500	19850	+22	0.13	150
13	N.D.	N.D.	N.D.	N.D.	N.D.	40.5	8000	20375	+26	0.07	N.D.
14	N.D.	N.D.	N.D.	N.D.	17.75	41.5	7975	20712.5	+30	0.1	N.D.
15											
16											
17	N.D.	61.9	N.D.	N.D.	12.15	43.58	9352.5	18812.2	+29	0.44	N.D.
18	N.D.	62.97	N.D.	N.D.	16.65	30.42	5991.7	23612.9	+58	0.8	50
19	N.D.	53.7	N.D.	N.D.	10.74	42.94	4996.8	22282			30

SAMPLE	CODE
Kumasinaroato stream	01
Camisea river- 500m before K. stream	02
Stream w/o name	03
Camisea river in front Camisea town	04
Urubamba river in front Camisea town	05
In front Pagoreni - A (Urubamba river)	06
Curve before Pagoreni - A (Urubamba rive	07
Capironshanpiari stream	08
Pagoreni stream - A (Curiosiari)	09
Yopoato stream (near Pagoreni D)	10
Shivankoreni stream	11
San Martín East (stream)	12
Arminhuari stream - 1	13
Arminhuari stream - 2	14
500m before Shell base (Urubamba river)	15
Nuevo Mundo community (Urubamba river	16

REFERENCES

N.D. = Non - detectable
T.D.S. = Total Dissolved Solids
T.S.S. = Total Suspended Solids
Nit. Am. = Nitrogen Amonium
T.P.H. Total Petroleum Hydrocarbons
Rd. Pot. = Redox Potential
Org. Mat. Organic matter
Dis. Ox. Dissolved Oxygen
N - Nitrat Nitrogen Nitrates

Appendix G

Evaluation Methods for Mammals, Herpetofauna and Arthropods

Appendix G1

Methodology for the Survey of Mammals and Herpetofauna

APPENDIX G1 METHODOLOGY FOR THE SURVEY OF MAMMALS AND HERPETOFAUNA

G1.1 *BACKGROUND*

Access to the evaluated locations occurred via helicopter and boat, leaving from the Shivangoreni community located at the Camisea River banks. From April 30 to May 5, 1997, points of interest were visited in an average for a period of four hours per location. Camisea and Shivangoreni communities, evaluated, located at the Urubamba and Camisea river banks, respectively, were consulted for information.

G1.2 *MAMMALS*

Background

For the mammals study, during the short visits to the locations of Pagoreni and San Martin-East, the following sampling methods combination was applied: direct observations, footprints, skin or cranium records and interviews with the inhabitants.

Direct observation

This method consists of recording any mammal or group of mammals during the daytime and night-time walks that were undertaken as part of the evaluation. All animals under study, species, study time, number of individuals, location and behavioural data were recorded.

Footprint, Skin and Cranium Records

Mammals footprint detection was carried out, during the daytime walks. This kind of observation can be made more easily in areas where the ground is soft, such as beaches areas or places in the forest with poor vegetal cover. Research was made of cranium and skin records. Cranians and skins found in communities close to the sampling areas, which mainly come from animals hunted by inhabitants for their own consumption, were assessed.

Interview

A rapid method for assessing mammal species in an area consists of interviewing the local inhabitants about the presence of animals in the surroundings of the community.

Herpetofauna Survey

For the herpetofauna evaluation in the different locations within the areas under study, a sampling methodology of each and every occurrence was used, based on transects along the cloughs and shortcuts. Water bodies were

also sampled close to the communities, such as lagoons, ponds and cloughs, searching young stages for amphibians. For each individual under study the time of occurrence, species, microhabitat, behaviour and location were recorded in relation to the transect or water body. The recorded samples were sexed, weighed and measured. In some cases, and particularly for the species of uncertain or very strange identification, photographic records were taken.

Recording

For preparing a list of mammals, reptiles and amphibians species, the only species included were those recorded during the field evaluations in the Pagoreni and San Martin-East well sites.

For the mammals' orders and family list, the classification proposed by Wilson and Reeder (1993) is followed. The amphibians and reptile list is presented in accordance to the scheme of Rodriguez *et. al.* (1993) and Carrillo & Icochea (1995). For the infraordinary categories, the results are presented in alphabetical order. The Libro Rojo de la Fauna Silvestre del Peru (Red Book of the Wild Fauna in Peru) was used to classify the species of mammals which are threatened and in danger.

Appendix G2

Methodology to Sample and Evaluate Arthropod Diversity

APPENDIX G2 METHODOLOGY TO SAMPLE AND EVALUATE ARTHROPOD DIVERSITY

G2.1 METHODOLOGY TO EVALUATE ARTHROPOD DIVERSITY

General observations on habitat and forest condition were made at each of the sites. This assessment focused mainly on general features of forest type and forest structure. Special attention was placed on recording forest gradients or changes along the pathways used to reach the designated co-ordinates.

G2.2 ARTHROPOD COLLECTION

At each site, a small collection of arthropods was made using a reduced set of standard sampling methods (Martin 1977, Oldroyd 1970). Given the logistic constrains and short time at each location, these sampling techniques were selected as to provide a point overview of the arthropod community at the target locations, and at the same time obtain as broad a representation of arthropods as possible. The forest strata selected for sampling were the forest floor, herbaceous understory and first layer of vegetation up to 3 meters. Higher strata required use of specialised equipment and extended visit time. The best strategy for a rapid assessment is to select methods that would sample different strata, such that the overlap between samples is minimised for maximum efficiency. All collections were considered qualitatively, although some of the techniques used can be treated quantitatively, but the lack of replicates would preclude this approach.

G2.3 ARTHROPODS ON THE FOREST FLOOR

Separation of small arthropods found on the forest floor and litter from the substrate is very time consuming if done by hand. Techniques to remove the specimens from the litter relay on the creation of an artificial 'environmental gradient', usually moisture, against which the arthropods will move. An area of 1 square meter is considered standard for many studies on soil arthropod communities. All litter and material is removed from this area and placed on a separating device. Separation of the samples was achieved using a standard winkler funnel. This device consists of a funnel-shaped cloth enclosement which holds the litter inside a mesh bag. A container with a little 70% ethanol (such as a simple plastic cup) is placed at the bottom of the funnel to collect the migrating arthropods. Although this method is most suited for highly mobile organisms (i.e. ants), given enough time slow animals will also move away from the gradually drying substrate and can thus be collected (Edwards, 1991). Samples of 1 square meter of leaf litter were obtained using an improvised grid. The litter material was collected into a plastic bag for later separation. Twigs and large leaves were excluded after careful examination for larger and mobile animals. Due to the high humidity content of the samples, they remained in good condition for 2 to 4 days until processed.

Samples were left on the winklers for six days. Only one sample of leaf litter was obtained at each location.

G2.4 *UNDERSTORY ARTHROPODS*

The sweeping/beating technique was used for sampling understory arthropods. This is a qualitative technique, and is somewhat subjective as the operator bias (particularities, preferences, etc. of the person handling the net or sheet) will influence the outcome. However, it can be very informative when trying to make a rapid assessment of the community as very distinctive species (usually those of interest) are usually favoured. For this method two different techniques were employed. The first technique used a 'sweeping net', which is an insect net with the bag made of heavy duty cloth material, and the ring and handle strongly built. Specimens at the bottom of the bag are collected either into a cyanide killing jar or directly into alcohol. The second technique uses a 'beating sheet' which consists of a piece of cloth of 80cm x 80 cm with a x-frame that can be improvised from thin straight branches, and extends it like an umbrella. The sheet is placed under a suitable habitat (a brush, or a small branch, or any agglomeration of plant material separated from the ground), the plant is strongly hit with a stick. The force of the impact will produce the arthropods to fall onto the clear surface of the beating sheet, where they can be easily picked up with forceps or an aspirator and placed directly into alcohol.

G2.5 *FLYING ARTHROPODS*

For flying insects, a malaise trap was used at certain locations. This technique is designed to collect insects flying through the forest. It is based on visual capabilities of insects, and the upward flying response that many insects have when encountered with an obstacle. The trap is designed to intercept flying insects, and direct them upwards towards a confined space, which has a collecting container with 70% ethanol. The insects meeting the trap fly up, get into the chamber and fall into the alcohol. Malaise sampling provides a large amount of material with little effort, but the success of the method depends on the length the trap is left out working (Townes 1972). A malaise trap was placed at certain locations for only a few hours.

G2.6 *ARTHROPODS IN SPECIALISED HABITATS*

Arthropods in specialised habitats such as fallen logs are rarely collected with more general methods. For this assessment, a reduced number of logs with loose or peeling bark were examined for arthropods. To make comparisons possible, usually similar logs of approximately same characteristics are chosen as sampling units. Type of wood, size, stage of succession, humidity, shade, are all factors that will influence the fauna to be found on these habitats. The specimens were collected directly into alcohol by means of forceps or an aspirator.

G2.7 *Occasional Collection*

This technique is the favoured method for many specialists. It basically involves entering the forest and seeking out arthropods in different microhabitats. Depending on the expertise of the collector, this method can still produce the best data, as fine observations on habitat, behaviour, etc. can be gathered together with the specimens. The amount of material collected is usually reduced, and the effort often high. Walks though the forest with a head lamp were made near the Shivankoreni village, as well as on the river beaches close by. Also, arthropods attracted to lights were collected, although not in the best locations as this activity was limited to the use of lights in the shelter, the area of influence of the light limited to the village and perhaps nearby (and disturbed) habitats.

G2.8 *Sample Processing and Determination*

Material collected and processed in the field was stored in whirl packs. This method is best suited for handling specimens in the field, and offers several advantages compared to the traditional glass or plastic vials, such as less weight, less volume, etc. Problems with dehydration are minimal as this is only a temporary storage. All samples were sorted and tagged for location, date of collection and collecting technique. This provides a unique code for each sample, and provides information on collecting technique, habitat and seasonality. A system of lot/sublot numbering was used for data recording and retrieval. This system incorporates identification data as it becomes available, and allows for tagging of samples down to individual specimens if necessary. Data elements in the system are designed to be compatible with international standards and recommendations (Hawsworth & Mound 1991). Determination of collected specimens was made on the field. Comparisons with collected material at San Martin-C site were used to aid in the identification of difficult groups. Voucher material will be deposited in the Collection at the Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima, Peru.

G2.9 *A Note on the Sampling Procedure*

For the assessment of arthropod communities and the establishment of baseline data for any monitoring effort, it is necessary to use a protocol that will be repeatable on different locations, and therefore allow a more or less direct comparison among the sites of interest. For this assessment, the sampling methods used yielded a total number of 193 species of arthropods collected using 'standardised' methodology. Obviously the arthropod community at any given site is much larger than that collected, and the more intensive and continuous the collecting effort, the faster the species accumulation curve may reach its flattening point. However, under the prevalent conditions and time frame, those species collected are indeed indicative of the community at large, and usually will correspond to groups characteristic of forest associations (all samples were obtained 'inside' the

forest). Widespread, common or opportunistic species have a smaller likelihood of being included in the sample.

G2.10 *Characterisation of San Martin-E Arthropod Diversity*

Collections of arthropods at the San Martin-E site were not made due to the difficulty in reaching the target area (observations were made on almost pure bamboo stands). From observations on the flight over the designated co-ordinates, the forest is a mixed bamboo-forest very similar to San Martin-C location. Although analyses of results from the intensive inventory effort at San Martin-C are still underway, it is feasible to use the general results of San Martin-C as a reference point for arthropod groups to be expected at San Martin-E. As an aid, an extra column has been included in on *Table 5.9c* indicates which groups found on the Pagoreni sites are to be expected in samples from San Martin-E. It is not possible to place a number of species as no collections were made.

Arthropod communities will be characterised for the presence of a large number of species associated with the bamboo. In particular, species that will use the water reservoirs present in the bamboo internodes. Groups most commonly found in samples of this specific habitat include Diptera Nematocera, Ephemeroptera and perhaps carnivorous Megaloptera larvae. Also abundant in San Martin-E would be Trichoptera. Observations at San Martin-C had shown a large number of species of this group attracted to lights and also on malaise samples. This group was not well represented in the Pagoreni sites. A group very important in San Martin-C was the Tettigonoidea (broad sense). Although samples from Pagoreni indicate a high number of these species, it would probably be found that Tettigonoidea are more important in San Martin-E. By contrast, Acridomorphs are expected to be more abundant in the Pagoreni sites. One of the most interesting findings at San Martin-C was the great abundance of Mantodea, which is a very spectacular predatory group, although difficult to collect and sample, and with secretive lifestyles. Perhaps this abundance could be explained by structural features of bamboo growth providing a complex substrate where these insects can dwell, coupled with a high abundance of smaller prey (Diptera, etc.). Cicadellids and Fulgoroids are also very important in malaise and light samples at San Martin-C, and they should be also expected to be important at San martin-E. Arthropods associated with forest litter may also show distinct features from Pagoreni sites. The leaf litter at San Martin-C is much thinner and dominated in many places by fallen bamboo leaves, which probably represents a different michohabitat than the thicker and usually denser leaf litter at Pagoreni. Among the Lepidoptera, an unidentified species of caterpillar (probably a large moth) which lives inside bamboo shots is consumed by locals. It probably constitutes an opportunistic item of food, but may not represent an important part of daily diet.

Appendix H

Noise Study

H1 INTRODUCTION

As part of the exploratory wells field survey, noise studies were carried out. The scope of this *Appendix* is to provide baseline data as well as generic noise data for operations that SPDP are already carrying out.

The operational noise levels will be compared to Peruvian National standards and Internationally recognised criteria to establish the extent of any potential impacts that may arise. Where possible, suggestions have been made as to mitigation measures that alleviate these potential impacts.

H2 BASELINE CONDITIONS

H2.1 INTRODUCTION

Noise measurements were carried out in two villages, Shivangoreni and Nuevo Mundo, and in the jungle, to establish the background noise level at each.

- Nuevo Mundo was selected on the basis that it is adjacent to the large part of the ongoing logistics activities in support of the appraisal drilling programme.

- Shivangoreni was selected on the basis that it is the nearest community to a proposed exploratory drilling site. It is also close to the flight paths adopted by the helicopters in making flights to the appraisal wells, providing the opportunity to assess the levels of noise experienced due to these activities.

The measurements were all carried out in hot, humid conditions, with very little wind. The equipment used consisted of Brüel and Kjær type 2260 sound level meter.

H2.2 SHIVANGORENI

Shivangoreni is a village situated on the north bank of the Rio Camisea approximately 1 kilometre from the point where the Rio Camisea feeds into the Urubamba. Shivangoreni has a population of approximately 240.

A number of measurements were made in and around the village of Shivangoreni, both during the day and at night. Typical noise sources during the daytime measurements included sound from the villagers, animal noise (chickens, cockerels *etc*), and SPDP helicopters (though none recorded here passed within 1-2km of the village).

Table H2.1 summarises the noise measurements made in Shivangoreni.

Table H2.1 Summary of Noise Levels Recorded in Shivangoreni - dB

Period	$L_{Aeq, period}$	L_{A90}
Daytime	47	32
Night-time	44	41

During the night-time measurements the noise climate consisted entirely of noise from indigenous fauna, mainly frogs and crickets. It should be noted that the L_{A90} increases during the night-time due to the increased activity of the fauna.

H2.3 NUEVO MUNDO COMMUNITY

Nuevo Mundo Community is situated to the east of the runway of SPDP's logistics site at Nuevo Mundo. Traditionally a trading post, Nuevo Mundo has a population of approximately 350. Noise measurements were made during the daytime on 6th May 1997.

Table H2.2 summarises the daytime background noise level measured in the community.

Table H2.2 ***Background Noise Measurements in Community at Nuevo Mundo - dB***

Period	$L_{Aeq, period}$	L_{A90}
Daytime	49	42

H2.4 JUNGLE ENVIRONMENT

A number of noise measurements were made in the jungle between the Rio Urubamba and Pagoreni C, one of the potential sites SPDP initially evaluated for future development.

Measurements were made close to the river, with the river just audible and with the river inaudible, these are summarised in *Table H2.3*. The noise from the river was considered typical since there were no rapids or other unduly noisy features.

Table H2.3 ***Background Measurements in the Jungle - dB***

Period	L_{Aeq}	L_{A90}	Sources
Daytime	45	44	Near River
Daytime	39	34	River just audible
Daytime	42	40	Deep jungle, river inaudible

The measurements made were of short duration, typically three minutes, since the noise was very steady. The sources, aside from the river, were derived entirely from the fauna in the area: monkeys, birds, frogs and insects.

It is noted that the L_{A90} drops off as the distance to the river becomes greater, until a point is reached where the noise from the fauna dominates and it rises again, *ie* there is an area where the river is less dominant and the density of the fauna is not as great as further into the jungle.

H3 CRITERIA

H3.1 HUMAN RECEPTORS

The following is a summary of existing standards and legislation that pertain to the protection and improvement of the human environment.

H3.1.1 *Peruvian National Legislation*

No Peruvian legislation exists controlling the emission of noise levels into the environment. Where Peruvian law deals with noise, it is on the basis of noise and its effect on a workforce.

H3.1.2 *International Standards*

The World Health Organisation

In 1980 the World Health Organisation (WHO) proposed environmental health criteria for community noise including consideration of noise levels at which sleep disturbance may take place and recommendations as to noise levels which allow for unimpeded communication in the open air.

A review of this document by an International Working Group was published in 1995 [1]. The 1980 guidance suggested that an internal L_{Aeq} below 35 dB was required to preserve the restorative process of sleep. The review observes that measurable effects on sleep start from an internal noise level of about 30 dB L_{Aeq} or 45 dB L_{Aeq} at the facade. This is equivalent to a free-field level of about 42 dB L_{Aeq}. A conservative criterion to prevent sleep disturbance is therefore an external free-field level of approximately 40 dB L_{Aeq} assuming open windows.

The assumption that an open window will reduce the external noise levels by approximately 10 dB is based on the relationship between the area of the open window and the area of the external wall, as well as the assumption that the building is of solid construction. The mainly wooden buildings in the Peruvian rain-forest are generally of a poor build and so could not be said to conform to a 'solid construction', thus a 10 dB reduction may be overstating the case. For the purposes of this assessment, it has been assumed that a 5 dB reduction is appropriate. Hence, this leads to a free-field level of approximately 35 dB to minimise the risk of sleep disturbance.

WHO state that with a community background level of 55 dB(A), speech in the open air can be understood fairly well, and at 65 dB(A) speech can be understood with slightly more vocal effort, for a speaker-listener separation distance of 1 metre.

---

(1) This review has been submitted to the WHO. The WHO has not currently adopted or ratified the document.

H3.1.3 *Other Relevant Standards*

Industry Standards

Standards in general use by the oil and gas industry generally follow international and national guidance. Examples include the WHO criteria above, British Standard BS 4142, below, and ISO Standard 1996.

British Standards

British Standard BS 4142 [2] is generally applied to assess the potential for noise from fixed installations to give rise to community response. This standard predicts the likelihood of complaint due to noise from a new or modified source.

Broadly, the method contained in BS 4142 compares the likely noise level from the industrial installation or activity, adjusted for tonal or impulsive components and called a rating level, against the existing background level and indicates the likelihood of complaints that may result. The greater the rating level is compared to the existing background levels, the greater is the likelihood for complaint. BS 4142 summarises the possible scenarios thus:

- rating level greater than 10 dB below the existing background level - *positive indication that complaints are unlikely;*
- rating level less than 5 dB greater than the existing background level - *decreasing likelihood of complaint with decreasing difference in levels;*
- rating level approximately 5 dB greater than existing background level - *marginal;*
- rating level approximately 10 dB greater than existing background level - *complaints are likely.*

British Standard BS 8233:1987 [3] gives an indication as to what level of noise is tolerable before speech interference occurs in an indoor environment. A level of 50 dB(A) is given as a maximum background noise level that will not interfere with speech based on normal vocal effort and a speaker to listener separation of 2 metres.

Others

The United Kingdom Department of Transport [4] concluded that maximum noise levels from aircraft movements as high as 80 dB outside residential properties may not cause significant sleep disturbance. Again this is based on westernised construction techniques, *ie* solid brick walls, solid roofs *etc*, and so a lower level, perhaps by as much as 15 dB, may be more appropriate for the region.

---

(2) British Standard BS 4142 (1990) Method for rating industrial noise affecting mixed residential and industrial areas

(3) British Standard 8233 (1987) Sound insulation and noise reduction for buildings

(4) Report of a field survey of aircraft noise and sleep disturbance, UK Department of Transport (1992)

H3.2 FAUNA

Much research has been done on the effect of noise on fauna. Most research falls into two areas: the research on the effects of noise in water on fish and other aquatic fauna; and research into the effects of airborne noise on land dwelling or airborne fauna.

No firm conclusions have been drawn as to a quantified level that can be said to adversely effect all species of fauna. As a general guide, introducing new noise sources to an area will initially disperse fauna, but after an amount of time, dependent on the characteristics of the noise, the wildlife will acclimatise to the noise and return. In general, unpredictable impulsive noises cause a more pronounced effect than regular non-impulsive noises.

For the purposes of this assessment, it has been assumed that the criteria for the human environment will be applicable to fauna as well.

H3.3 ADOPTED CRITERIA

A combination of absolute and relative criteria seem to be appropriate, depending on the situation.

In populated areas, *ie* the villages, the criteria for steady-state noise should be based on the existing background noise climate and transient noise sources should be subject to absolute criteria.

Examples of this may include: operational equipment that operates 24 hours a day near a village will be expected to not increase the background noise level by more than 1 dB; hovercraft passing a village once a day will be expected to allow the free exchange of conversation in the open air during the daytime and to not give rise to sleep disturbance during the night.

A summary of the criteria is shown in *Table H3.1* below.

Table H3.1 Summary of Proposed Criteria

Location	Noise Source	Criteria	Comments
Village	Steady	L_{A90} - 6	Not increase b/gnd by more than 1 dB
	Transient	55 daytime	Speech criteria
		35 night-time	Sleep disturbance
Utilised areas of forest, *eg* hunting grounds	Steady	65 daytime	All non residential criteria based on SPDP Environmental Policy
		55 night-time	
	Transient	65 daytime	
		55 night-time	

Table H3.2 below sets out the specific criteria for each of the villages visited, based on the measurements made.

Table H3.2 Summary of Assessment Criteria in Settlements - dB

Settlement	Period	Measured L_{A90}	Criterion
Nuevo Mundo	Daytime	42	36
	Night-time	-	35
Shivangoreni	Daytime	32	26
	Night-time	42	35

To clarify the methodology through which the criteria have been derived, *Box H3.1* below sets out a generic case study illustrating the salient points.

Box H3.1 ***Case Study Illustrating Derivation of Criteria***

As the situation stands at present, the background noise level in the vicinity of a notional village in the jungle, within the Camisea region, is 40 dB(A). There is no contribution to that noise level from activities attributable to SPDP, all contributing sources are naturally occurring, *eg* fauna.

In order to keep the noise levels in the notional village to acceptable levels, it has been decided that the background noise level should not increase by more than 1 dB(A) as a result of SPDP operations. To ensure this is the case, the noise level resulting from SPDP's activities should be 6 dB below the background noise level by the time it reaches the village, *ie* 34 dB(A).

Drilling activity carried out by SPDP produces a nominal noise level of 72 dB(A) at a distance of 70 metres and the noise from this operation will diminish as the distance from the drilling rig grows.

For the drilling operation to meet the 34 dB(A) level, the drilling rig should not be placed closer than 4.5 km away. This does not include any corrections for the effects of the forest which will attenuate the noise to a greater extent and thus allow the drilling rig to meet the noise criterion at a closer distance.

Assuming the noise level attributable to SPDP's drilling operation, when measured in the village, were 34 dB(A), then the background level in the village would rise to 41 dB(A).

H4 MEASURED OPERATIONAL AND CONSTRUCTION DATA

H4.1 INTRODUCTION

The noise from a number of SPDP's current activities was measured, including: helicopter operations; hovercraft and boat operations; drilling operations; and construction activities.

In this assessment, the measured noise levels from the activities will be used to predict the potential for adverse impacts at sensitive receptors near the future locations of work.

H4.2 OPERATIONAL LEVELS

H4.2.1 *Air Transport - Rotary Wing Aircraft*

Aside from the fixed wing operations at Nuevo Mundo, SPDP operations require two types of rotary wing aircraft to be available for use: a Chinook for the distribution of heavy equipment and supplies; and a Bell 212 for the distribution of lightweight materials and supplies as well as personnel movements.

Only Nuevo Mundo has sufficient clearances for the Chinook to land, so cargoes are delivered and picked up whilst the Chinook hovers at a height of between 1500 and 2000 feet.

The primary use of the Bell 212 is passenger transport between the various sites, though lighter cargoes, notably aviation fuel, are carried too.

The optimum flight details of the two craft are summarised in *Table H4.1* below.

Table H4.1 Helicopter Flight Details

Helicopter	Cruising Speed (knots)	Cruising Height (feet)
Chinook	120 (no load) 80 (fully loaded)	15000
Bell 212		

Table H4.2 below indicates the noise levels measured below the Chinook whilst a cargo was delivered to the site at San Martin. It is assumed that the Chinook was hovering at its optimum height between 1500 and 2000 feet.

During the measurement made at 0936 the Chinook deposited its cargo, and during the subsequent measurement the Chinook picked up a cargo and departed.

During the course of the measurements in the Nuevo Mundo community, a Chinook helicopter took off from the airstrip and flew over the edge of the

village. *Table H4.2* presents the noise levels recorded during this take off and departure.

Shortly after the Chinook had departed, the Bell 212 arrived and landed at San Martin. *Table H4.2* below sets out the noise levels measured during the landing, from a distance of approximately 40 metres away.

On 3rd May 1997 the Bell 212 landed on the large football pitch at Shivangoreni, approximately 200 metres from the centre of the village. *Table H4.2* below sets out the noise levels measured in the village during the landing and take off as well as whilst the helicopter idled on the pitch. There was a direct line of sight to the helicopter during the measurements.

The background levels in the village directly before the helicopter's arrival were: L_{Aeq} 46 dB; and L_{A90} 41dB.

During the field trip, a number of helicopter flights passed over or near the village of Shivangoreni. *Table H4.2* below indicates the noise levels measured in the village for these flights. The distance to the helicopter, the Bell 212, was not known, but it is possible that the flight path was up to a kilometre from the village.

H4.2.2 *River Transport*

SPDP is using two types of river transport for operations where air transport would be inappropriate. Fuel is transported from Atalaya in the north by hovercraft on a daily basis, and boats are used to reach the native Indian communities on an irregular basis.

The hovercraft, named Manta, is a passenger/cargo craft with four Deutz 387 kW engines. It measures almost 25 metres in length and was built in Australia in 1995. The daily trip to Atalaya takes eight hours in travel time for the return journey. *Table H4.2* below sets out the noise levels of the Manta during a measured bypass on the Rio Urubamba, and the noise levels measured during typical onshore manoeuvring operations.

The distance from the sound level meter to the hovercraft was approximately 100 metres. The background level on the river bank before the hovercraft's arrival was: L_{Aeq} 51 dB; and L_{A90} 42 dB.

The background levels immediately before the hovercraft's departure was: L_{Aeq} 50 dB; and L_{A90} 44 dB.

During the period immediately before the pass-by of the hovercraft, an opportunity presented itself to measure a 'peqe-peqe'. The peqe-peqe is the most common boat in the region, owned and used by the native Indians. The hull section is often no more than a hollowed-out tree trunk, though commonly of more modern construction. The engine is small, perhaps as small as 10 horse power, mounted on a long propeller shaft at the back of the boat. The propeller enters the water at a very shallow angle and is used to steer the boat. The engine makes a very distinctive tapping noise which has

led to the name of the boat. *Table H4.2* below sets out the measurements of the peqe-peqe.

The boats used by SPDP are approximately 10 metres long and powered by a single Evinrude 65 outboard engine. The number of trips made by the boats is unpredictable, and is generally dictated by the Community Liaison Officers.

Measurements were made of an example of these boats during a typical pass-by. The results of these measurements are summarised in *Table H4.2*.

Table H4.2 Summary of Measurements of Operational Noise Sources - dB

Source	Activity	Time	Duration	Distance (m)	L_{Aeq}	L_{Amax}	L_{AE}	L_{A90}	Notes
Chinook	Hovering	0936	-	450-600	91	103	115	-	
Chinook	Hovering	0941	-	450-600	88	96	113	-	
Chinook	Take Off	0952	2m 20s	-	58	-	-	53	Measured in Nuevo Mundo community
Bell	Landing	0950	-	40	85	93	110	-	
Bell	Landing	0840	4m	200	73	89	97	-	Measured in Shivangoreni
Bell	Idling	0845	31s	200	60	63	75	-	Measured in Shivangoreni
Bell	Take Of	0903	2m	200	73	88	95	-	Measured in Shivangoreni
Bell	Flypast	1253	short	-	51	58	56	47	Measured in Shivangoreni
Bell	Flypast	1538	20s	-	61	66	74	53	Measured in Shivangoreni
Hovercraft	Bypass	1637	2m	100	76	85	97	-	
Hovercraft	Arrival and park	1734	1m	30	80	88	98	-	
Hovercraft	Start up	0557	45s	30	64	76	81	-	
Hovercraft	Idling	0558	40s	30	64	65	80	-	
Hovercraft	Turn and depart	0559	1m 10s	30-100	70	78	89	-	
Hovercraft	Depart	0601	1m	100+	70	77	88	-	
Peqe-peqe	Bypass	1525	30s	5	63	67	78	-	
SPDP Boat	Bypass	1437	1m 18s	80	57	77	76	-	
SPDP Boat	Bypass	1439	1m 17s	80	57	73	76	-	
SPDP Boat	Bypass	1442	1m	80	56	71	74	-	

H4.2.3 Drilling

Two visits were made to Armihuari, the current well site, to establish the noise levels from a typical drilling operation. Despite the two visits to the site, the drilling rig was not drilling during either visit. During the first visit the drilling rig was carrying our reaming operations and during the second visit the rig was performing a similar operation. Reaming is essentially an operation that is used to clean out the hole. The drill is actually turning during the operation, but the noise levels emanating from the rig are, according to the operators, much lower than when drilling proper.

Measurements were made at, or close to, the four corners of the site, numbered one to four, repeated at the second visit. The two visits are listed separately, in *Table H4.3* and *Table H4.4* since the operations during each visit were different.

Table H4.3 Noise Levels Measured During Reaming Operations - dB

Location	Approx. Distance to centre of site - m	L_{aeq}	L_{A90}	L_{AE} (SEL)	L_{Amax}
1	70	72	71	97	79
2	30	75	74	100	79
3	90	67	65	91	81
4	70	68	67	92	78

Table H4.4 Levels Measured During Cleaning Operations - dB

Location	Approx. Distance to centre of site - m	L_{Aeq}	L_{A90}	L_{AE} (SEL)	L_{Amax}
1	70	73	71	100	85
2	30	73	72	98	75
3	90	69	67	95	73
4	70	71	70	99	75

Other plant measured on site at Armihuari included a water pump located on the fringes of the site. There are two diesel operated pumps located side by side, of which only one is used at any one time, the other being a back up. Noise measurements were taken at a distance of 15 metres from the cooling fan, the loudest part of the plant, and are summarised as follows:

- L_{Aeq} 81 dB;
- L_{Amax} 82 dB;
- L_{AE} (SEL) 105 dB.

H4.2.4 Construction

A number of measurements were carried out at the San Martin-1 site where construction activity was, at the time of the visit, underway.

The activities observed on site were generally limited to site clearance, and the plant on site included, but was not limited to, graders, bulldozers and rollers/compactors.

Measurements were made at various locations, mostly in the far-field so as not to be unduly influenced by any one item of plant. The distance to the centre of the activities was generally around 100 metres. The results are summarised below:

- LAeq 70 dB;
- LA90 63 dB;
- LAE (SEL) 95 dB;
- LAmax 89 dB.

Measurements were also made of a diesel powered generator located near to the main camp. The results are summarised below:

- L_{Aeq} 78 dB;
- L_{A90} 77 dB;
- L_{AE} (SEL) 101 dB;
- L_{Amax} 91 dB.

H4.3 ATTENUATION TESTS

Very little research has been conducted into the noise attenuating properties of rain-forest flora. Due to the greater density of undergrowth in particular, it is expected that the rain-forest offers a much higher level of attenuation than could be expected from the type of forest typically encountered in Europe for example. To determine the extent to which a rain-forest outperforms a European forest, in terms of noise attenuation, a series of tests were carried out.

The attenuation tests were carried out using a stationary noise source of constant output, in this case a diesel water pump. Measurements were made over 5 minute periods close to the pump and at a given distance into the jungle.

Table H4.5 below sets out the average results in octave bands for the two positions; 11m from the pump at the edge of the jungle, and 31m from the pump (20m into the jungle).

Table H4.5 Attenuation Test Results - dB

	Frequency - Hz							
Position	**63**	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
11 m from pump	42	63	72	70	75	71	63	52
31 m from pump	33	53	51	53	57	54	48	40
Difference	**9**	**10**	**21**	**17**	**18**	**17**	**15**	**12**

It is possible to calculate the attenuation one could expect from a more typically forested area using the following equation:

$$A_f = 0.01\ r\ \sqrt[3]{f}$$

where:

- A_f is the attenuation at frequency f in dB;
- r is the distance of travel through the forest in metres; and
- f is the frequency in Hertz.

Table H4.6 below compares the measured attenuation in the rain-forest with the attenuation predicted to occur from a more typical European forest. Both sets of numbers are shown for 20 metres of forest.

Table H4.6 ***Comparison of Measured Attenuation and Predicted Attenuation - dB***

	Frequency - Hz							
	63	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
Measured	9	10	21	17	18	17	15	12
Predicted	0.8	1	1.3	1.6	2.0	2.5	3.2	4.0

The section of rain forest used in the attenuation test was secondary forest, not the more dense primary forest that is likely to be encountered around the Pagoreni and San Martin East sites. The above attenuation figures can therefore be assumed to be an underestimation performance in reality.

H5 PREDICTED IMPACTS

H5.1 IMMEDIATE IMPACTS

In order to quantify impacts resulting from each of the various sources of noise that will be present during the life of SPDP's operations, a methodology is used that is simple, yet will give a good indication of the likelihood of significance.

Two methods of assessment are utilised here. The first is to look at the instances recorded above where noise sources due to SPDP's operation were measured in the communities, *ie* the sensitive receptors, these are mainly air or river transport sources. The second approach is to superimpose the noise sources measured elsewhere onto the sensitive environments.

This second approach is used to indicate suitable separation distances or avoidance paths rather than assess the likely impacts from a given source. The reason for this is that the exact locations for the various installations has not yet been finalised.

H5.1.1 *Air Transport*

Measurements were made in the community at Nuevo Mundo of the Chinook during take off. The background level was generally in the region of 42 dB, and the L_{Aeq} of the Chinook was recorded at 58 dB. This would constitute a significant impact when compared to the ambient level, though it is only marginally higher than the criterion set for transient sources affecting speech in the open air.

The measurements made in the community of Shivangoreni of the Bell 212 show that landing near the community causes significant noise disturbance, an average of 71 dB. The background level in the village at the time of the landing was generally 32 dB.

It was generally observed that helicopters flying past Shivangoreni in particular caused a noise disturbance. The two measurements recorded above, L_{Aeq}s of 51 and 61 dB, probably represent flights at two different distances from the village. The lower recorded level is below the criterion for disturbance within residential properties (55 dB external), though the higher is substantially above this criterion.

There were no measurements of helicopter or fixed wing aircraft movements from outside of the village environment, so no superimposition can be carried out.

H5.1.2 *River Transport*

Three different types of river transport were measured during the field trip: hovercraft, SPDP boats, and peqe-peqes. The last of these is representative of

the kind of river transport used by the local communities, and it provides a useful benchmark against which the SPDP craft can be compared.

The hovercraft and the SPDP boat are significantly noisier than the peqe-peqe, which is unsurprising. The difference in the levels is almost 40 dB between the peqe-peqe and the hovercraft and almost 20 dB between the peqe-peqe and the SPDP boat. Given these differences in level, there is potential for the noisier craft used by SPDP to cause noise impacts.

The tonal content of the different type of craft is broadly similar, with the hovercraft having a dominant 100 Hz tone, and the SPDP boat having peaks at 200 and 400 Hz.

The measurements of the three types of river craft were all taken in similar positions at the side of the river. The position was chosen as representative of the berthing areas of the villages and the residential properties closest to the river's edge.

The levels measured for the hovercraft were generally in the region of L_{Aeq} 76 dB, whilst the background noise levels were generally 42 dB L_{A90}. During the pass by the hovercraft was approximately 100 metres away from the meter.

The noise from the SPDP boat was measured at L_{Aeq} 57 dB, over a background level of approximately 38 dB. During the measurement, the SPDP boat passed approximately 80 metres from the meter.

To quantify the impact the SPDP craft have on the environment, the noise measured noise levels can be compared against the native river craft, the peqe-peqe. Because each craft was measured at a different distance from the sound level meter, it is necessary to normalise all the measurements to the same distance, *eg* 10 metres.

The measured noise levels, normalised to 10 metres, are:

- hovercraft 96 dB;
- SPDP boat 75 dB;
- peqe-peqe 57 dB.

It can be seen from the above that the SPDP craft are significantly louder than the native craft, and so the potential for impacts is much greater as can be expected.

H5.1.3 Construction

The extent of the potential impacts arising from the construction of the various installations will be defined by the methods of working and supply used. The 'on the ground' operations should provide a reasonable potential for successful mitigation given that all of the sources will be working in a defined area. The supply chain, *ie* the method used to bring in workers and

materials, will be more difficult to mitigate as the transport routes will need defined corridors from the supply base to the site.

The primary means of supply to the drillsites will be by air, as used at the current construction site at San Martin-1. This will need to be managed more closely than at San Martin-1 given that Pagoreni and San Martin East may be close to a populated area.

H5.1.4 *Operations*

General

The sources within the drilling area are stationary and tend to be easier to screen than the mobile sources, so the scope for providing in situ mitigation is much higher than for the various transportation modes. The density of the surrounding flora should ensure that the area affected by the operational sources is kept to a bare minimum.

It is possible to determine the closest distances at which the drilling rigs can be located using the methodology set out in the Concawe Report No 4/81 *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities.*

There have been assumed to be three possible paths that the noise could follow:

- direct through the forest;
- at tree canopy level; and
- through atmospheric effects 'bending' the noise.

The amount of 'bending' occurring is dependant on the amount of turbulence in the air, stratification etc etc

Direct Path

The direct path is attenuated by geometrical spreading with excess attenuation from the forest foliage. This has been assumed to be equal to that in a European forest to ensure a worst case scenario is represented, *ie* the attenuation from a European forest will be less than would occur in a rain-forest.

Canopy Path

The canopy has been assumed to be a substitute ground, providing no attenuation due to ground effects (*ie* hard ground).

Atmospheric Effects

The refraction of sound by wind velocity and atmospheric temperature gradients has an important effect on the received sound pressure level. Sound waves may be effectively 'bent' back towards the receptors under certain atmospheric conditions.

Atmospheric stability is a measure of the turbulence of the air, particularly of the vertical motions present. To model the atmospheric effects on noise, it is classified by *Pasquill Stability* categories, A to F. Stability A is the unstable extreme, representing very convective conditions with large vertical motions, while F is a very stable category where vertical motion is suppressed. Stability category D refers to neutral conditions, where mechanically generated turbulence is caused by surface winds.

It has been assumed that the categories most likely to occur in the Peruvian rain-forest in the vicinity of the Camisea region are category A during the day, and D during the night. These, coupled with an assumed wind speed of between 0.5 and 3.0 m/s, translate to Concawe defined atmospheric stability categories 4 and 5 respectively.

Further assumptions made relate to the temperature and relative humidity of the area. Concawe only allows for temperatures of 30°C, so this was assumed, together with a relative humidity of 90%.

Exclusion Zone

The relative split between each of these paths was assumed to be equal, to represent a worst case, and split 80:10:10 (direct:canopy:atmosphere) to represent a more realistic scenario.

Modelling each of these conditions, exclusion zones for each of the villages are set out in *Table H5.1* below.

Table H5.1 ***Exclusion Zones - metres***

Noise Path Split	Shivangoreni
33/33/33	2,200
80/10/10	1,500

The above numbers indicate the closest distance at which the operational drilling rig could be placed and still meet the operational criteria stated in *Section 3.3*.

The equivalent distances for the construction activities are a little smaller, so the drilling activities become the determining factor.

It should be noted that the above calculations used the measurements of the drilling rig conducted whilst the drilling carried out reaming operations, so there may be some scope for the noise produced by the drilling equipment to exceed these levels. In this case, the distances above are likely to be insufficient to ensure that the criteria are satisfied. Re-calculation should be carried out once the noise levels produced by the drilling rig in full operating mode are established. However, the nearest drilling site to Shivangoreni is Pagoreni D, 3.1 km away from the village.

H5.2 CUMULATIVE IMPACTS

Each of the impacts identified above are significant for the duration that each activity lasts, but the duration of the activities is small in comparison to the time period over which the assessment is taken, *ie* all day.

The construction and operation phases of the project are likely to contribute a great deal to the overall daily noise level in the areas affected by the activities, whereas the logistical links will provide a much more sporadic, though potentially much higher, impact.

H5.3 MITIGATION

Each of the potential sources of impact are investigated individually to establish the extent of any mitigation measures that may be possible.

H5.3.1 *Air Transport*

Since the nature of the work is such that air transport is essential, the only viable option for mitigation is rigid management of the flight patterns. Ensuring that the aircraft, both fixed wing and especially rotary wing, circumnavigate a zone of airspace that covers the villages and any sensitive lands they use, then it should be possible to mitigate the possible impacts. Some further work would be needed to establish suitable zones based on noise measurements of flying and hovering helicopters at known distances from the point of noise measurement. Using these data, in combination with community consultation, it would be possible to derive flight paths that met both safety objectives whilst minimising nuisance to the local communities.

A navigation system would need to be set up to ensure that these paths are safely followed, *eg* a system of navigation beacons to guide the pilots.

H5.3.2 *River Transport*

The use of quieter models of river transport would greatly reduce the possibility of adverse impacts resulting from their operation. SPDP no longer proposes to use the hovercraft and this craft constitutes the major surface transport noise source. For other river vessels, careful management of the routes used, the times at which journeys are undertaken, and especially the number of journeys should minimise the potential for impacts.

H5.3.3 *Construction*

The use of inherently quiet plant, good management practices and judicious use of screening will form the basis of the mitigation for the construction works.

H5.3.4 *Operation*

The mitigation measures most suitable for the operational activities consists of screening and careful plant selection. The selection of quiet plant for the

drilling activities is limited by the need to use the existing drilling rig, along with its associated auxiliary equipment.

It should be possible to screen the works from any nearby sensitive receptors, either by custom made noise screens, or by orienting the site such that there is a natural barrier or earth cut that breaks the line of sight.

H5.4 CONCLUSION

This study has investigated the potential for SPDP's activities to cause adverse impact on the local populations. The investigative methods used, direct measurement and superposition as well as limited modelling, has simplified the assessment to enable realistic conclusions to be drawn.

Each of the individual impacts is mitigable to the extent where they should cause no adverse impacts. The main mitigation for all potential sources of impact is management, be that re-routing air transport sufficiently far from receptors to cause minimal impact, or locating drilling sites suitably far away.

The cumulative impacts should be negligible provided that each individual impact is managed properly.

Annex I

Archaeology

Appendix I1

Methodology for the Archaeological Survey

APPENDIX I1 METHODOLOGY FOR THE ARCHAEOLOGICAL SURVEY

I1.1 INTRODUCTION

This Appendix presents the methodology for the archaeological within the vicinity of the well sites. The survey comprised:

- direct reconnaissance;
- exploration soundings;
- interviews with community members.

I1.2 DIRECT RECONNAISSANCE

This activity comprised *in situ* exploration of the area. The co-ordinates for the survey are presented in *Table 2a.* Once the well site was located, it was projected on a radial basis around the point, to a 100 m diameter. This area was surveyed and records made of any evidence of cultural resources.

Table I1 Geographic Co-ordinates for the Archaeological Survey

Site	Co-ordinates (UTM)	
San Martín-East (SM-A)	757969	8695102
Pagoreni		
• PR-A	720584	8708682
• PR-C	726543	8706659
• PR-D	727406	8703902

Restrictions to this survey techniques are associated with vegetation density and access limitations. To aid reconnaissance, Matsiguenga guides were used to facilitate access to the survey sites.

I1.3 EXPLORATION SOUNDINGS

Observation and assessment of test pits (soil sampling sites), typically of 1 m^2, was undertaken by soil experts. Stratigraphy was examined and analysed in order to identify the existence of soil layers with cultural remains.

I1.4 INTERVIEWS WITH COMMUNITY MEMBERS

Representative members of the Machiguenga community (Nuevo Mundo, Camisea and Shivangoreni) were consulted to obtain information about historic finds within the area. The community representatives were shown

artefact (photos) material [1] and archaeological remains found and reported in similar areas of the Amazon.

I1.5 *RECORDING*

To facilitate the determination of the age of the field survey findings, the archaeological evidence recording was undertaken to describe the setting of all finds. Samples were dated with radiocarbon.

(1) Artefact material comprised vases, pottery remains, stone axes, funerary remains etc.

Appendix I2

Details of Lythic Material (Preliminary Analysis)

I1.1 DETAILS OF LYTHIC MATERIAL (PRELIMINARY ANALYSIS)

- Chopper.- Solid piece on a pebble, with an edge made with one-faced **lascamientos** ; carved on one face and along a single end, forming a sinuous, straight, edge, in a vertical plane. The piece recorded is on an oval-shaped pebble. The raw material is grey quartzite, with cuttings. Rough artefact, made in a careless manner and probably used to work wood; etc.

- Denticulate, tabular or solid.- On a thin base, with retouched and separated edges, having these edges a different alignment with continuous notches. The raw material is black thick- grained quartzite. No cuttings.

- Weights.- Globular-shaped piece worked from a cobble, of quartzite rock, with a circular central hole made through rotatory incision (abrasion). The stone was polished to make its edges and the surface even. These artefacts were placed in wooden sticks and fishing nets.

- Ax.- Made with two different work techniques: first to carve the stone, then, to pierce and polish it; in this case, both techniques are combined. It is a T-shaped artefact made from an oval-shaped pebble; the raw material is grey-greenish quartzite, slightly oval.

Both faces were worked through little detachments in order to make the tie thin; the ends were worked to obtain a convex useful edge, slightly sharp and straight, achieving a shiny polish finish.

Photo 1 Lythic utensil, made of black granodiorite (chopper).



Photo 2 Denticulated lythic utensil, made of black quartzite.



Photo 3 Pebble weight with shiny surface, made of quartzite.



Photo 4 T-shaped stone ax.



Appendix J

Participatory Maps

Appendix K

Photo Log

List of Photographs

1 Logistics Base in Nuevo Mundo - beginning of May.

2 Security of waste storage.

3 Cargo plane Antonov delivering [unloading] in Nuevo Mundo.

4 Waste management [managing waste] in Nuevo Mundo.

5 Compensation programme/[social capital] at the mothers' club in Nuevo Mundo.

6 Compensation programme/[social capital] construction of medical post in Nuevo Mundo.

7 Logistics Base in Nuevo Mundo starting with greenhouse for the programme of [revegetation].

8 Cashiriari 2 Well (previously named Armihuari) - mid June.

9 Cashiriari 2 Well - installations - camp in the background.

10 "Chinook" line for provision of supplies to Cashiriari 2.

11 Construction of San Martín 3 Well - laminated with green steel [green laminated steel] on the site; construction of cuttings pit; camp area and helicopter in the background - 13 June.

12 Construction [building] for hillside erosion control at San Martín 3.

13 Cuttings pit with [ ] at San Martín 3 - 17 June.

14 Boats providing supplies for the logistics base at Nuevo Mundo.



Photo 1



Photo 2



Photo 3


E TRABAJO CUIDADO ZONA DE TRABAJO CUIDADO ZONA DE TRABAJO CUIDADO ZONA DE TRABAJO CUIDADO ZONA D
S.A. COSAPI S.A. COSAPI S.A. COSAPI S.A. COSAPI S

Photo 4

Photo 5

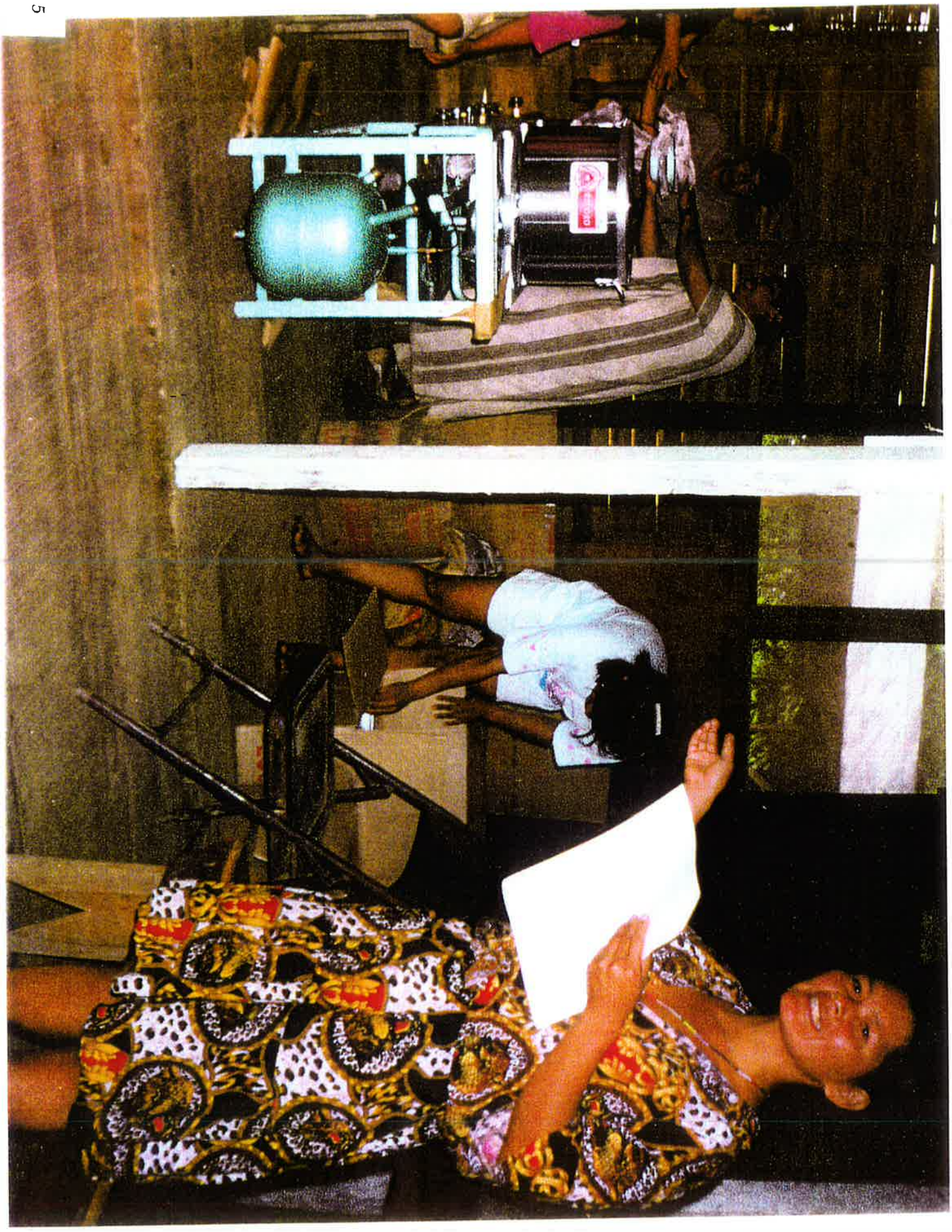


Photo 6



Photo 7



Photo 8

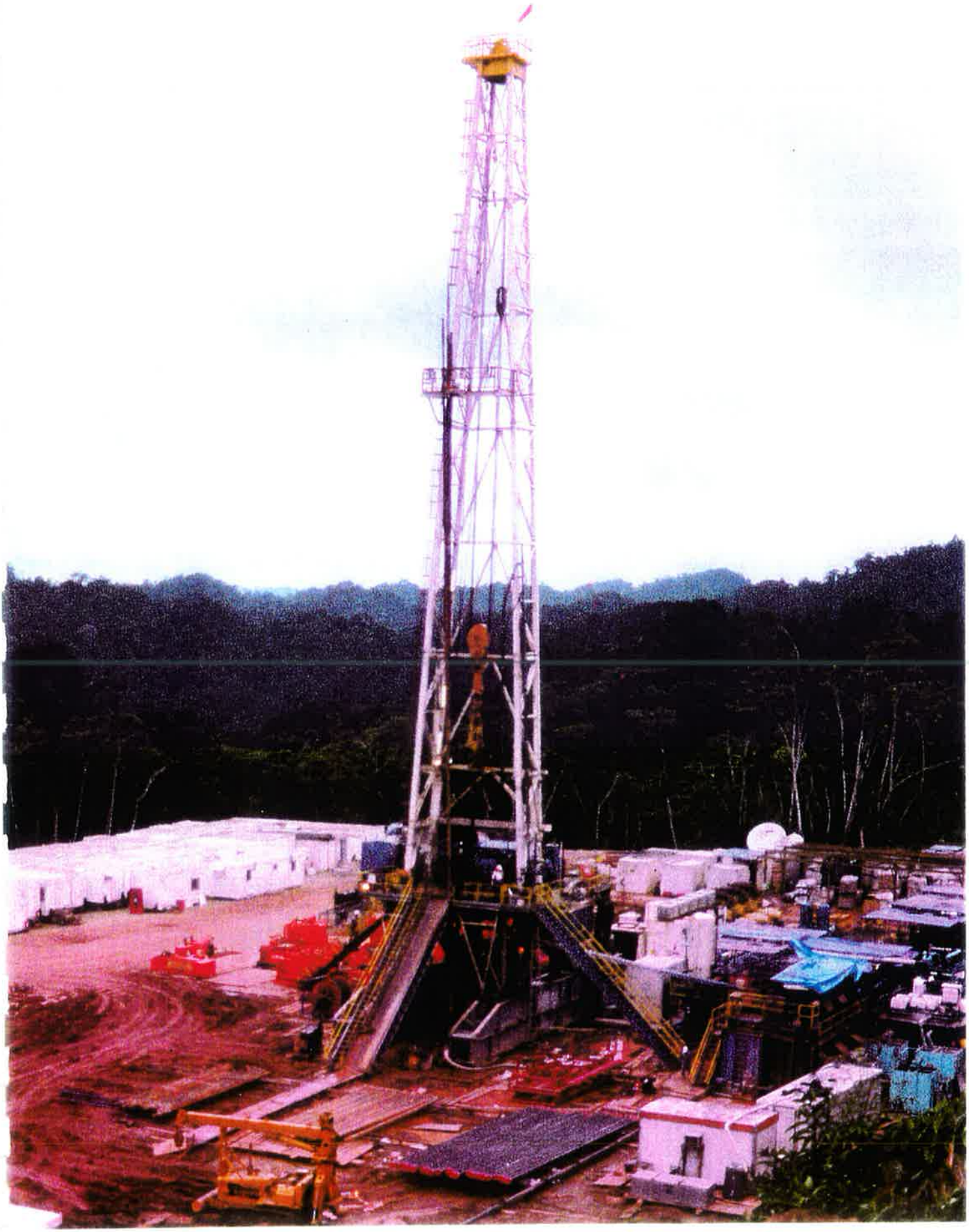


Photo 9



Photo 10

Photo 11

Photo 12

Photo 13



Photo 14