AZERI, CHIRAG & DEEP WATER GUNASHLI FULL FIELD DEVELOPMENT PHASE 2

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

SEPTEMBER 2002

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Units and abbreviations

Units

%	Percent
%v	Percentage by volume
%w	Percentage by weight
µ	Microns
μgm^{-3}	Micrograms per cubic metre
"	Inches
‰	Parts per thousand
Barg	1 bar (gauge) = 14.5 psi
bbl	Barrel (6.2898 barrels = 1 m^3)
bopd	Barrels of oil per day
Bpd	Barrels per day
Bq/Kg	Bequerels per kilogram (measure of radioactivity)
$Cells.l^{-1}$	Cells per litre
$Cells.m^{-3}$	Cells per cubic metre
cm	Centimetre
cms^{-1}	Centimetre per second
$cmyear^{-1}$	Centimetres per year
dB	Decibel
gm^{-1}	Grams per metre
gm^{-2}	Grams per square metre
ha	Hectare
Hz	Hertz (Measure of frequency)
Kev	Kilo-electron Volt (measure of radioactive energy release)
kg	Kilograms
km	Kilometre
km^2	Square kilometre
Kte/yr	Kilo-tonnes per year
Lb/mmscf	Pounds per million standard cubic feet
litres/hr	Litres per hour
m	Metres
m TVD BRT	Depth in metres (True Vertical Depth) (Below the Rotary Table)
m/hour	Metres per hour
m^2	Square metre
m^3	Cubic metre
m^3/day	Cubic metres per day
m^3/h	Cubic metres per hour
mbgl	Metres below ground level
mbpd	Thousand barrels per day
$mgkg^{-1}$	Milligram per kilogram
mgl^{-1}	Milligrams per litre
Mg/m^3	Milligrams per cubic metre
mm	Millimetres
mm/hr	Millimetres per hour
mmscf	Million standard cubic feet
mmscfd	Million standard cubic feet per day
MPN/100ml	Most Probable Number per 100 millilitres
mstdbpd	Thousand standard barrels per day
ms^{-1}	Metres per second
MW	Megawatt
^oAPI	Degrees (American Petroleum Institute (Oil density measurement)).

^{o}C	Degrees centigrade
pH	$-\log_{10} [H^{+}]$ (Measure of acidity or alkalinity)
ppb	Parts per billion
ppbv	Parts per billion by volume
ppm	Parts per million
ppmv	Parts per million by volume
Scf/bbl	Standard Cubic Feet per Barrel
Sm^3	Standard cubic metres
Sm^3/hr	Standard cubic metres per hour
te	Metric tonnes
Te/day	Metric tonnes per day
$/te	US dollars per tonne
US$	US dollars
US$M	US Dollars (Millions)
μgg^{-1}	Micrograms per gram
μgl^{-1}	Micrograms per litre

Abbreviations

4WD	4-wheel drive
AAAF	Anaerobic-Aerobic-Air Flotation (Fire fighting foam)
AAS	Atomic Absorption Spectrophotometry
ACCMP	Archaeological/Cultural Construction Monitoring Programme
ACG	Azeri, Chirag, Gunashli
AD	Anno Domini
ADMS3	Atmospheric Dispersion Modelling System Version 3
AERMOD	A computer programme that models air dispersion
AET	Azerbaijan Economic Trends
AETC	Azerbaijan Environment and Technology Centre
AGT	Azerbaijan, Georgia and Turkey Projects
AIDS	Acquired Immune Deficiency Syndrome
AIOC	Azerbaijan International Operating Company
AMP	Archaeological Management Plan
APE	Alkyl Phenol Ethoxylates
API	American Petroleum Institute
AQS	Air Quality Standard
ARB	Azerbaijan Red Book (list of threatened wildlife in Azerbaijan).
AR-FFFP	Alcohol-resistant- Film-forming Fluroprotein
ASA	Applied Science Associates
ASCE	Azerbaijan State Committee for Ecology
ASFC	Azerbaijan State Fisheries Concern
ASSC	Azerbaijan State Statistical Committee
ASY	Azerbaijan Statistical Yearbook
AZM	Azerbaijan Manat
BACT	Best Available Control Technology
BAP	Biodiversity Action Plan
BAT	Best Available Technology
BCES	Baku City Electrical Services
BFCC	Biofouling and Corrosion Control System
BHA	Bottom hole Assembly
BIC	Business Information Centre
BMT	British Maritime Technology
BOD	Biological Oxygen Demand
BOP	Blow Out Preventer
BP	British Petroleum

BPCS	BP Caspian Sea
BPEO	Best Practicable Environmental Option
BS	British Standard
BTC	Baku-Tbilisi-Ceyhan
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
BU	Business Unit
C&WP /CWP	Compression and Water Injection Platform
c.	Approximately
CA	Central Azeri
CAPEX	Capital expenditure
CCPG	Combined Cycle Power Generation
CDV	Canine Distemper Virus
CEL	Caspian Environmental Laboratory
CEP	Caspian Environmental Program
CERC	Cambridge Environmental Research Consultants
CFC	Chlorofluorocarbon
CH_4	Methane
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
CITES	Convention on the International Trade of Endangered Species
CLO	Community Liaison Officer
CMC	Contracts Management Committee
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COD	Chemical Oxygen Demand
CRI	Cuttings Reinjection
CRM	Community Relations Manager
CRP	Community Relations Programme
CRRP	Coastal Rehabilitation and Reinstatement Programme
CVP	Capital Value Process
DBA	Derrick Barge Azerbaijan
DC/AC	Direct Current/ Alternating Current
DDT	Dichlorodiphenyltrichloroethane
DES	Drilling Equipment Set
DLE	Dry Low Emission
DLN	Dry Low NOx
DPS	Diverse Path Shutdown System
DQ	Drilling and Quarters Platform
DSM	Drilling Support Module
DST	Drill Stem Test
DSV	Dive Support Vessel
DTI	Department of Trade and Industry
DTM	Digital Terrain Model
EA	Environmental Assessment
EA	East Azeri
EAP	Environmental Action Plan
EBRD	European Bank for Reconstruction and Development
EC	European Community
ECA	Export Credit Agency
ECEWP	Early Civil Engineering Work Programme
EEC	European Economic Community
EFRT	External Floating Roof Tank
EHRA	Environmental Hazard and Risk Assessment
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment

EMP	Environmental Management Plan
EMS	Environmental Management System
EOP	Early Oil Project
ERL	Effects range low (threshold level for environmental metal contamination).
ERT	Environment & Resource Technology Ltd
ES	Environmental Statement
ESIA	Environmental and Socio-Economic Impact Assessment
ESS	Emergency Shutdown System
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FE	Fugitive Emissions
FEED	Front end engineering design
FFD	Full Field Development
FOCs	Foreign Oil Companies
FSU	Former Soviet Union
GCA	Gunashli, Chirag, Azeri
GC-MS	Gas Chromatography- Mass Spectrometry
GCP	Garadag Cement Plant
GD	Garadagh District
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GHSER	Getting HSE Right
GI	Gas Injection
GIS	Geographic Information System
GLP	Good Laboratory Practice
GPS	Global Positioning System
GT	Gas turbine
GWP	Global Warming Potential
H_2S	Hydrogen Sulphide
HADT	Hazardous Area Drainage Tank
HFCs	Hydrofluorocarbons
HIPPS	High Integrity Process Protection System
HIV	Human Immunodeficiency Virus
HOCNF	Harmonized Offshore Chemical Notification Format
HOVHL	High Voltage Overhead Line
HP	High Pressure
HRSG	Heat Recovery Steam Generator
HSE	Health, Safety & Environment
HSEMS	Health, Safety & Environment Management System
HVAC	Heating Ventilation Air Conditioning
HVDC	High Voltage Direct Current
HYDROMAP	A globally re-locatable hydrodynamic model capable of simulating complex circulation patterns due to tidal forcing and wind stress quickly and efficiently anywhere on the globe, developed by ASA.
ICP	Inductively Coupled Plasma
ICSS	Integrated Control and Safety System
IDP	Internally Displaced Persons
IEA	National Institute of Ethnography and Archaeology
IFC	International Finance Corporation
IFI	International Finance Institutions
IFRT	Internal Floating Roof Tank
ILO	International Labour Organisation
IMDG	International Maritime Dangerous Goods
IMF	International Monetary Fund

IMO	International Maritime Organisation
ISAR	Initiative for Social Action and Renewal in Eurasia
ISO	International Organisation for Standardisation
ITT	Invitation to Tender
IUCN	International Union for the Conservation of Nature
IWMP	Integrated Waste Management Plan
KAP	Knowledge, attitudes, practices
KCl	Potassium Chloride
KOH	Potassium Hydroxide
KP	Kilometre Point
KW_{elec}	Kilowatts of Electricity
L_{10}	Noise level exceeded for 10% of measurement time
L_{50}	Noise level exceeded for 50% of measurement time
L_{90}	Noise level exceeded for 90% of measurement time
LAO	Linear alpha olefin
LCM	Loss Control Material
Leq (L_{Aeq})	equivalent continuous noise level
LER	Local Equipment Room
L_P	Pressure Level
LP	Low Pressure
LSA	Low specific activity
LTU	Large Taxpayers Unit
L_W	Power Level
MARPOL	International Convention for the Pollution of Prevention by Ships, 1973, as modified by the Protocol of 1978
Max	Maximum
MCR	Maximum Capacity Rating
MDHS	Method for Determining Hazardous Substances
MEG	Mono-Ethylene Glycol
MEL	Maximum Exposure Level
MENR	Ministry of Ecology and Natural Resources
MEPC	Marine Environmental Protection Committee
MIGA	Multilateral Investment Guarantee Agency
Min	Minimum
MLA	Multilateral Lending Agency
MOD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MOL	Main Oil Line
MOU	Memorandum of Understanding
MOWP	Minimum Obligatory Work Programme
MP	Medium Pressure
MPC	Maximum Permitted Concentration
MPN	Most Probable Number
MSD	Marine Sanitation Device
MSDS	Material Safety Data Sheet
MUDMAP	Computer model that predicts the near and far field transport and dispersion of drill muds, cuttings and produced water. Developed by ASA.
MW	Megawatt
$MW_{elec.}$	Megawatts of electrical energy
$MW_{heating}$	Megawatts of heating energy
MW_{mech}	Megawatts of mechanical energy
N_2O	Nitrous oxide
NDT	Non Destructive Testing
NE	Northeast

NER	Northern Export Route
NETCEN	National Environmental Technology Centre
NGO	Non-governmental Organisation
NMVOC	Non-methane Volatile Organic Compounds
NO	Nitrogen monoxide
NO_2	Nitrogen dioxide
NORM	Naturally Occurring Radioactive Material
NO_x	Nitrogen Oxides
NW	Northwest
NWBM	Non Water Based Mud
OAQPS	Office for Air Quality Planning and Standards
OBM	Oil Based Mud
OCNS	Offshore Chemical Notification Scheme
OECD	Organisation for Economic Cooperation and Development
OHGP	Open-hole gravel packs
OPEX	Operating expenditure
OPF	Organic continuous phase invert-emulsion drilling fluid
OPIC	Overseas Private Investment Corporation
OSCP	Oil Spill Contingency Plan
OSIS	Oil Spill Information System, developed by BMT
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the North East Atlantic
PACP	Poly-anionic cellulose based polymer
PAH	Polycyclic aromatic hydrocarbons
PCB	Polychlorinated biphenyls
PCDP	Public Consultation and Disclosure Plan
PCS	Process Control System
PDQ	Production, drilling and quarters platform
PDUQ	Production, drilling, utilities and quarters platform
PEC	Predicted Environmental Concentrations
PFCs	Perfluorocarbons
PHC	Primary Health Care
PLONOR	Presenting Little Or No Risk to the Environment
PM	Particulate matter
POB	Persons on Board
PPAH	Pollution Prevention and Abatement Handbook
PPD	Purified Protein Derivative (Skin Test)
PPE	Personal Protective Equipment
PSA	Production Sharing Agreement
PSA	Particle Size Analysis
PSD	Project Summary Document
PSI	Pounds per square inch
PSS	Process Shutdown System
P-Tank	Pressure Tank (cement)
PW	Production Water
PWRI	Production Water Reinjection
QA	Quality assurance
RAM	Reliability, Availability and Maintainability
RAP	Resettlement Action Plan
RKB	Rotary Kelly Bushing (standard terminology given for well depths)
RO	Reverse Osmosis
Ro/Ro	Roll-on / Roll-off
ROP	Rate of penetration
ROV	Remotely operated vehicle
ROW	Right of Way

SBM	Synthetic Based Mud
SCE	State Committee for Ecology
SCI	State Caspian Inspectorate
SCNR	Selective Non-Catalytic Reduction
SCPP	South Caucasus Pipeline Project
SCR	Selective Catalytic Reduction
SCSSV	Surface Controlled Subsurface Safety Valves
SD	Shah Deniz
SDGP	Shah Deniz Gas Pipeline
SE	Southeast
SF_6	Sulphur hexafluoride
SIC	Sound Emission Contours
SO_2 /SO_x	Sulphur dioxide
SOCAR	State Oil Company of the Azerbaijan Republic
SOLAS	Safety of Life at Sea
SOW	Statement of Work
Spp.	Species
SPS	Shelfprojectstroy
SPT	Standard Penetration Test
SRP	Semi-desert Restoration Program
Stbd	Standard barrels per day
STD	Sexually Transmitted Disease
STRAI	Spur-thighed Tortoise Rescue and Awareness Initiative
SW	Seawater
SW	Southwest
SWOT	Strengths, Weaknesses, Opportunities and Threats
TACIS	Technical Assistance for the Commonwealth of Independent States
TAE	Trans-Asia-Europe Fibre-Optic Line
TB	Tuberculosis
TCN	Third Country Nationals
TD	Target Depth
TEG	Tri-Ethylene Glycol
THA	Total Hydrocarbon Analysis
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TOP	Top of Pipe
TPH	Total Petroleum Hydrocarbons
TRACECA	Transport Corridor Europe Caucasus-Asia
TWA	Time Weighted Average
TWMI	Total Waste Management International
UCM	Unresolved complex mixture
UH	United Hospital
UK	United Kingdom
UKOOA	United Kingdom Offshore Operators Association
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Food Programme
UNICEF	United Nations Children's Fund
USA	United States of America
USEPA	United States Environment Protection Agency
USExIm	United States Export-Import Bank
USSR	Union of Soviet Socialist Republics
UTM	Universe Transverse Mercator

UV	Ultra -Violet
UVF	Ultra –Violet Fluoroscopy
VECs	Valued Ecosystem Components
VOCs	Volatile Organic Compounds
WA	West Azeri
WBG	World Bank Group
WBM	Water Based Mud
WD	Well Depth
WER	Western Export Route
WHO	World Health Organisation
WHR	Waste Heat Recovery
WTO	World Trade Organisation
XCD	Xanthan gum biopolymer (Drill fluid/ additive)

0. NON-TECHNICAL SUMMARY

0.1 Introduction

The Azerbaijan International Operating Company (AIOC) are in the process of developing the Azeri, Chirag and Deep Water Gunashli (AGG) oil fields in the Azerbaijan sector of the Caspian Sea (**Figure 0.1**). Work first began in 1995, with extraction of early oil from the Chirag field in 1997 (the Early Oil Project). It is continuing with the development of the Phase 1 Central section of the Azeri field (first oil planned for 2005), Phase 2 West and East Azeri section, (first oil planned for 2006) and Phase 3 Deep Water Gunashli field (first oil planned 2008) (see **Figure 0.2**). These Phases are all stages in the ACG Full Field Development (FFD) that has been the ultimate aim of the Project from the outset. This Non-Technical Summary presents the findings of the Environmental and Social Impact Assessment (ESIA) for the Phase 2 project.

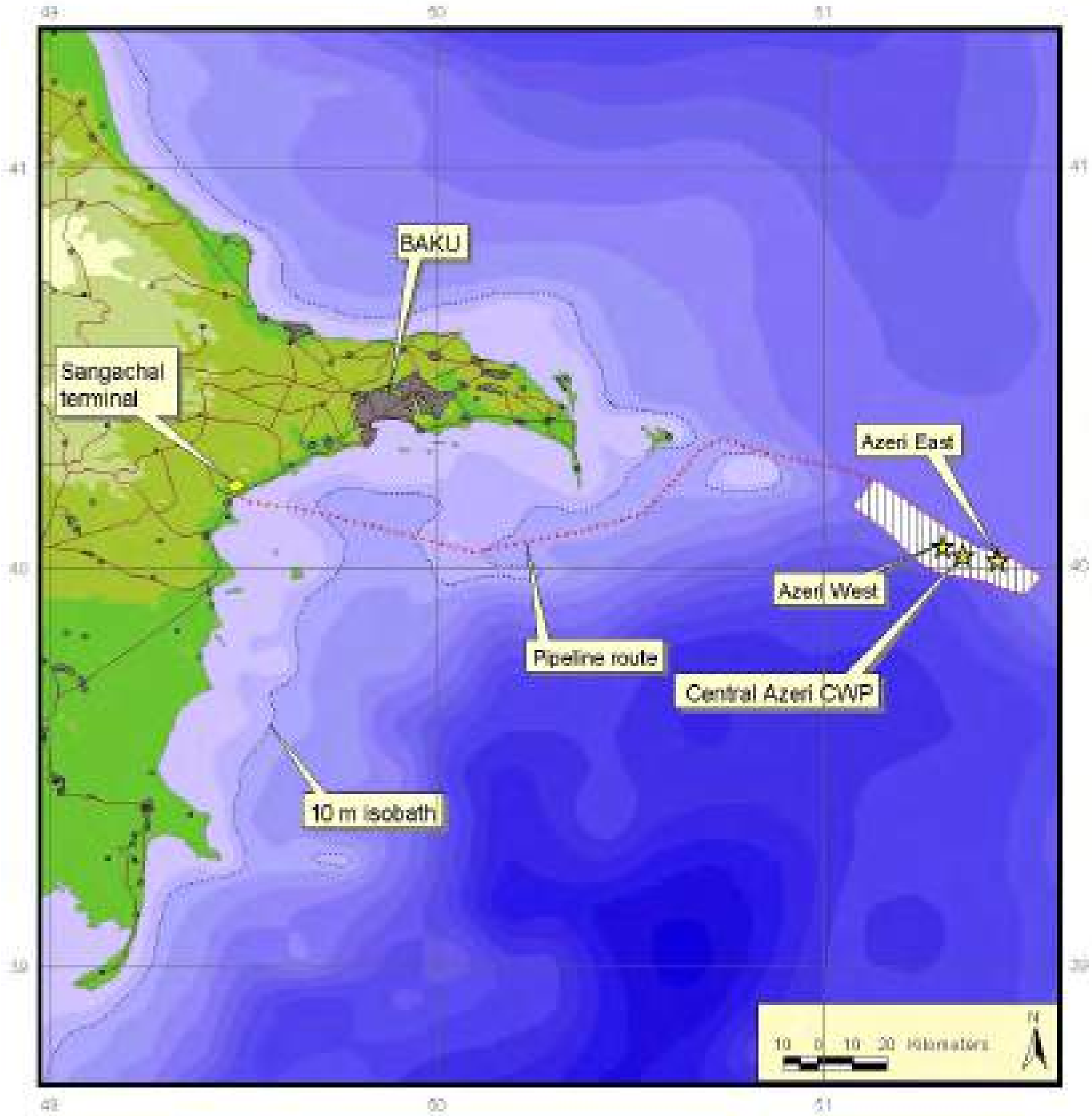

Figure 0.1: The AIOC Contract Area, Pipeline Corridor and Terminal Site

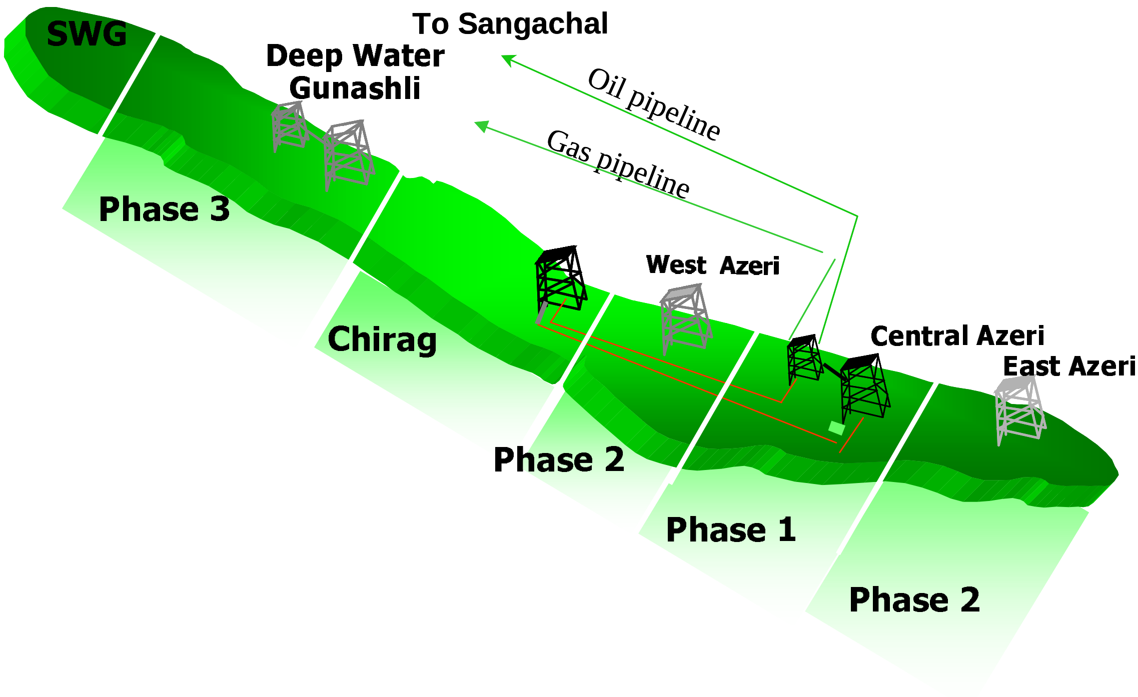

Figure 0.2: The Azeri, Chirag & Deep Water Gunashli Full Field Development as conceived at the present time

Phase 2 will comprise two fixed platforms for drilling and production, a new 30" diameter subsea oil pipeline to Sangachal terminal, further expansion of the terminal and new pipelines connecting facilities between the offshore fields (shown diagrammatically in **Figure 0.3**). The Phase 2 of FFD ESIA has been prepared at the planning stage so that the potential impacts of the development on the environment and on human health and welfare are identified, assessed and measures to reduce any adverse impacts can be built into the subsequent design proposal.

Overall control of the development of the ACG oil field is governed by a Production Sharing Agreement (PSA) between the Azerbaijan Government and AIOC. It is a legally binding agreement that specifies the work to be undertaken and the environmental standards that must be met. Adherence to the PSA ensures compliance with Azeri laws and incorporates the requirements of international guidelines and standards.

0.2 Project Alternatives

Studies were carried out in accordance with "BP Amoco Upstream Environmental Performance Guidelines for New Projects and Developments" with the aim of ensuring that the selection of the final development concept and the chosen technical solutions represents the Best Practicable Environmental Option (BPEO) within the project's engineering and financial constraints.

The evaluation of Phase 2's engineering design options was generally carried out by means of a four-stage process:

- definition of specific health, safety and environmental (HSE) goals;
- identification of potential control measures/technology options;
- quantification of contribution of options towards Project goal(s); and

- evaluation of options (in terms of cost, reduction in environmental impact and net environmental benefit).

This evaluation process resulted in the project design that is summarised in the following section and identified a number of issues that are still to be evaluated (see **Section 0.5.2**).

0.3 Description of the Project

The aim of the Phase 2 project is to recover oil and gas reserves from the East and West Azeri sectors of the ACG oil field. Oil will be carried by pipeline to Sangachal terminal where it will be processed before being transferred through the Baku-Tbilisi-Ceyhan (BTC) pipeline to a tanker terminal at Ceyhan on the Mediterranean coast. Other options may also be considered by some of the companies in the AIOC consortium. Gas will be piped to the same terminal and fed into the Azerbaijan (SOCAR) pipeline network. This will be achieved through the construction of the components described below and illustrated in **Figure 0.3**.

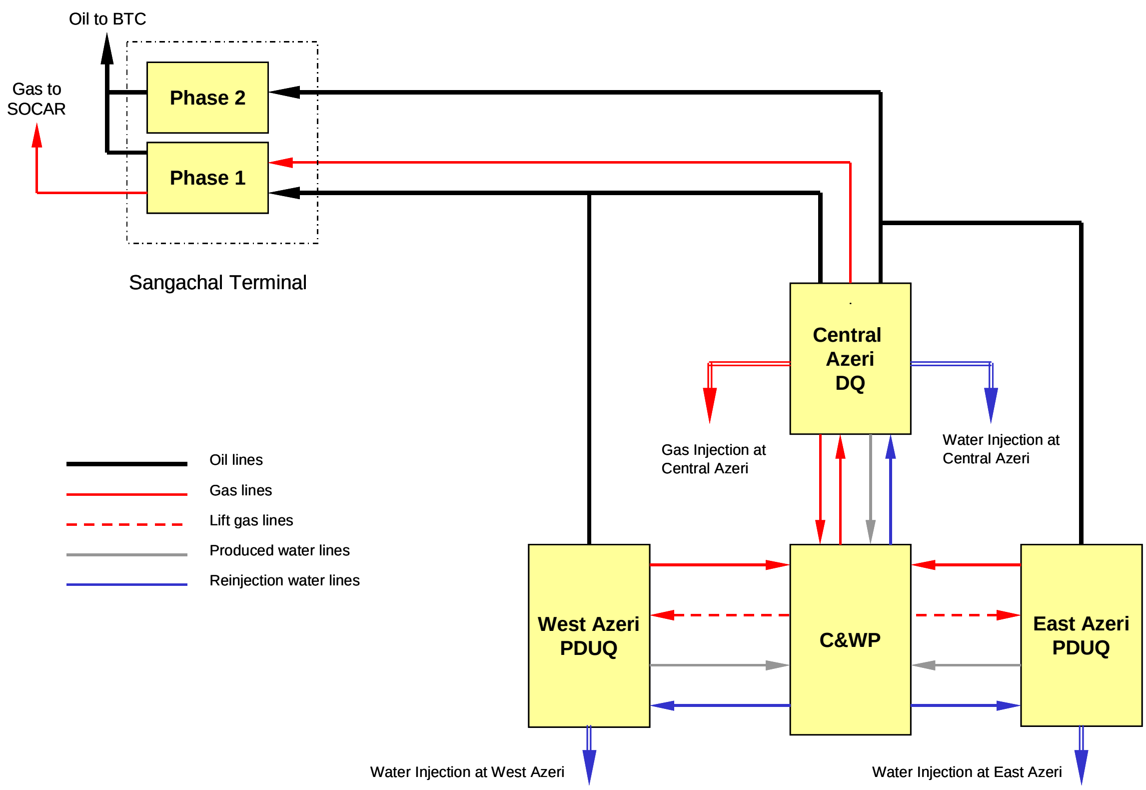

Figure 0.3: The components of Phases 1 and 2 of the ACG

0.3.1 West Azeri and East Azeri Production, Drilling, Utilities and Quarters Platforms

Two platforms, the West Azeri and East Azeri Production, Drilling, Utilities and Quarters Platforms (PDUQs) will be required for drilling and production operations. Each platform will have 48 drilling slots arranged in a 12 x 4 pattern. Currently, 34 production wells are planned for the West Azeri platform. In addition, there will be six water injection wells (used to keep the reservoir pressure at the required level) and two cutting disposal wells, leaving 6 unused slots. On the East Azeri platform it is planned to have 36 production wells, 10 water injection wells and 2 cutting injection wells.

On the platforms the reservoir fluids will be separated into oil, water and gas using high or low-pressure separators. The oil will be pumped ashore by pipeline, the gas is compressed and produced water is removed before both are pumped to the Compression and Water Injection Platform (C&WP) for reinjection.

In order to support the drilling and separating operation the platforms are fitted with a range of utility systems. These include fuel, power, flare, cooling water, drainage, waste, sand removal and chemical injection systems. In addition, the platforms will each provide accommodation for a permanent workforce of 180 and 100 temporary construction workers. The layout of the platforms can be seen in **Figure 0.4**.

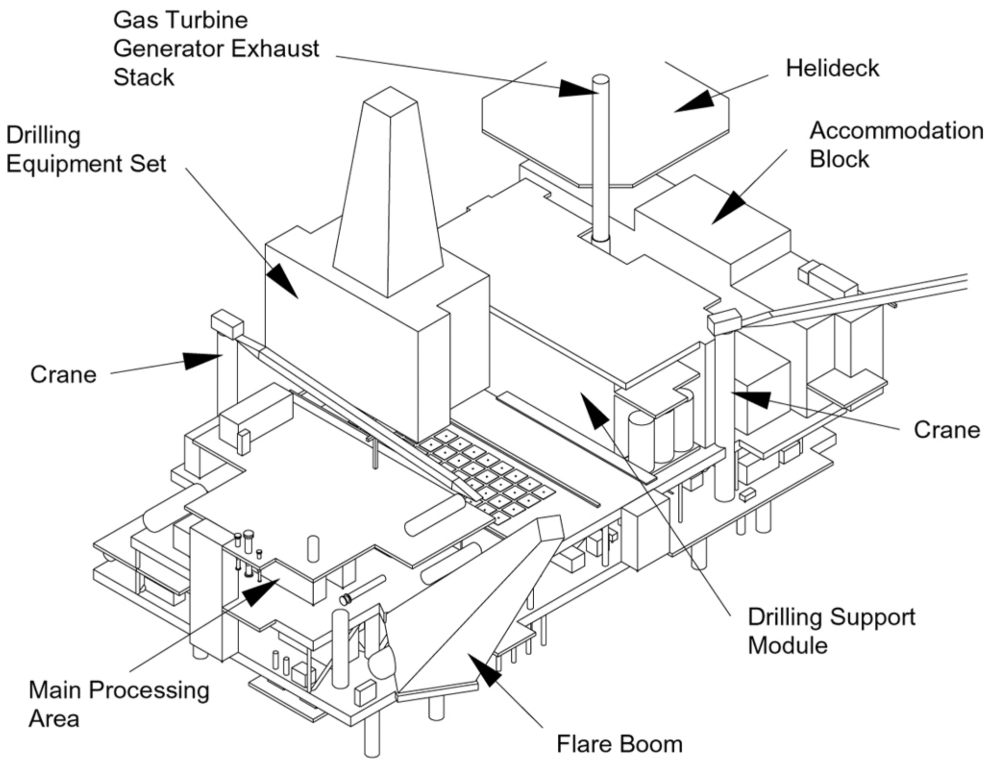

Figure 0.4:Layout of a Production and Drilling Platform

0.3.2 Compression and Water Injection Platform

This will be an unmanned platform that will be linked by bridge to the Central Azeri platform. It will be installed during Phase 1 of the project but will also meet the needs of Phase 2. The layout of the platform is shown in **Figure 0.5**.

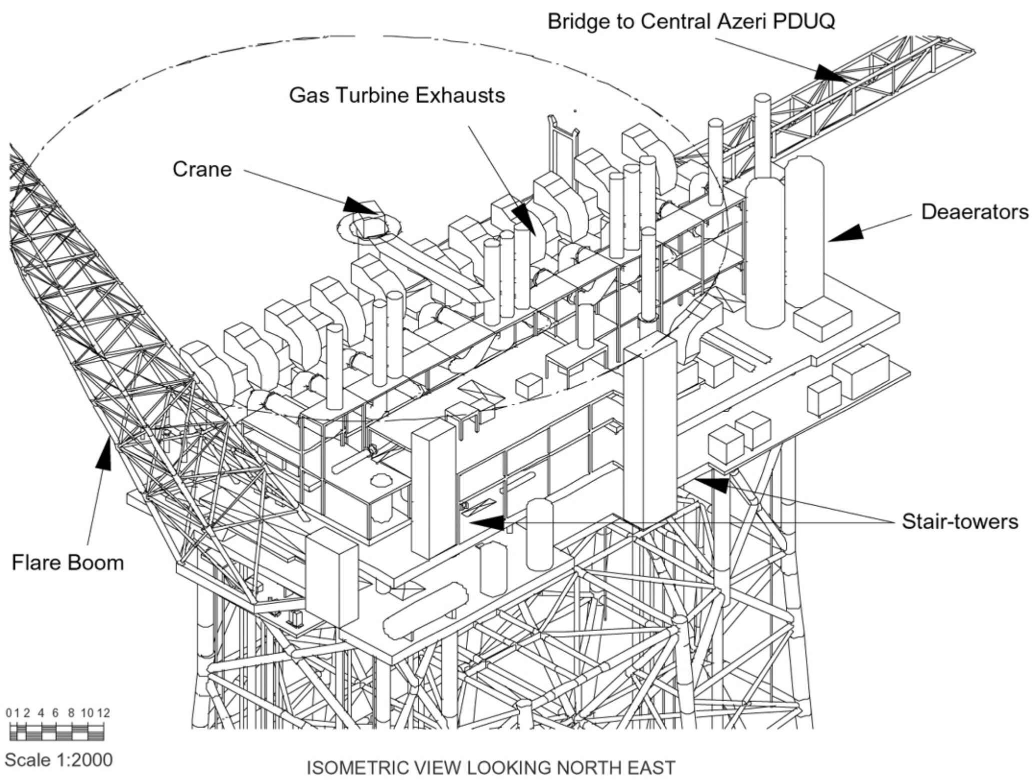

Figure 0.5: The Compression and Water Injection Platform

The platform will perform three principal functions:

1) it will receive and compress all the gas from the field and prepare it for re-injection, gas lift to facilitate reservoir exploitation or onshore processing;

2) it will receive all the produced water from the field, mix it with additional sea water required for reservoir pressure maintenance, pressurise it and return it to the production platforms; and,

3) it will be an offshore electrical power hub, importing and exporting power to the production platforms.

Necessary equipment for these operations includes dehydration facilities, de-aerators, gas turbines, compressor pumps and pigging facilities. The platform is to be fitted with a number of utility systems that will support the above activities, many of which are similar to those on the production platforms.

0.3.3 Pipelines

The project will require the installation of a number of subsea pipelines to allow export of crude oil to Sangachal terminal and to allow movement of gas, produced water and re-injection water within the field (see **Figure 0.3**). The new 30” diameter oil export pipeline from Central Azeri platform to Sangachal will follow the same route as the existing Early Oil Project pipeline and the Phase 1 30” oil pipeline.

0.3.4 Sangachal Terminal

Under Phase 2 of the project the Sangachal terminal will be expanded to enable the processing of crude oil pumped ashore. At the terminal dewatering and stabilisation will be carried out to meet export requirements. The BTC pipeline will then take the oil to Ceyhan while the gas will be fed into the SOCAR pipeline network.

The terminal expansion will involve the installation of two new systems of crude oil and water separation and stabilisation plant, together with associated power and utilities systems. The capacity of the Phase 1 crude oil tanks will be increased in order to accommodate Phase 2. The proposed layout is shown in **Figure 0.6**.

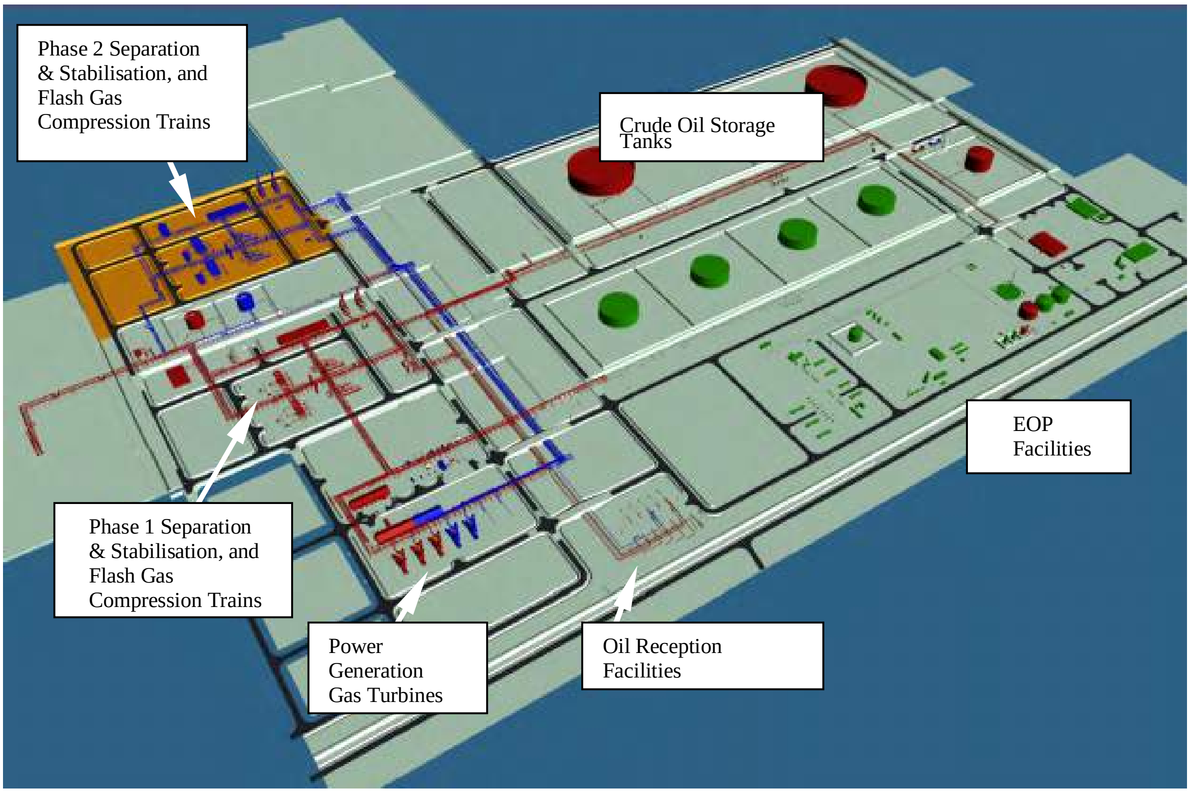

Figure 0.6: Proposed Layout of Sangachal Terminal

0.4 Project Implementation

0.4.1 Construction of Templates, Jackets and Platform Topsides

Contracts for the construction of the production platforms are to be awarded in the third quarter of 2002. The platforms will be constructed onshore, at a base or bases to be decided (possibly in Azerbaijan), in three separate parts:

- the templates – a grid that guides the drilling and casing pattern and is needed specifically for drilling from the semi-submersible drilling rig prior to platform installation (**Figure 0.7** shows the installation of the Phase 1 drilling template);
- the jackets – the legs of the platform; and,

- the topsides – the deck and all the facilities on top of it.

Figure 0.7: Installation of the Phase 1 Drilling Template

At the same time the pipeline contracts will be awarded. The onshore section of the pipeline to Sangachal will be trenched so that the top of the pipe is 1 metre below the surface. At Sangachal Bay a pier will be built to allow an excavator to trench in the nearshore zone. Winches will be built onshore to pull the pipe ashore from a laybarge, an existing, purpose-built ship designed for laying pipelines (see **Figure 0.8**). Offshore, the laybarge will move progressively along the pipeline route welding on additional lengths of pipe and lowering them onto the seabed. The barge will be supplied with pipe by barges towed by tugs. The remaining intrafield pipelines will be laid in the same manner.

Figure 0.8: The Pipelay Vessel, *Isralif Guseinov*

Prior to the installation of the platforms the template will be put into place using barges and then pre-drilling will begin. The pre-drilling will be necessary to test the reservoir and will be the first stage in the drilling of the production wells. A mobile semi-submersible drilling rig will be used for this (see **Figure 0.9**). Drilling will be carried out in accordance with standard oilfield procedures and industrial practices and is anticipated to last for 576 days.

Figure 0.9:The *Dada Gorgud* Semi-submersible Drilling Rig

When pre-drilling has been completed the jackets will be placed on a barge, towed to their final location, and lowered into place. Piles will keep the jackets in place and a pipelay barge will tie-in the pipelines. Tugboats will tow the topsides to the location and ballasted barges will lower them onto the jackets. Once all the tie-ins are complete the entire system will be tested and commissioned.

0.4.2 Drilling and Production

The ACG Phase 2 wells will be drilled directionally from drilling centres located at East and West Azeri. Large diameter well sections (36", 26", and 16") in the upper 500m of the well will be oriented close to the vertical; smaller diameter sections of the well-bore (12¼" and 8½") may gradually be steered closer to the horizontal. Eventually, the wells will be fanned-out to access parts of the reservoir as much as four or five km from each drilling centre. The aim is to provide a radiating pattern of wells and associated side-tracks in order to maximise hydrocarbon recovery.

As described above, each well is comprised of a series of 'hole sections' which decrease in diameter from the 30" surface conductor down to 8½" at the base of the well. The sequence of hole sections is as follows:

- The 30" conductor casing will be driven 150 m through the seabed sediments by means of hydraulic hammer.
- The 26" surface section will be drilled to 500 m using seawater with viscous sweeps or water based drilling mud (WBM). The mud will be circulated to the rig

through a marine riser. Cuttings with adhered WBM will be separated by solids control equipment and discharged to the sea via the Cuttings Caisson.

- all other sections of the well will be drilled with a Non Water Based Mud (NWBM), with the possible exception of the 8½" section where an inhibitive brine based drilling fluid may be used to protect against formation damage.

All cuttings below the 26" surface section will either be disposed of offshore using a Cuttings Reinjection System or shipped to shore for onshore disposal.

The main platform drilling programme is anticipated to last for 7-8 years.

0.4.3 Decommissioning

In accordance with the PSA, AIOC will produce a field abandonment plan one year before 70% of the identified reserves have been produced. The plan will cover all aspects of plugging and abandoning wells, removal of platforms and jackets, and decommissioning of the pipeline and the terminal.

0.5 Key Environmental and Socio-economic Impacts

0.5.1 Environmental and Social Impact Assessment Process

Initially, stakeholder consultations were held and a Scoping Report produced identifying issues that needed to be addressed. Consultations and dialogue are continuing and will continue throughout the planning, design and construction.

During preparation of the ESIA further data were obtained from the design consultants, stakeholders, and published data sources. In addition, a number of surveys were specially commissioned to identify and assess the potential impacts of this Phase of the project.

The ESIA considers the environmental and socio-economic impacts of the ACG Phase 2 Project as well as cumulative impacts related to the Full Field Development and other projects in the area. For each aspect of the study the likely *magnitude* (size) and *significance* (importance) of any impacts were assessed using the professional judgment of experienced consultants. The impacts that will remain after the mitigation measures have been implemented, termed *residual impacts*, are those that are ultimately the most important and they are highlighted in this summary document, together with an overview of the plans for the future environmental and socio-economic management of the project.

0.5.2 Environmental Impact Assessment of Normal Operations

Introduction

The ACG Phase 2 Project Design has incorporated a number of measures to mitigate some of the potentially most important environmental impacts. These include;

- Drill cuttings reinjection. NWBM will be used for sections of wells below the 26” section. A cuttings reinjection (CRI) system will be in place so that all mud and cuttings will be reinjected into dedicated disposal wells offshore. If there is any downtime on the CRI system then cuttings will be contained and shipped to shore for disposal. Drilled out cement will also be reinjected or shipped to shore;
- Disposal of produced sand into dedicated disposal wells offshore using the CRI or ship to shore if the CRI is out of operation; and,
- Reinjection of produced water offshore for reservoir pressure maintenance.

Other potential residual impacts are discussed below:

Nearshore Construction Activities

The laying of pipelines nearshore requires the use of finger piers. For the Early Oil Pipeline a finger pier was built and left in-situ. Localised erosion/accretion has been identified on either side of the structure and a similar pattern of seabed mobility can be expected for further piers if left in the bay. Changes in sediment patterns will impact on benthic fauna community composition as this is usually strongly correlated with particle size distribution. Increase in turbidity and sedimentation could also impact on sea grass and red algae habitats in Sangachal Bay. It is therefore planned to remove the finger pier after use. The trenching required to bury the nearshore pipeline will also result in a degree of habitat destruction and increased turbidity and sediment deposition.

The impacts to these habitats are expected to be temporary and a relatively rapid recovery after the cessation of construction activities is anticipated (see, also **Section 0.5.5**)

Discharge of Mud and Cuttings

Drill cuttings produced from the 26" hole section will be discharged to the marine environment. The likely drilling fluid is seawater with added viscous sweeps (natural organic cellulose or gum substances). The sweeps are non-toxic and biodegradable. The assessment is therefore based on a more complex Water Based Mud (WBM) system may be used as a contingency. The assessment has concluded that the impacts of the discharges of WBM cuttings will be confined to a limited area around the East and West Azeri platforms. They will cause physical smothering of benthic communities that are widespread in the area. Recolonisation and recovery of impacted areas can be expected after drilling stops, although differences in particle size distribution may result in some change to the make up of the fauna. The extent of impacts will be investigated by a post-drilling monitoring survey.

Discharge of Cooling Water

The modelling of the cooling water discharge from the East Azeri, West Azeri and C&WP platforms indicates that temperatures will rapidly drop to within 3°C of ambient temperature and any impacts to aquatic organisms will therefore be limited to the immediate vicinity of the discharge. Biofouling control in the cooling water system is achieved by using a system that releases both chlorine and copper. These components work synergistically at very low concentration levels. Levels will be even lower in the cooling water at the point of discharge and further dilution will occur on release to the marine environment. No measurable impacts on marine organisms are anticipated.

Other Offshore Operational Discharges

For sanitary and domestic waste it was concluded that the level of dilution and dispersion in the marine environment would be such that discharges will not result in any significant impacts on water quality or marine organisms.

Discharge of produced water will occur if water injection has to be temporarily halted. Treatment prior to discharge will be to standards exceeding the requirements of the PSA, resulting in very low concentrations of oil in the discharge stream. The effects on marine organisms in the mixing zone are expected to be insignificant.

Air Emissions

Likely releases of emissions to the air have been computer modelled to reveal any impacts on air quality in the vicinity of Sangachal terminal. The results show that the predicted emission of NO_x and SO_2 are well within the internationally accepted air quality standards.

Issues still to be evaluated

In addition to the above, the ESIA process has identified a number of issues that are still in the evaluation stage and where there are a number of possible options. The issues in question are:

- disposal of the hydrotest water for the Phase 2 30” oil pipeline;
- disposal of hydrotest water from the testing on onshore installations at the Sangachal terminal;
- storage and disposal of produced water from the Sangachal Terminal; and,
- the possible need for disposal of sulphur should the levels of hydrogen sulphide be sufficiently high in the Azeri reservoir well stream.

Once evaluations have been completed for these issues, the environmental implications will be the subject of separate assessments and appropriate documentation will be provided to the Ministry of Ecology and Natural Resources and other stakeholders as applicable.

0.5.3 Environmental Impact Assessment of Accidental Events

Marine Hydrocarbon Spills

The results from oil spill modelling indicate that in the unlikely event of an offshore blowout in the ACG Contract Area, the area most likely to suffer oil pollution is restricted to the open sea to the South-Southeast. There is however a 5 to 10% probability of oil reaching the coastline of the Caspian, with the highest likelihood in winter. The coast that could be contaminated with oil stretches from just south of Baku to the Kura River delta. Contamination could also reach the Iranian and Turkmenistan coastline.

Although the probability is low, a pipeline leak or rupture could potentially occur at any point along the pipeline route. As the majority of the pipeline is located in nearshore waters south of the Absheron peninsula, this is the area most likely to be affected. In the ACG Phase 1 ESIA, a possible offshore pipeline rupture was modelled and the effects were found to be comparable with those from an offshore blowout.

In the event of a spill the following areas have been identified as the most sensitive:

- **The vicinity of the landfall at Sangachal**. The area has a high probability of contamination from a pipeline leak and rupture. The entire area has water depths less than 10 m, and seagrass communities are observed within the area. In addition, seabirds are distributed in these nearshore waters throughout the year and on the Pirsagat Islands.
- **The eastern part of the Absheron peninsula and islands**. This area has a high probability of oil contamination from a pipeline leak or rupture. It also has a high probability of oil from an offshore blowout in the winter season. Caspian seals are frequent in this area in summer. The area also contains some shoreline areas of higher environmental sensitivity.
- **The Kura River delta**. This area is within the area of influence from an offshore blowout in the winter season. The area is important for fisheries, are nursery grounds for juvenile sturgeons, and also has high densities of seabirds throughout the year. A significant part of the shoreline in this area is of high sensitivity.
- **An area that includes the Kyzyl-Agach Bay**. Although this is outside the area of influence as defined by the oil spill modelling, it is still designated as a potential risk area since Kyzyl-Agach is a Ramsar site, containing bird

populations of global significance and has a high sensitivity shoreline.

The risk of impact to these areas will be reduced by implementation of an Oil Spill Response Plan that has the key aim of containing as much as possible of the oil as close to the source as possible and minimising oil reaching sensitive nearshore areas.

Onshore Hydrocarbon Spills

Hydrocarbon spills at the Sangachal Terminal will generally be contained by bunds. The oil storage tanks are in bunded areas that have the capacity to contain the tank contents and the distance between tanks is designed to prevent a fire in one tank spreading to others. The tanks are also designed to withstand earthquake events. It is concluded that any spills within the terminal area are unlikely to affect an area beyond the boundary of the terminal site.

Between the landfall and the terminal the pipeline crosses a wetland area that drains into a stream flowing into the Caspian to the north east of the landfall. A spill here could potentially contaminate the wetland and the coastal margin. However, the area that could be affected is likely to be limited in extent compared to the overall size of the habitat.

The probability of significant onshore spills will be reduced by the maintenance and inspection procedures that are to be put in place. The implementation of the Oil Spill Response Plan will seek to contain any spills and reduce the environmental impacts to a minimum.

0.5.4 Socio-economic Impact Assessment

The key positive impacts include direct and indirect employment, albeit short-term, created by the project and the training provided to build the capacity of local populations to work in both the oil and gas and other sectors. Also, there is likely to be an improvement in health due to the increased incomes. There will also be a significant benefit to the Azerbaijan economy through tax revenues, employment and other soicial investment activities.

Potentially key negative impacts are associated with unrealised expectations of employment in the settlements of Sangachal, Umid and Sangachal. Following demobilisation, there will be significant impacts in terms of unemployment, as there are unlikely to be any follow-on projects of a similar scale. This can be mitigated to a certain extent by implementation of the following measures:

- management of unemployment through early implementation of training in transferable skills;
- clear communication to workers regarding their contracts; and,
- collaboration with other projects to maximise alternative employment possibilities following demobilisation.

0.5.5 Cumulative Impacts

The impacts of ACG Phase 2 Project cannot be considered in isolation. The cumulative impacts of the Full Field Development, the Shah Deniz project and the associated infrastructure needed to export gas to international markets are considered below.

Pipeline Construction Activities

Nearshore pipeline construction activities will impact the benthic communities and sea grass and red algae beds in Sangachal Bay. Recovery of these communities may be prolonged by successive waves of construction activity associated with the phases of the ACG and Shah Deniz development.

BP is fully aware of this issue and is studying the options for nearshore pipeline sections to be laid concurrently.

Air Emissions

Air emissions modelling has shown that internationally accepted Air Quality Standards for NO_x and SO_2 will not be exceeded at receptor locations as a result of emissions from the ACG Full Field Development and Shah Deniz Developments.

Noise

Noise levels for the combined ACG Full Field and Shah Deniz developments at Sangachal will exceed the World Bank Guideline of 45dB(A) (night time) by approximately 2 dB(A) in an area currently occupied by herders. However, it is unlikely that the herders will remain in their current location. If they do, then acoustic barriers will be used to reduce noise levels below guideline levels.

There is also a very small possibility that guidelines will be exceeded at residential properties close to Sangachal terminal for very short periods during emergency flaring. However, the noise impacts of the flares are short-lived, as the HP flares will only operate for periods between 3 minutes and two hours. The Project is designed and will be operated to minimise flaring. The flare is necessary to provide protection to the facility itself, the workers and neighbouring community and the environment. The peak noise levels will occur for periods of between 3 and 15 minutes when the flow of gas is at the maximum. The likelihood of the flares having to operate together is very low. Although the Guidelines will be exceeded, the impact of noise from flaring is not considered to be significant and there is little likelihood of an adverse impact on individual well being or community well being.

Health

The cumulative impact of the additional employment and increase in incomes should have a significant beneficial effect on the health status of the families of those employed in the Baku and Garadagh areas, particularly in the settlements of Sahil, Umid and Sangachal.

However, there is a range of significant potential negative health impacts that include increased incidence of transmissible diseases and respiratory problems especially in Umid, and increased probability of road accidents. Measures to minimise these impacts include health screening, community health education programmes, limiting contact between workers and surrounding villages, providing good working conditions, traffic management plans, emergency response procedures and driver training.

Employment

There are significant positive, but short-term, social impacts associated with the ACG/Shah Deniz project as a result of increased employment and enhanced family incomes. There is a significant adverse impact associated with rapid demobilisation. These impacts can be both enhanced and mitigated through:

The impact of the rapid demobilisation may be mitigated by devising a schedule for all project-related activities that will reduce the rate of demobilisation and/or the numbers demobilised over a specific time period. Also, other measures implemented through a Social Investment Programme may assist in alleviating this major increase in unemployment through;

- skills capacity-building;
- creation of conditions conducive to small and medium size business creation; and/or,

- expansion and supply chain management to ensure maximum local input to supporting the ACG and related investments.

Economy

The ACG and Shah Deniz developments will make a considerable contribution to the Azerbaijan economy, through taxes, employment and other social investment activities. However, there are a number of possible dangers related to the impacts of increased oil and gas investment and revenues on the national economy;

- risks to monetary stability and increase in the inflation rate;
- appreciation of the national currency making imports cheaper and exports dearer; and,
- growth in bureaucracy and corruption.

Managing these risks will be the responsibility of the Government of Azerbaijan assisted by International Finance Institutions as appropriate.

Transport

There will be increased pressures on a number of external and internal transport modes and routes. It is expected that the impacts will not be significant because of the magnitude of the change is small in relation to the capacities. There may be very localised areas of difficulty, but disruption in these areas these can be avoided or minimised by preparation and implementation of a logistics plan focusing on important transport modes and corridors in Azerbaijan.

0.5.6 Transboundary Impacts

Two issues, atmospheric pollution and accidental oil spills, have been identified as possibly having transboundary effects. Regarding acid rain, it is concluded that the amounts of SO_2 and NO_x produced in connection with the Phase 2 Project will not result in any significant transboundary impacts downwind of the proposed development sites. With regard to accidental oil spills, modelling carried out for the ACG Phase 2 Project has identified that a ‘worst case’ accidental spill could possibly impact Iran and Turkmenistan. However, such an incident is very unlikely and does not take into account the Oil Spill Response Plan that would come into operation should such an event occur.

0.6 Environmental and Socio-Economic Management

The ESIA has identified a number of possible impacts and associated mitigation and control measures. The ACG Phase 2 Project will use the findings of the ESIA as input into an Environmental Management Plan and socio-economic management strategies. These systems will ensure that feedback as a result of auditing and monitoring, together with training of staff and contractors will enable the objective of continuous improvement and best possible environmental performance to be achieved.

Taking all of the issues raised in this report into consideration and evaluating potential positive and negative impacts it is concluded that there is an overall economic and social benefit from the continued development of the Phases of the ACG fields.

1. INTRODUCTION

The aim of this Chapter is to introduce the Environmental and Social Impact Assessment (ESIA) report in respect of;

- *Previous environmental and social studies including those carried out for the Early Oil Project (EOP) and the Azeri, Chirag and Gunashli (ACG) Phase 1 Project;*
- *The commercial background of the ACG Project;*
- *Other developments in the area; and,*
- *A brief of overview of the ESIA objectives and scope.*

1.1 General

This document contains the findings of the Environmental and Social Impact Assessment (ESIA) that has been carried out in connection with the proposed Phase 2 development of the Azeri, Chirag and Deep Water Gunashli (ACG) oil fields in the Azerbaijan sector of the Caspian Sea. The ESIA must be submitted to the Ministry of Ecology and Natural Resources (MENR), the regulatory body in the Republic of Azerbaijan, in order to gain approval for the project in accordance with national legal requirements and policies. The ESIA process has also been implemented in a manner designed to comply with the requirements of International Funding Institutions (IFIs) and is also an integral part of BP's Health, Safety and Environment (HSE) Policy.

The Phase 2 ESIA is the latest in a series of environmental and social studies undertaken by the Azerbaijan International Operating Company (AIOC) since activities started in 1994. The Phase 2 ESIA report therefore builds on existing information wherever possible and avoids unnecessary repetition of information already contained in documents approved by the MENR and available in the public domain. The approach to the Phase 2 ESIA has been discussed and agreed with the MENR, Non-Governmental Organisations (NGOs), the Azerbaijani scientific community and other relevant stakeholders during the scoping process (see **Section 1.3**).

1.2 Commercial and Development Context

The first Production Sharing Agreement (PSA) in Azerbaijan was signed in 1994 between the State Oil Company of the Azerbaijan Republic (SOCAR) and AIOC. AIOC is a consortium of Foreign Oil Companies (FOCs) the members of which are as follows (shareholding shown in parenthesis):

- BP (34.14%)
- Unocal (10.28%)
- SOCAR (10.00%)
- LUKoil (10.00%)
- Statoil (8.56%)
- Exxon Azerbaijan Ltd (8.00%)
- TPAO (6.75%)
- Devon (5.63%)
- ITOCHU (3.92%)
- Delta Hess (2.72%)

In June 1999, BP was appointed operator for the PSA on behalf of the AIOC member companies.

The ACG Contract Area (**Figure 1.1**) has estimated oil reserves in excess of 4.6 billion barrels of oil and 3.5 trillion cubic feet of associated natural gas, representing roughly half of the proven oil reserves in Azerbaijan's offshore fields. It is located approximately 120 km south east of Baku and covers an area of 432 square kilometres in water depths ranging from 100 m to 400 m. Primary oil bearing zones occur at depths of between 2,500 m and 3,000 m below the seabed.

AIOC's operation in Azerbaijan started with the Minimum Obligatory Work Programme (MOWP) set out in the PSA, which contained an objective to commence the production of oil as rapidly as possible. In this setting, the Early Oil Project (EOP) was developed as the first production activity in the Contract Area and has been producing oil since 1997.

Beyond the initial production of early oil, the development of the ACG Contract Area is known as Full Field Development (FFD). It is currently conceived that FFD will be achieved through the implementation of three further phases of development (**Figure 1.2)** resulting in potential oil production rates in excess of one million barrels per day (bpd). Overall, FFD represents a large capital investment in the Caspian Sea region. It is expected to cost approximately $10 billion, over the phased life of the project.

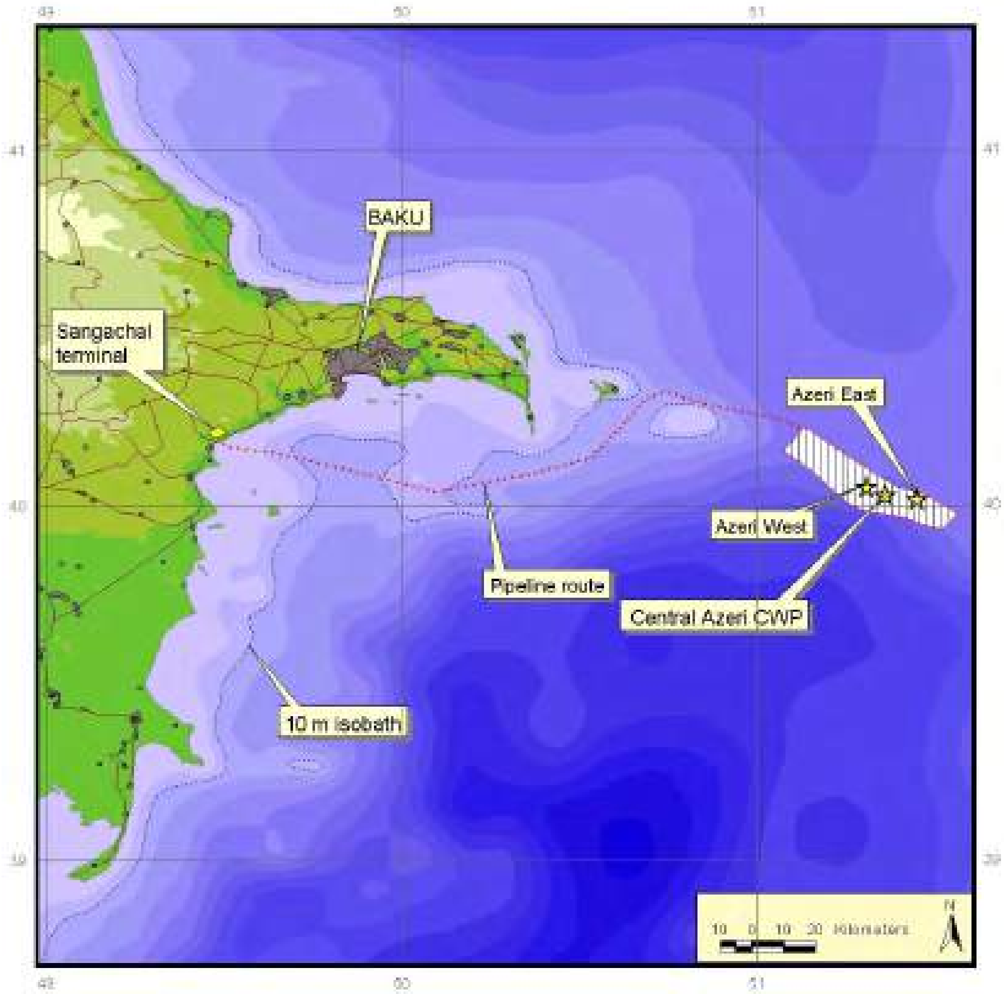

Figure 1.1: The AIOC Contract Area, Pipeline Corridor and Terminal Site

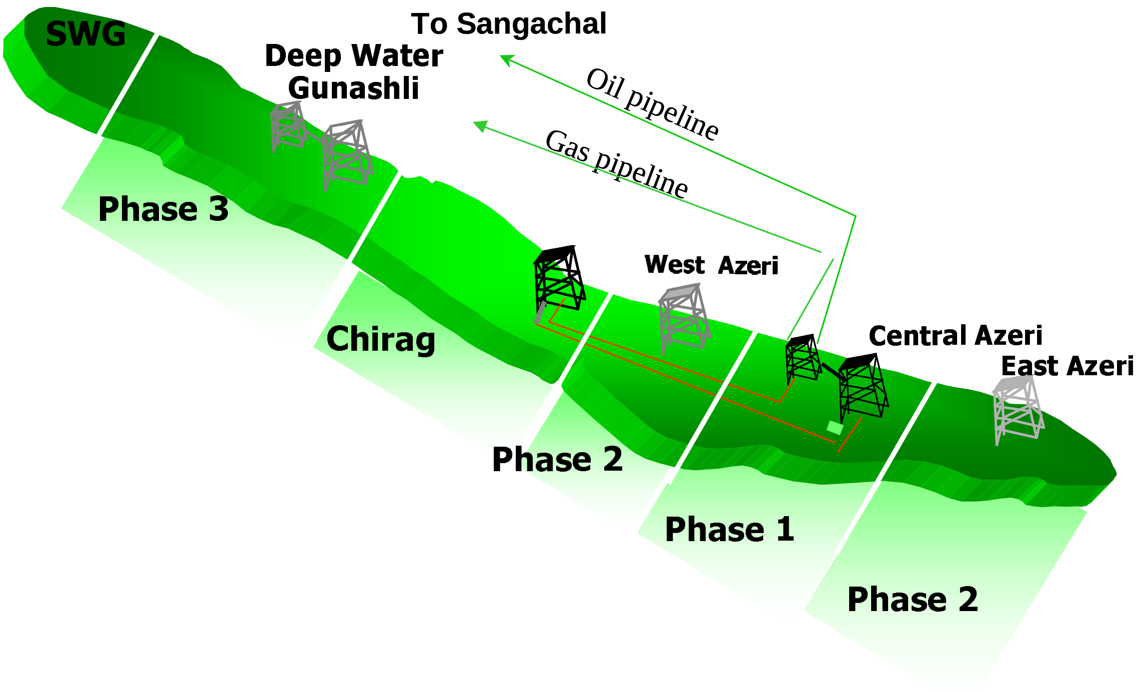

Figure 1.2: The ACG Full Field Development (FFD)

The ACG Phase 2 Development represents the second stage of the ACG FFD. Earlier environmental and socio-economic reports, studies and programmes carried out by AIOC in the ACG Contract Area are shown in **Table 1.1**.

Table 1.1: AIOC ACG Environmental and Social Studies and Programmes

Environmental / Social Programmes undertaken	Date
ACG Baseline Assessment	1995
Seismic Survey EIAs	1995
Appraisal Drilling EIAs for GCA Wells 5, 6	1996
Northern Route Export Pipeline EIA	1996
Western Route Export Pipeline EIA	1997
Supsa Terminal EIA	1997
EOP Environmental Impact Assessment	1997
Ongoing monitoring for EOP	1997 - present
ACG Phase 1 Baseline Assessments	1998, 2000 & 2001
FFD consultation with regulators and NGOs	2000 - ongoing
Early Template Well EIA for ACG Phase 1	2001
Sangachal Terminal, Early Civil Engineering Work Programme ESIA (ACG FFD Phase 1 and Shah Deniz Gas Export Stage 1)	2001
ACG Phase 1 ESIA	2002
ACG Phase 2 Offshore Baseline Survey	2002
Baku-Tbilisi-Ceyhan Main Export Pipeline ESIA	2002
South Caucasus Pipeline ESIA	2002

The ACG Phase 2 Project has to be seen in the context of other ACG developments or developments involving the Sangachal Terminal (see below) or export pipelines. The relevant projects are therefore briefly described below:

The Early Oil Project (EOP)

The EOP comprises the Chirag-1 platform and transfer of oil through a 24” subsea oil pipeline from Chirag-1 to an onshore oil reception terminal situated 38 km south of

Baku at Sangachal. Gas export from Chirag-1 is through a 16” sub-sea gas pipeline to SOCAR’s Oil Rocks facility to the north west of the Contract Area. Oil is exported to market from Sangachal by one of two pipeline routes to Black Sea ports; the Northern Export Route (NER) across Russia to Novorossiysk, and the Western Export Route (WER) to Supsa, Georgia. First oil from EOP was exported from Sangachal Terminal in the fourth quarter of 1997. Current oil production rates from the EOP are some 125,000 bpd with gas export to the local market of around 100 million standard cubic feet per day (MMscfd).

ACG FFD Phase 1 Project

The Phase 1 project will develop the central part of the Azeri reservoir, to the south east of Chirag-1, and will consist of: 1) a production, drilling and quarters platform (PDQ) bridge-linked to a compression and water injection platform (C&WP); 2) a new 30” sub-sea oil pipeline from the PDQ to shore; and, 3) a new 28 ” gas line to shore. The Sangachal Terminal will be expanded to receive the increased production and export requirements. In addition, the Chirag-1 platform will be integrated with the Phase 1 project by means of interfield oil and gas sub-sea pipelines. First oil production from Phase 1 is scheduled for early 2005.

ACG FFD Phase 2 Project

Phase 2, which is the subject of this document, will be designed to develop the remaining part of the Azeri reservoir to the west and east of the Phase 1 development and will include two fixed production and drilling facilities, a new 30” sub-sea oil pipeline, in-field sub-sea pipelines and further expansion at the Sangachal Terminal. First oil production from Phase 2 is anticipated in 2006.

ACG FFD Phase 3 Project

Phase 3 will develop the Deep Water Gunashli reservoir and is planning for first oil production in 2008.

Baku-Tbilisi-Ceyhan Main Export Pipeline

The proposed Baku-Tbilisi-Ceyhan (BTC) pipeline will transport oil from the Sangachal Terminal through Azerbaijan, Georgia and Turkey to the Mediterranean Sea port at Ceyhan. The length of the pipeline totals around 1,750 km and has a proposed diameter of 42”. The pipeline will have a peak capacity of one million barrels of oil per day. The construction schedule is planned such that the pipeline will be available to deliver the first oil from the ACG Phase 1 development.

Shah Deniz Gas Export Project

The Shah Deniz gas/condensate field lies approximately 100 km to the south-west of Baku in water depths ranging from 50 m to 500 m. Early appraisal well drilling indicated that Shah Deniz is a world-class gas condensate field, the full potential of which requires further appraisal.

Full Field Development (FFD) of the Shah Deniz field will also be undertaken in a series of stages. Initial Stage 1 development will comprise a fixed production and drilling platform and two sub-sea pipelines to deliver gas and condensate separately to a new reception and gas-processing terminal to be constructed adjacent to the existing ACG oil-receiving terminal at Sangachal. First gas delivery from the Shah Deniz field is anticipated in 2005.

South Caucasus Pipeline (SCP) Project

Shah Deniz gas, conditioned for transportation and sales, will be transferred from the terminal to an export pipeline system, ultimately delivering the gas to the Turkish market. The proposed pipeline route would run from the Sangachal Terminal, through Azerbaijan and Georgia and into Turkey. Markets in Turkey will be supplied from the town of Erzurum. If sanctioned, SCP will run in parallel with the BTC oil pipeline.

All the projects described above are the subject of separate ESIAs.

Since frequent reference is made to the Phase 1 ESIA in this Phase 2 document, it is of particular relevance that the Phase 1 ESIA has been approved by the MENR and has undergone an extensive public disclosure programme.

1.3 Objectives and Scope of the ESIA

An ESIA is a process for predicting the likely consequences for the bio-geophysical environment and human health and welfare of implementing particular activities. It is undertaken at a stage when it can materially affect the decision of those sanctioning the development proposals. In accordance with this definition, the ACG Phase 2 Development is currently in the planning stage allowing feedback between the ESIA team and design engineers and enabling incorporation into the final design of any issues arising from environmental or socio-economic considerations.

The ESIA is a multidisciplinary study and its success in connection with any given proposal depends largely on the ability to identify at an early stage the key environmental and socio-economic issues which should be focused upon. Scoping is the process of determining which issues are likely to be important, including the identification of Valued Ecosystem Components (VECs) (see **Chapter 8**). The scoping process for the Phase 2 ESIA is documented in a Scoping Report (AIOC, 2002). An integral and essential component of this process is that of Stakeholder Consultation. Extensive consultation has been carried out in connection with earlier phases of the ACG Full Field Development as mentioned in the Scoping Report. Specific Phase 2 consultations are fully documented in the Public Consultation and Disclosure Plan (PCDP) which will be issued as a separate document. Issues of stakeholder significance are further discussed in **Chapters 8** and **9**.

Meetings have held with MENR early in the ESIA process (5th February 2002) and also after consultations with other stakeholders had been carried out (7th March 2002) in order to brief the MENR on the outcomes of these meetings. Consultations with the MENR and also other stakeholders will continue throughout the the ESIA process (summarised in **Figure 1.3**).

It is important to note that, as shown in **Figure 1.3**, the ESIA process does not end at the time of approval of the ESIA report by the MENR but continues into the management and monitoring of operations.

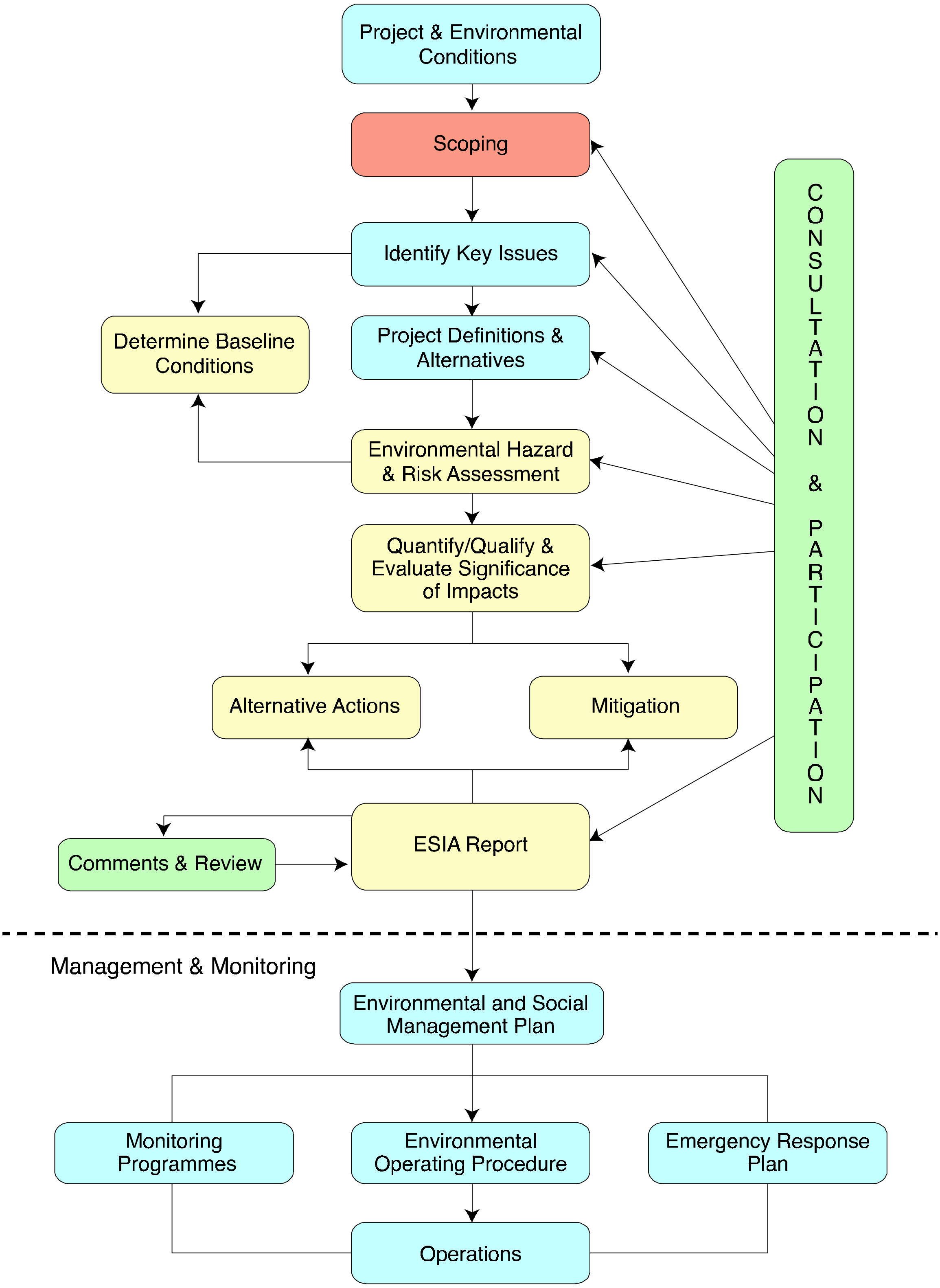

Figure 1.3: The ESIA Process

2. POLICY, REGULATORY AND ADMINISTRATIVE FRAMEWORK

The aim of this Chapter is to provides an outline of the sources of environmental legislation and controls applicable to ACG Full Field Development Phase 2 Project including;

- *Statutory requirements; and,*
- *Controls and guidance applicable to the operations.*

The information is summarised in Figure 2.1.

2.1 Legislative Controls

2.1.1 Azeri, Chirag, Gunashli Production Sharing Agreement

As shown in **Figure 2.1**, the production sharing agreement (PSA) is the overriding legal document that controls AIOC's operations within the ACG Contract Area. Each PSA negotiated by the Azerbaijan Government after ratification by parliament constitutes a law of the Azerbaijan Republic and is a legally binding document, which in addition to specifying the work that AIOC must undertake outlines the environmental standards that must be applied to the operations.

The ACG PSA between the State Oil Company of Azerbaijan Republic (SOCAR) and AIOC was signed in September 1994 and ratified in December of the same year. Under the terms of the PSA, AIOC has the right, until 2024, to develop and produce hydrocarbons from the ACG offshore fields.

According to Article 26.3 of the PSA, AIOC shall comply with present and future Azerbaijani laws or regulations with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than current international petroleum standards and practices at the execution date of the PSA. In addition, environmental standards that must be met throughout the contract life are stipulated in Appendix IX of the PSA.

The requirement to prepare environmental documentation, including an Environmental Impact Assessment of any new facilities, and gain approval from the Azerbaijan Ministry for Ecology and Natural Resources (MENR) is a condition of Appendix IX Section II B of the PSA.

The environmental standards and practices set out in the ACG PSA are provided in **Appendix 1**.

2.1.2 National Legislation

The current legislation designed to ensure that the protection of the environment within the Azerbaijan Republic is based on the principles and guarantee promulgated by the Constitution of the Azerbaijan Republic of 1995, the Constitutional Law on the Foundations of the Economic Independence of 25th May 1991 and the Constitutional Act on the State Independence of 18th October 1991.

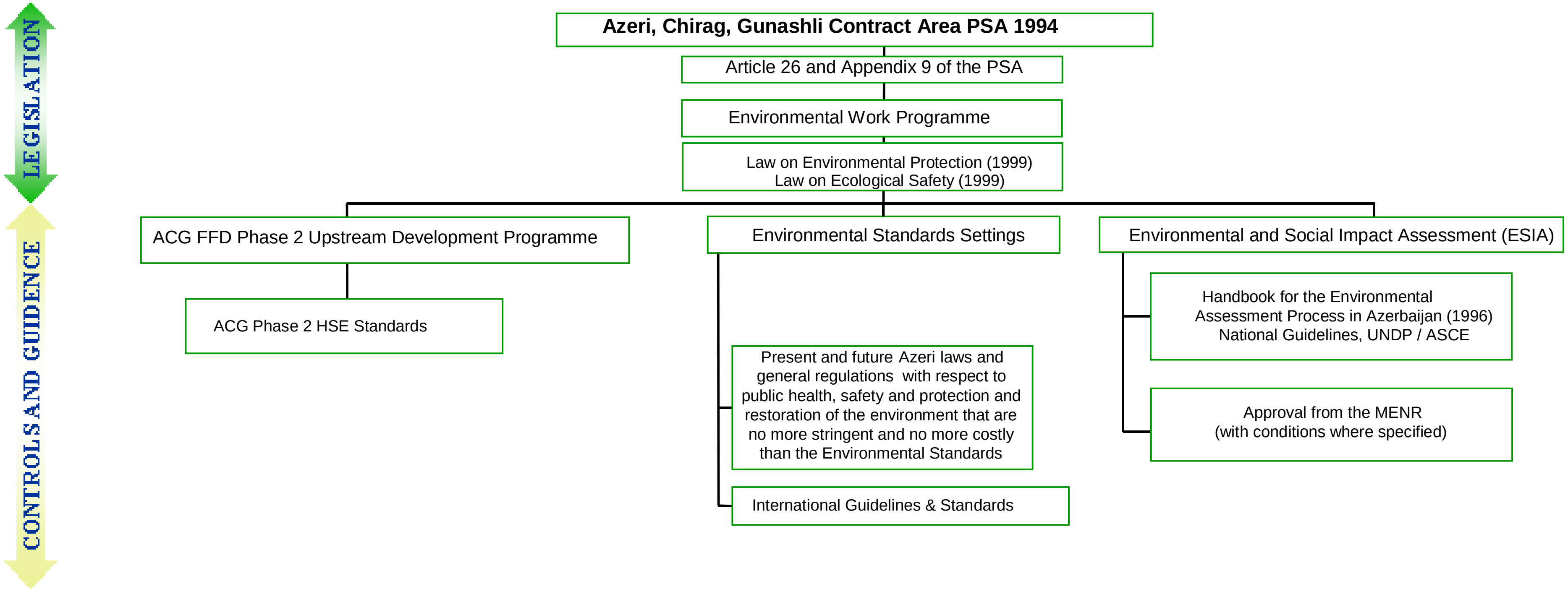

Figure 2.1: Environmental Legislation and Controls Applicable to the ACG Full Field Development Phase 2

The principal legislation in the Azerbaijan Republic is contained in the following statutes;

- Law on ‘Environmental Protection’, dated 8th June 1999 (which outlines the fundamental principle of the ESIA process); and,
- Law on ‘Ecological Safety’ dated 4th August 1999 (which effectively replaces the ‘Law on Environmental Protection and Use of Natural Resources’ of 1992).

The main regulating environmental body is the Ministry of Ecology and Natural Resources (MENR), recently formed from the merger of four state organisations comprising the State Committee for Ecology (ASCE – the former regulator), State Committee for Hydrometeorology, State Forestry Committee, and the State Committee for Geology. This body is responsible for the following;

- development of draft environmental legislation for submission to the Supreme Soviet (Milli Mejlis);
- implementation of environmental policy;
- enforcement of standards and requirements for environmental protection;
- suspension or termination of activities not meeting set standards;
- advising on environmental issues; and,
- expert review and approval of environmental documentation, including Environmental and Socio-economic Impact Assessment.

In addition, the responsibility for implementation of the requirements set out in international environmental conventions ratified by the Azerbaijan Republic lies with the MENR. Further definition of the roles and responsibilities of this new environmental body are anticipated within the next few months as the re-organisation proceeds.

2.2 Controls and Guidance

2.2.1 Corporate Environmental Policy and Management System

BP as operator of the AIOC consortium are committed to undertaking the AIOC operations in accordance with the BP Azerbaijan Business Unit Health, Safety and Environmental Policy, as shown in **Figure 2.2** and BP’s Upstream Environmental Expectations.

In addition to the above, the AIOC partner Contracts Management Committee (CMC) have developed and approved Phase 2 Health, Safety & Environment (HSE) Design Standards. These are based on standards set out in the PSA and take into consideration international standards and local environmental conditions. Therefore, while the PSA is the legal basis for conducting operations, these self-imposed standards seek to supplement, enhance and further define those set forth in the PSA. These standards are provided in **Appendix 2**.

Health Safety & Environmental Policy

We fully endorse the BP Group Policy and are committed to our worldwide corporate goals: no accidents, no harm to people and no damage to the environment.
Getting HSE right is a fundamental part of our business in the Caspian Sea Region and BP through our operations in exploration, development, extraction and transporting of oil & gas fully supports its goals and requirements.
In meeting with this policy we will:

1. Expect all personnel to demonstrate commitment to, and leadership in, health, safety and environmental (HSE) protection, performance and compliance.
2. Manage HSE performance in compliance with the expectations in the BP "Getting HSE Right" management system.
3. Audit the environmental management system against ISO 14001.
4. Inform our employees, contractors, partners, stakeholders, government agencies and the public of relevant HSE aspects of our operations. Openly listen, consult and respond to their concerns.
5. Endeavour to continuously improve HSE performance.
6. Meet or exceed applicable HSE legislation, regulations and company requirements.
7. Ensure our employees and contractors are familiar with our HSE systems, and are competent and trained to carry out their work safely and with due regard for the environment.
8. Provide employees with a safe place to work.
9. Maintain a commitment to incident and pollution prevention, maintain emergency response plans and resources, and manage emergency situations resulting from our activities.
10. Set annual HSE objectives and targets and openly report our performance. Audit compliance with our policies and take corrective action where appropriate.

No task is so important that we cannot take time to plan and implement it in a safe and environmentally responsible manner.

David Woodward
Business Unit Leader BP Azerbaijan
September, 2001

Figure 2.2: BP Azerbaijan Business Unit HSE Policy

2.2.2 National Guidance

Guidelines for the EIA process in the Azerbaijan Republic are given in the 'Handbook for the Environmental Impact Assessment Process in Azerbaijan' (United Nations Development Programme (UNDP) / ASCE, 1996).

In this handbook the sequence of events is described in detail. It describes how the Developer has to submit his application to the MENR and outlines the process of scoping, the production of the EIA, public consultation, the role of the Environmental Review Expert Group (following its submission to the MENR, the document is reviewed for up to three months by an expert panel) and the ultimate decision, along with any appeal process.

2.2.3 International Conventions

The Azerbaijan Republic has entered into and ratified a number of international conventions. The conventions relevant to the ACG FFD Phase 2 development include;

- 1971 Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar, ratified 2000;
- 1972 Convention for the Protection of the World Cultural and National Heritage, ratified 1994;
- 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (The London Convention), ratified 1997;
- 1973 Convention on the Prevention of Pollution from Ships and Protocol 1978 (MARPOL 73/78 Annexes I and II), ratified 1998;
- 1979 Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), ratified 2000;
- 1985 Vienna Convention for the Protection of the Ozone Layer and Montreal Protocol (1990) and Copenhagen amendments (1992), ratified 1996;
- 1987 Montreal Protocol on Substances that Deplete the Ozone Layer, ratified 1995;
- 1998 Convention on Access to Information, to Public Participation in the Decision Making Process and the Administration of Justice concerning Environmental Matters (Aarhus Convention), ratified 1999;
- 1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention), ratified 1999;
- 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes, ratified 2000;
- 1992 Convention on Biological Diversity, ratified 2000;
- 1992 United Nations Framework Convention on Climate Change, ratified 1995; and,
- 1994 Convention on Combating Desertification, ratified 1998.

The following conventions are particularly relevant to the ESIA process for the ACG Phase 2 development;

1998 Convention on Access to Information to Public Participation in Decision Making Process and the Administration of Justice concerning Environmental Matters (Aarhus Convention)

The objective of the Convention is to guarantee the rights of access to information, public participation in decision-making, and access to justice in environmental matters, in order to protect people's rights to a healthy environment. The convention sets out the following;

- Obliges public authorities to make sure that environmental information is available to the public upon request without discrimination and without having to state an interest;
- Entitles the public to participate in environmental decision-making concerning a wide range of economic activities, not only those covered by environmental impact assessment procedures. Government authorities should ensure that the public is involved at as early stage of the project planning as possible when various project options are open for discussion; and,
- Ensures that anyone who considers that his or her request for information has been inadequately dealt with has access to court for a review procedure.

1991 Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention)

The main objective of this Convention is to promote environmentally sound and sustainable economic development, through the application of ESIA, especially as a preventive measure against transboundary environmental degradation.

Under the terms of this Convention, Azerbaijan is required to notify other contracting states if there is a potential impact upon their environment, resulting from a development on the territory of Azerbaijan, including its waters. This notification can be done directly or through a third party coordinator.

In the strictest sense, the Espoo Convention is only applicable if both the party conducting a proposed project and the affected party have ratified the Convention. The only other Espoo signatory parties bordering Azerbaijan or the Caspian include Armenia and Kazakhstan. Should potential transboundary impacts to these countries be identified, these countries should be notified of the project by the relevant Azerbaijani authorities. Notified countries are required to respond as to whether they wish to participate in the ESIA process. Should these countries wish to participate, Azerbaijan should ensure that the public of these countries be provided with the opportunity to participate in the ESIA process equivalent to that provided to the public of Azerbaijan.

1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes

The main objective of this Convention is to prevent, control or reduce any transboundary impact resulting from the pollution of transboundary waters caused by human activity. Transboundary waters are defined as those surface or ground waters that are located on, or pass into, the boundaries of another convention state. As the Caspian is bordered by four other states, two of which are Parties to the convention, it is considered a transboundary watercourse. Article 16 of the Convention contains requirements for public information. Under these requirements, Azerbaijan should ensure that information on the conditions of transboundary waters, measures taken to control, reduce and mitigate transboundary water pollution, and the effectiveness of these measures are made available to the public.

Azerbaijani authorities should provide the information to littoral Parties of the convention, which include the Russian Federation and Kazakhstan, upon reasonable payment.

1973 Convention on the Prevention of Pollution from Ships and Protocol 1978 (MARPOL 73/78 Annexes I - II)

The MARPOL definition of a ship includes fixed or floating platforms, therefore the Azerbaijani government may view the ACG FFD Phase 2 development in this category. The requirements of this convention are set out below.

Annex I of this convention is primarily aimed at oil tankers and sets standards for ships including retaining oily wastes on board, oil/water separation, discharge monitoring systems, segregated ballasts, crude oil washing and double hulls. However, all ships, including platforms, are to be regulated in terms of machinery space discharges; in effect, machinery space discharges are only allowed under the following conditions;

- the ship is not in a special area (the Caspian is not considered a 'special area' under this convention);
- the oil content is < 15 parts per million (ppm) oil in water;
- the ship is proceeding en route; and,
- the ship has oil discharge monitoring and control system and oil filtration equipment.

In addition, an emergency plan for oil pollution response is also required under a 1991 amendment.

Annex II of this convention sets mandatory discharge criteria for noxious substances (or mixtures containing noxious substances) carried in bulk. As it is likely that substances will be transported in bulk for FFD Phase 2 (e.g. diesel for refuelling), the Azerbaijani government may seek to apply this Annex. The substances are categorised into four categories with Category A being the most hazardous. The Annex prohibits release of these substances according to the following parameters;

- maximum quantity of substance that may be discharged;
- speed of ship;
- distance from nearest land;
- depth of water;
- maximum concentration in the ship's wake; and,
- dilution of substance prior to discharge.

Discharge of any noxious substance is prohibited within 12 miles of the nearest land and more stringent requirements are in force for special areas (the Caspian is not considered a special area). Category A discharge to a reception facility is mandatory unless the discharge occurs from a completely emptied, washed tank to which clean water has been added.

2.2.4 International Finance Institution Environmental and Social Guidelines

As external project finance may be sought on behalf of some shareholders of AIOC, environmental and social standards, practices and guidelines set forth by International Finance Institutions (IFIs) have been reviewed in the preparation of this ESIA. Potential IFIs include;

- World Bank Group (WBG) including the International Finance Corporation (IFC) and Multilateral Investment Guarantee Agency (MIGA);

- European Bank for Reconstruction and Development (EBRD);
- United States Export-Import Bank (US ExIm);
- Overseas Private Investment Corporation (OPIC);
- Other Multilateral Lending Agencies (MLAs); and,
- Other Export Credit Agencies (ECAs).

The requirement for environmental assessment (EA) of projects proposed for IFC financing are outlined in the *World Bank Policy on Environmental Assessment (OP 4.01, 1998).* This document outlines the following;

- The EA process - including evaluation of a project's potential environmental risks and impacts, project alternatives, mitigation and environmental management;
- The requirement for environmental baseline data (natural environment, human health, safety and social aspects, transboundary and global environmental aspects);
- Responsibilities for conducting the EA;
- The requirement to refer to the *World Bank's Pollution Prevention and Abatement Handbook (1998)* which states pollution prevention and abatement measures and emission levels that are normally acceptable to the IFC;
- The various EA instruments, including EIA, environmental audit, hazard or risk assessment and environmental action plan (EAP);
- Environmental screening to determine the appropriate extent and type of EA;
- The requirements for public consultation and information disclosure; and,
- The requirement to determine compliance with measures outlined in the EA, implementation of the EAP, the status of mitigatory measures and the findings of monitoring programmes during project implementation.

In addition to the above, the following guidelines and policies have also been reviewed as part of the ACG Phase 2;

- *IFC Environmental, Health and Safety Guidelines, Oil & Gas Development (Offshore) (2000)* – outlines the requirement for EHS management systems, emissions and discharge levels that are acceptable to the IFC, environmental best practice, emergency response, human health and safety aspects and monitoring and reporting;
- *World Bank Oil & Gas Development (Onshore) (1998)* – this outlines waste characteristics associated with onshore oil and gas production, pollution prevention and control, target pollution loads, treatment technologies, emissions guidelines and monitoring and reporting;
- *EBRD Public Information Policy (2000)* – broadens the scope of the information that the EBRD will make available to public scrutiny. Particular measures related to EIA of projects include consultation with the public to identify key issues, making the EIA publicly available at or near the project site for comment, provision of an executive summary in an appropriate local language, the placing of EIAs on developers websites and provision of the EIA for comment at the EBRD Business Information Centre in London; and,
- *EBRD Environmental Procedures (1996)* – outlines procedures to ensure that the environmental implications of the Bank's activities are taken into account early on in the planning and decision making process and identifies ways in which the Bank's investments can be enhanced through the provision of environmental benefits or improvements.

2.3 Conclusions

The PSA is the overriding legal document that control's AIOC's operations within the ACG Contract Area. The environmental standards and practices set out in the ACG PSA are provided in **Appendix 1**.

Once approved by the MENR, the ESIA report for ACG Phase 2 will enable AIOC to proceed with operations based on the based on the concepts, strategies and commitments that are contained in this report. When solutions are developed for any issues that are still under evaluation at the time of ESIA submission these will be conveyed to the MENR and the environmental implications assessed in an Addendum to the ESIA report.

3. PROJECT DESCRIPTION (PART A: DESCRIPTION OF FACILITIES)

This section of the ESIA describes the ACG Phase 2 Project. It is set out in two parts;

- The first part provides an outline of the ACG Phase 2 Project, the principal processing facilities associated with the development, and their interfaces - including those with pre-existing ACG Phase 1 installations. More detailed descriptions are then provided of each of the ACG Phase 2 facilities in terms of their production processes, materials' throughputs, utility systems, and the sources of environmental releases; and,
- The second part of the section describes the activities, which will be necessary to implement the project, in terms of construction and installation activities, infrastructure development, materials supply and logistics, and pre-drilling activities.

Many aspects of the ACG Phase 2 Project - particularly those associated with construction and installation - are similar to those of ACG Phase 1, which have already been described, at some length, within the document '*Environmental & Socio-economic Impact Assessment, Azeri, Chirag & Gunashli Full Field Development Phase 1*', URS, February 2002. Therefore, where aspects of the two project phases do not differ significantly, or where Phase 2 will follow the precedents established by Phase 1, reference has been made within this project description to the Phase 1 ESIA where more detailed information can be found. The intent of this approach is to avoid unnecessary duplication of information already held within the public domain.

3.1 Overview of Facilities

The overall objective of the ACG Phase 2 Project is to recover oil and gas reserves from the East and West sectors of the Azeri Field (Phase 1 recovers the reserves from Central Azeri). The oil will be processed to a sales specification and transferred to the BTC oil export pumps for delivery, via pipeline, to the tanker terminal at Ceyhan on the Mediterranean coast. Recovered gas (associated gas less that reinjected for reservoir pressure maintenance) will be processed ready for SOCAR distribution system within the Azeri national gas grid.

In order to achieve this aim the Project will install or develop the following key production, transfer and processing facilities;

- a new offshore Production, Utilities, Drilling and Quarters platform (PDUQ) will be installed at West Azeri to develop and part-process reserves in the Western sector of the reservoir;
- a new PDUQ will also be installed at East Azeri. This platform will develop and similarly process reserves in the Eastern sector;
- the offshore Compression and Water Injection platform (C&WP) put in place at Central Azeri by Phase 1 will be expanded. The platform will provide water and gas reinjection for the development of the reservoir;
- new in-field pipelines will be installed to facilitate the necessary transfer of gas and produced and reinjection water between the offshore platforms;
- a new 30" offshore/onshore export pipeline will be installed to facilitate transfer of oil to Sangachal Terminal; and,

- the existing onshore oil and gas reception facilities at Sangachal Terminal will be expanded. The terminal will further process incoming crude oil to a specification suitable for its export.

A block flow diagram illustrating the general arrangement of the above facilities is presented in **Figure 3.1**.

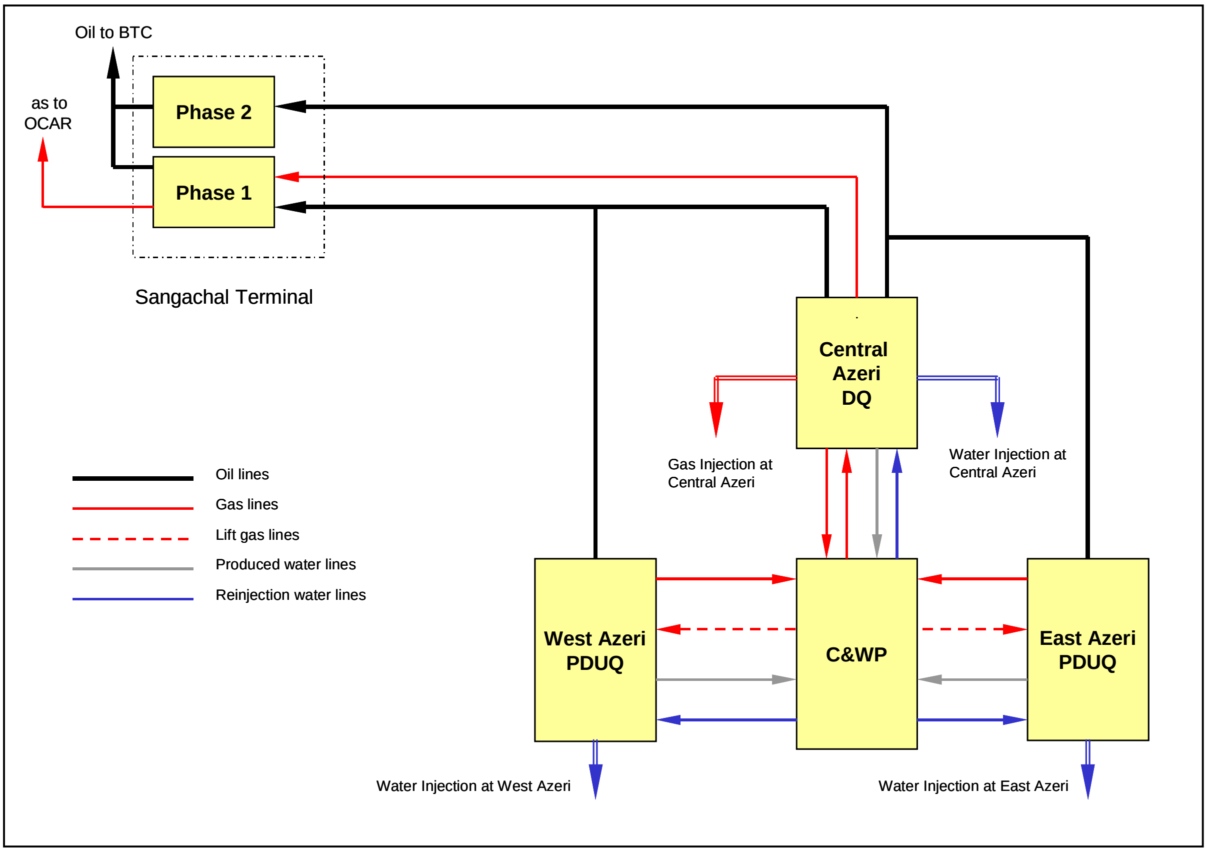

Figure 3.1: ACG Phase 2 Development Block Flow Diagram

3.1.1 East and West Azeri PDUQs

The two PDUQs are manned platforms, which support drilling and production operations. The platforms enable the recovery of well fluids from their respective reservoir sectors, and the separation of these fluids into the constituent oil, water and gas phases. These products are then handled as follows;

- partially stabilised oil is pumped from West Azeri to Sangachal Terminal via the existing 30" export pipeline installed by the ACG Phase 1 project. Oil from East Azeri is transferred to Sangachal via the new 30" export pipeline installed as part of the ACG Phase 2 project; and,

- dry gas is transferred from East and West Azeri to the C&WP via 22" pipelines. The gas is handled as follows;

  -the majority of the gas is reinjected into the reservoir at Central Azeri[1]; and,

  -a small proportion of the gas is returned to the PDUQs, via 6" pipelines for use as 'lift gas'.

- de-oiled produced water is pumped from East and West Azeri to the C&WP via 14" pipelines. The water is mixed with seawater as necessary, pressure-boosted and returned to the platforms via 16" and 18" pipelines for reinjection into the reservoir.

3.1.2 C&WP

The C&WP is an un-manned platform, which is bridge-linked to the Phase 1 Central Azeri DQ platform. The C&WP acts as the offshore hub for the ACG Phase 1 and Phase 2 developments, its functions being to;

- supply high pressure (around 450 barg) reinjection water to the East, West and Central Azeri platforms for reinjection into the reservoir. The reinjection water is a variable mixture of treated produced water received from the East, West and Central Azeri platforms and seawater lifted at the C&WP. The reinjection is required both for the purpose of reservoir pressure maintenance, and as a means of produced water disposal;
- compress gas received from the East, West and Central Azeri platforms and the existing Chirag-1 platform (installed as part of the Early Oil Project) and supply it to;

  -the Central Azeri platform for reinjection into the reservoir (at a pressure of around 380 barg) for purposes of pressure maintenance,

  -all three platforms for use as lift gas, and

  -Sangachal Terminal for processing ready for SOCAR distribution system.

- provide backup electrical power to the East and West Azeri platforms by means of a subsea cable.

The water and gas distribution schemes for the combined Phase 1 and Phase 2 projects are illustrated in **Figure 3.2** and **Figure 3.3**.

[1] The reinjection gas is a mixture of 'excess' gas from Phase 1 (a proportion of the Phase 1 gas is transferred to shore via a new 28" gas export line) and gas from Phase 2.

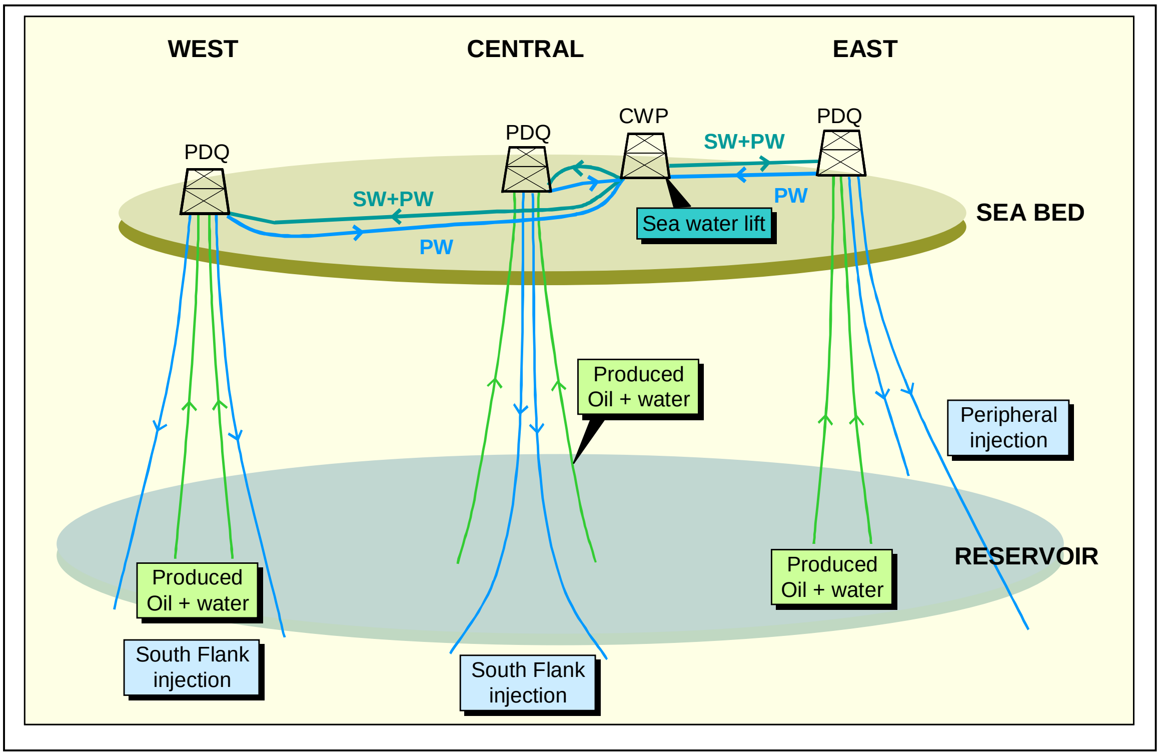

Figure 3.2: Phase 1 and 2 Produced Water and Reinjection Water Distribution Scheme

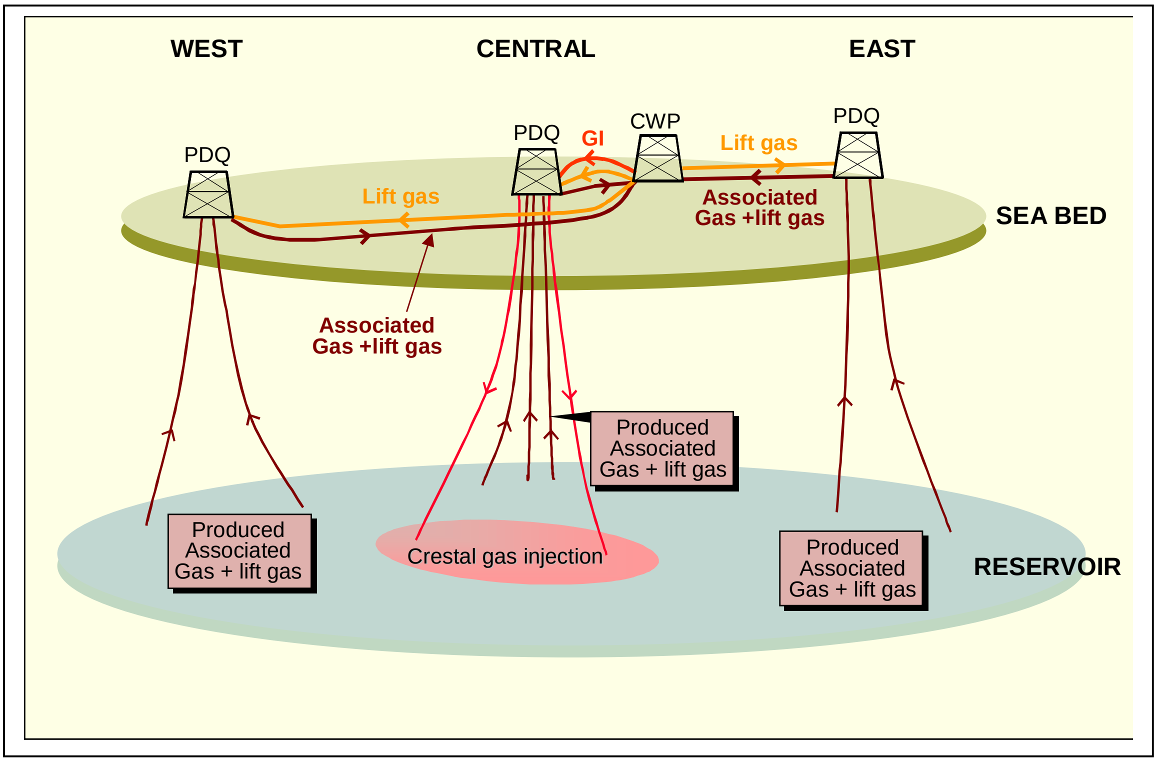

Figure 3.3: Phase 1 and 2 Gas Distribution Scheme

3.1.3 Sangachal Terminal

Sangachal Terminal receives the partially stabilised crude oil from offshore and processes it to a sales-specification product by the removal of associated gas (stabilisation) and residual produced water (separation):

- oil is sent to storage within the existing Phase 1 crude oil storage tanks, from where it is transferred to the main BTC oil pumps and exported to Ceyhan via the BTC pipeline;
- associated gas is compressed, dehydrated, and mixed with the gas received from offshore via the 28" gas line[2]. A proportion of this gas is used as fuel within the terminal with the bulk being exported to SOCAR; and
- produced water is sent to storage within the Phase 1 produced water storage tank. It is currently planned to dispose of the water by injection into a deep aquifer. However, there is an ongoing feasibility study, which is considering alternatives. A decision will be forthcoming.

3.1.4 Production Profiles

The West Azeri platform will come on-stream during 1Q 2006 and the East Azeri platform a year later during 1Q 2007. Under the conditions of the PSA the ownership of the Full Field Development reverts to SOCAR's ownership in 2024. In the intervening period it is anticipated that the ACG Phase 2 Project will develop approximately 1.5 billion barrels of oil and make excess gas at Sangachal available to SOCAR. The production profiles for the project life are presented in **Figure 3.4**.

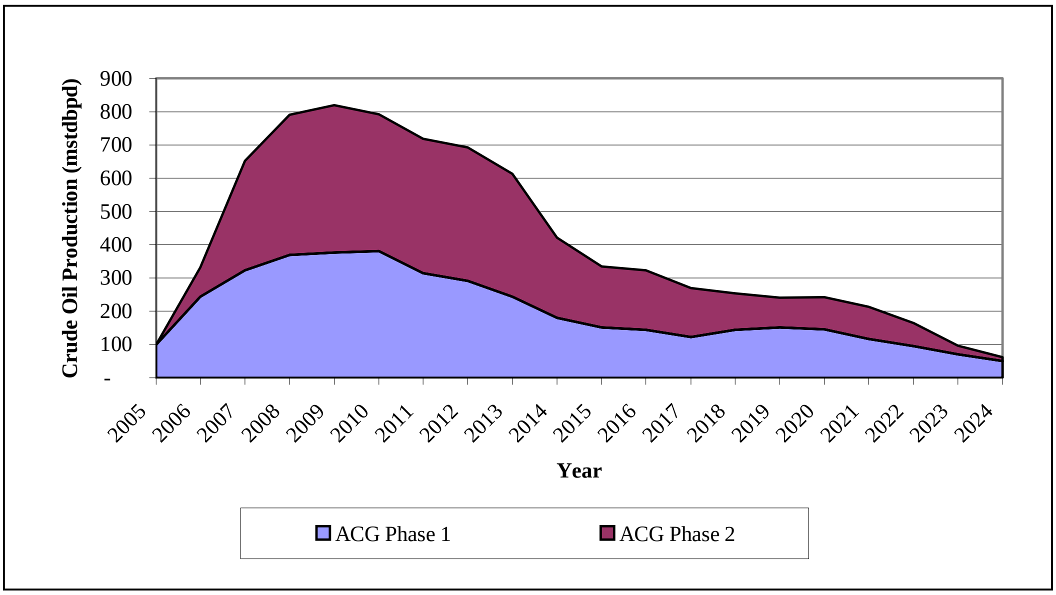

Figure 3.4: ACG Phase 1 and Phase 2 Production Profiles

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[2] The Phase 1 ESIA states that the gas line is 24" in diameter. This was based on the assumption that the pre-existing 24" oil pipeline from Chirag-1 to the EOP Terminal at Sangachal could be converted to gas service by Phase 1. However, the 24" oil was subsequently deemed unacceptable for the proposed gas service due to the potential presence of H_2S within the East/West Azeri gas mix. A new 28" gas line, constructed of materials suitable for the transport of sour gas, was therefore laid by the Phase 1 project.

The product flow rates between the offshore platforms and to Sangachal Terminal are summarised in **Table 3.1**. The rates given are peak rates (i.e. at plateau in 2010) and are indicative only. For the sake of completeness the product flows from the Central Azeri DQ and Chirag-1 have also been included.

Table 3.1: Oil Gas and Water Flows Around ACG Phase 1 and Phase 2 Facilities

Constituent	Peak Flow Rates	Units
OIL EXPORT		
West Azeri to Sangachal	340	mbpd
East Azeri to Sangachal	265	mbpd
GAS PRODUCTION		
West Azeri to C&WP	370	mmscfd
East Azeri to C&WP	315	mmscfd
Central Azeri to C&WP	500	mmscfd
Chirag to C&WP	Unspecified	mmscfd
GAS RETURN		
Injection gas from C&WP to Central Azeri	920	mmscfd
Lift gas from C&WP to Central Azeri	40	mmscfd
Lift gas from C&WP to West Azeri	70	mmscfd
Lift gas from C&WP to East Azeri	80	mmscfd
GAS EXPORT		
C&WP to Sangachal	180	mmscfd
PRODUCED WATER		
West Azeri to C&WP	130	mbpd
East Azeri to C&WP	160	mbpd
Central Azeri to C&WP	105	mbpd
INJECTION WATER		
C&WP to West Azeri	325	mbpd
C&WP to East Azeri	405	mbpd
C&WP to Central Azeri	300	mbpd

3.1.5 Project Availability and Design Life

The ACG Phase 2 project has been designed to achieve a minimum production availability of 95%. The design life for the facilities has been set at 25 years.

3.2 East and West Azeri Production, Drilling, Utilities and Quarters Platforms (PDUQS)

The East and West Azeri PDUQs are manned platforms, which support drilling and production activities sufficient to meet the requirements of the field production profiles described earlier. The two platforms are virtually identical in terms of processing activities, process plant and platform layout, and are little different in this regard from the Central Azeri PDUQ described in the Phase I ESIA3.

[3] Within the Phase 1 ESIA the Central Azeri platform is referred to as a DQ. However, this designation implies differences from the East and West PDUQs, which do not exist. Therefore, for the avoidance of confusion, the common term of PDUQ is used hereafter within this document.

3.2.1 Process Description

The PDUQs separate fluids received from the producing wells at East Azeri and West Azeri into their constituent oil, water and gas phases. The separated components are then forwarded to other Project facilities, as described in the section above. In order to carry out the separation and materials transfer operations each of the PDUQs is fitted with the following principal process plant items:

- HP and LP Production Manifolds;
- 2 x 50% Separation Trains each comprising:
  - a high pressure (HP) separator
  - a low pressure (LP) separator
- 2 x 50% electric motor driven flash gas compressor trains;
- Test Manifold and Test Separator;
- 1 x 100% Gas Dehydration package;
- Oil pumping facilities:
  - 3 x 50% oil booster pumps
  - 3 x 50% MOL pumps
- 1 x 100% Produced Water Treatment Package;
- 2 x 50% Produced Water Transfer Pumps;
- Oil, produced water, and gas pipeline pigging facilities;

An isometric drawing showing the layout of the PDUQs is presented in **Figure 3.5** overleaf.

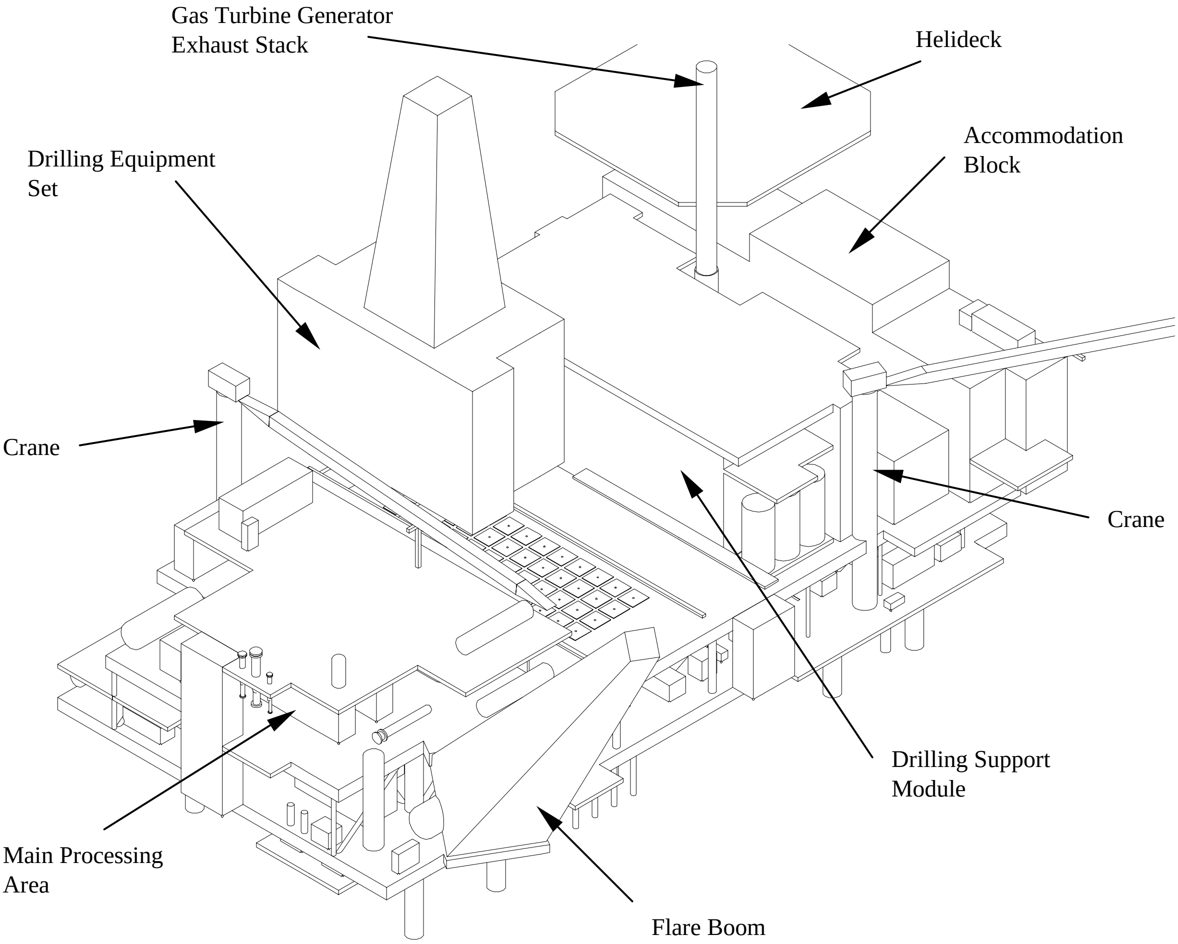


Figure 3.5: East/West Azeri PDUQ Isometric

Well fluids are transferred from producing wells to the PDUQs via flow-lines, which tie into either the HP or LP Production Manifold on each of the platforms. From the manifolds the fluids are piped to the separation trains where gas, oil and produced water separation is carried out. This is illustrated in **Figure 3.6**.

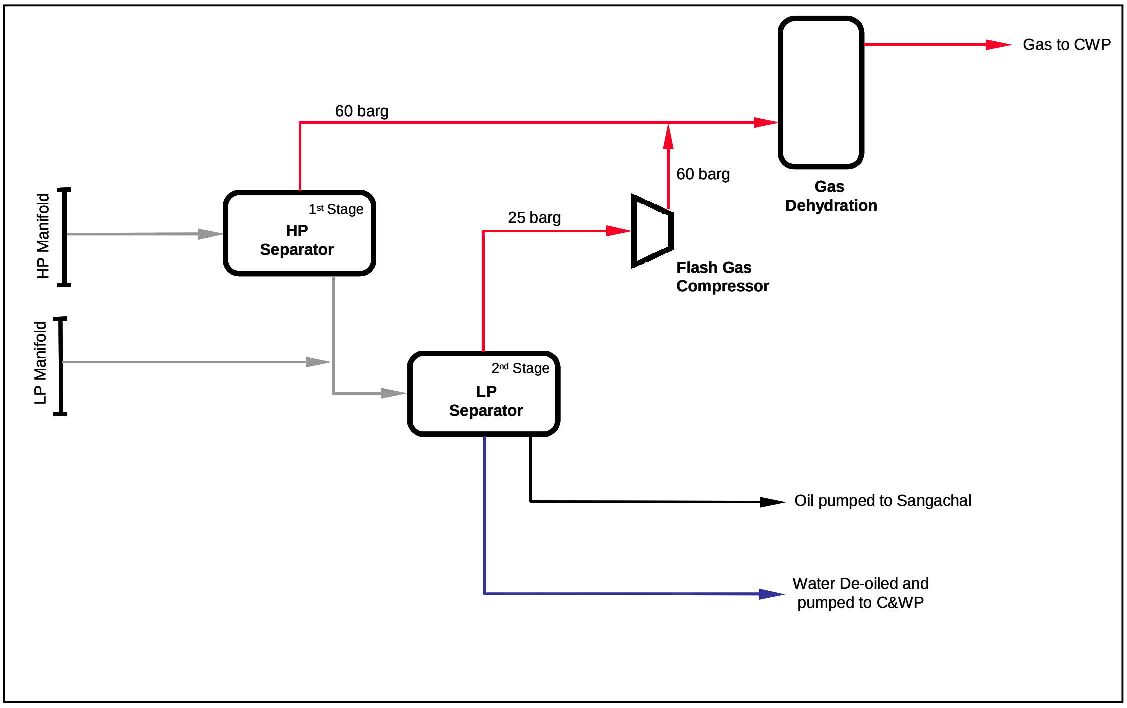


Figure 3.6: PDUQ Separation Process

Each separation train comprises an HP Separator, which receives well fluids from the HP Production manifold, and a downstream LP Separator, which receives fluids from the HP Separator and from the LP Production Manifold. The HP separator permits two-phase separation of gas from liquids at a pressure of 60 barg. The LP Separator enables further separation of the gas, at a pressure of 25 barg, and separation of the oil from the produced water. The LP Separator is designed to achieve a partially stabilised oil product with a maximum oil-in-water content of less than 5% by volume.

In the early years of field life all of the wells will tie into the HP Manifold, but as the reservoir pressure declines, or produced water breaks through, the wells can be tied into the LP Manifold and flow direct to the LP Separators.

Oil

Oil is recovered from the LP Separators and pumped to Sangachal Terminal via the 30" oil pipelines. The pumping is carried out by an arrangement of oil booster pumps and MOL pumps. Both of these pump sets are electric motor driven and both are installed in an *N+1* configuration.

Produced Water

Produced water recovered from the LP Separators is sent to the Produced Water Treatment Package which is a system comprising two hydrocyclone vessels, and a produced water-degassing drum. The treatment package;

- de-oils the produced water to a maximum total oil-in-water concentration of 42 mg/l as a daily average, and 29 mg/l as a monthly average4; and,
- de-gasses the cleaned water.

Recovered oil is recycled to the LP Separators, and the cleaned and degassed produced water is pumped by the Produced Water Transfer Pumps to the C&WP via the produced

[4] The ACG Phase 2 HSE Design Standard for the discharge of produced water to the Caspian.

water pipelines. The current produced water profiles for East and West Azeri are illustrated in **Figure 3.7**.

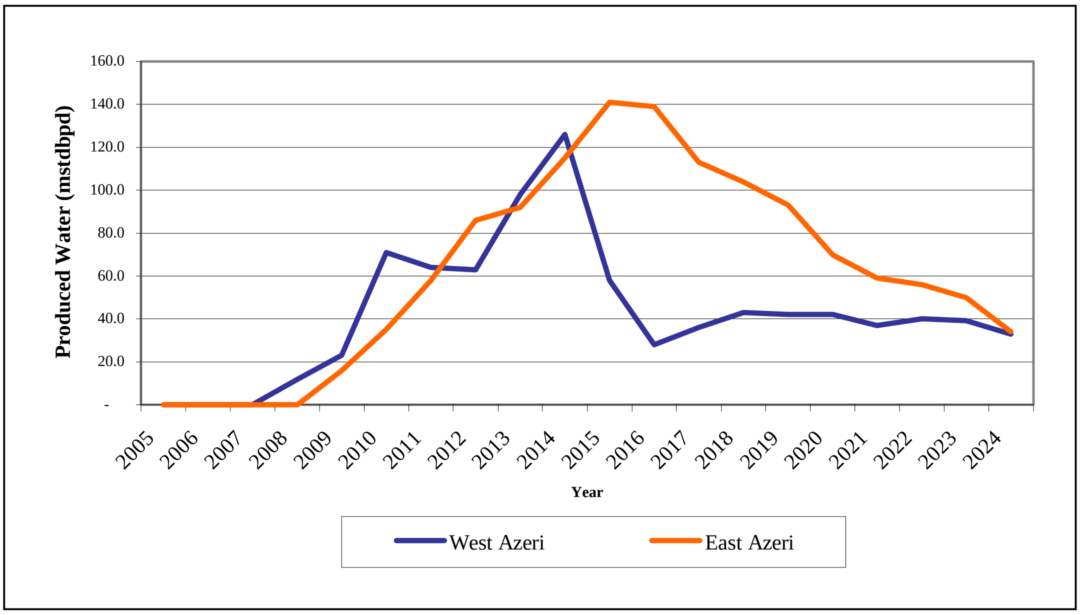


Figure 3.7: East and West Azeri Produced Water Profiles

At the C&WP the produced water is combined with seawater, pressure-boosted, and pumped back to the PDUQs for reinjection into the reservoir: under normal operating conditions, therefore, all of the produced water from East and West Azeri will be reinjected. However, in the event of a failure of the C&WP's water injection system treated produced water (i.e. water meeting the above oil-in-water specification) will be intermittently discharged to the Caspian at the PDUQs via the Open Drains Caisson.

Gas

Flash gas liberated from the LP Separator, at a pressure of 25 barg, is compressed to 60 barg, cooled, and combined with the gas from the HP Separator. The gas compression is carried out in two 50% electric motor driven Flash Gas Compressors. The combined gas stream is then cooled and passed to the gas dehydration package.

The gas dehydration package comprises a Glycol Contactor and a Glycol Regenerator. The package is designed to reduce the water content of the combined separator flash gas stream to a level of 4 lb/mmscf. The purpose of the dehydration process is to prevent hydrate formation and corrosion within the gas pipeline as the gas is returned to the C&WP at the seabed temperature of 5 ºC.

The flash gas passes through the Glycol Contactor where it is scrubbed by a recirculating solution of lean tri-ethylene glycol (TEG). The TEG absorbs the water within the gas stream and some heavy hydrocarbons, including BTEX. The rich TEG is then sent to the Glycol Regenerator where it is heated to release the absorbed compounds. The off gas from the Regenerator is cooled to condense the water present and the residual gaseous hydrocarbon stream is sent to the LP Flare Header. The now lean glycol is then recycled to the contactor.

Once dehydrated, the majority of the flash gas is piped to the C&WP for injection into the reservoir at Central Azeri. A proportion is retained on each platform for use as fuel gas.

3.2.2 Drilling Activities

The Phase 2 drilling programme will be carried out in two phases;

- prior to the installation of the PDUQs a set of wells will be pre-drilled at each of the platform locations by means of a mobile drilling rig. The current plan is to pre-drill 10 wells at West Azeri (9 producers and one cuttings reinjection well) and 6 wells at East Azeri (5 producers and one cuttings reinjection). The purpose of the pre-drilling is primarily to minimise the amount of time between the installation of the PDUQs and the delivery of first oil, and the subsequent production ramp-up; and,
- following installation of the PDUQs drilling will continue from the platforms themselves. This 'platform drilling' is a long-term activity and would be expected to continue from hook-up of the platforms through to the completion of the well drill programme.

The purpose of this section of the ESIA is to provide an overview of Phase 2's platform drilling operations only and to describe those activities and processes, which are significant in terms of releases to the environment, and their control. Pre-drilling activities are essentially involved with the development (rather than the continued operation) of the project, and for this reason they are described in Part B of this Project Description.

A quantification of the environmental releases occurring as a result of both platform and pre-drilling activities is provided in Chapter 5 of this document "Releases to the Environment".

Platform Drilling Activities

Both of the PDUQs are 48 'drilling slot' platforms, enabling the development of a *maximum* of 48 wells (including pre-drilling). Wells fall within three categories: a) oil producing wells, b) water injection wells, and c) cuttings reinjection wells.

The current proposals for the number of well types at each platform is summarised in **Table 3.2.**

Table 3.2: East & West Azeri Wells

Well Types	No. of Well Types	
	East Azeri	West Azeri
Producers	36	34
Water Injection	10	6
Cuttings Reinjection	2	2
Unused well slots	0	6

The ACG Phase 2 wells will be drilled directionally from drilling centres located at East and West Azeri. Large diameter well sections (30" casing and 26" and 16" hole) in the upper 500m of the well will be orientated close to the vertical; smaller diameter sections of the well bore (12¼" and 8½") may gradually be steered closer to the horizontal. Eventually, the wells will be fanned-out to access parts of the reservoir as much as four or five km from each drilling centre. The aim is to provide a radiating pattern of wells and associated side-tracks, for each to exploit approximately 200 acres of reservoir, and so maximise hydrocarbon recovery from the Pereriv formation.

Drilling Facilities

On both PDUQs drilling will be carried from the following facilities;

- Drilling Equipment Set (DES); and,

- Drilling Support Module (DSM).

Drilling Equipment Set (DES)

The DES is the platform-based structure from which drilling is physically undertaken. It is a moveable rig, which can be positioned, by means of hydraulic rams, over each of the drilling slots (see **Figure 3.5**). It comprises the following principal equipment items:

- Power swivel
- Mast/Derrick
- Draw works
- Well control system (BOP)
- Solids control system
- Drilling waste management system, including cuttings reinjection (CRI) system
- Ship-to-shore system
- Drilled cuttings containment system
- Rig skidding system

Drilling Support Module (DSM)

The DSM is a fixed unit, which is used for the storage and mixing of mud and cement, and other chemicals necessary to support drilling. The module comprises the following principal equipment items:

- Pipe rack and lay-down area
- Low and High Pressure mud systems
- Mud Chemical Stores
- Fluid Bulk Stores
- Dry Bulk Stores
- Mud mixing
- Cementer Unit
- 3 x Cement Powder Storage Tanks
- Hazardous Stores
- Forklift

Well Drilling Programme

Each well is comprised of a series of 'hole sections', which decrease in diameter from 30" surface conductor drilling out with 26" down to 8½" hole at the base of the well. The sequence of hole sections is as follows;

- The 30" conductor casing will be driven 150 m through the seabed sediments by means of hydraulic hammer (or drilled with seawater with cuttings returns directly to the seabed for the pre-drilling from the semi-submersible rig);
- The 26" surface section will be drilled to 500 m using water based drilling mud (WBM). This will either be seawater with viscous sweeps or, as a contingency, a more complex WBM. The WBM will be circulated to the rig through a marine riser. Cuttings coated with WBM will be separated by solids control equipment and discharged to the sea via the Cuttings Caisson;
- The 16" intermediate section will be drilled to about 1,250 m using an synthetic oil based mud or a low-toxicity oil based mud – hereafter referred to as Non-

Water Based Mud (NWBM). The cuttings from this section will not be discharged to the sea. It is proposed to dispose of the cuttings, using a CRI Unit;

- The 12¼" section will be drilled down to the top of the Pereriv reservoir formation. During the drilling of the section the angle of directional wells will be increased. The vertical depth of the section target depth (TD) will be around 2,700 m, but the section length in the wells with the longest reach may exceed 4,000 m. The field average section length is assumed to be 2,700 m. OPF drilling fluid is used in the section. Once again cuttings from the section will be disposed of via the CRI system; and,
- Finally, the 8½" section will be drilled through the Pereriv pay zone to TD at around 3,300 m. The directional nature of the section means the section length could be around 800 m. The section may be drilled with inhibitive brine based drilling fluid to protect against formation damage. Cuttings will be reinjected.

Table 3.3: Estimated Cuttings Discharge Volumes from each Platform Well

Hole Section	Section Length	Drilling Fluids	Cuttings Generation		Mud Generation		Total Volume/ Section
			Cutting Volume	Cuttings Volume	Mud Volume	Mud Volume	
(in)	(m)		(m^3/hr)	(m^3)	(m^3/hr)	(m^3)	(m^3)
36/30	150	Not applicable (n/a) [1]	n/a	n/a	n/a	n/a	n/a
26	350	Seawater/WBM [2]	9.86	173	5.92	104	277
16	750	NWBM [3]	2.35	118	1.41	71	189
12¼	1440	NWBM	2.10	121	1.05	60	181
8½	600	Acid soluble carbonate or viscosified brine.	1.01	24	0.40	10	34
Total							**681**

Notes:

1) As the 30" conductor pipe is being driven there will be no cuttings generated and as the pipe will fill with seawater there will also be zero mud discharge. This is the base case. However, operational difficulties may require this hole section to be partially or wholly drilled with seawater with cuttings discharge direct to the seabed. This is taken into consideration in the inventory (**Section 5.4.2**).

2) Cuttings and mud generated have been calculated by reference to Phase 1 ESIA, Table 5.12.

3) The 16", 12¼" and 8½ "sections will have zero discharge of cuttings and mud. See CRI Section.

Cuttings Reinjection

There will be no discharge to sea of cuttings generated from drilling the sections below the 26" hole sections. The design base case for the disposal of the drilled cuttings and mud is reinjection into a dedicated disposal well by the use of a cuttings reinjection (CRI) facility. There is provision for two such wells on each platform.

Facilities will be provided on board the PDUQs to collect, treat, store and inject non water-based mud (NWBM) cuttings (from the 16", $12^1/_4$" and 8 ½" hole sections) as well as used drilling muds, produced sand and drilling and non-hazardous open drains. Considerable work has been undertaken on this method of cuttings disposal, with the emphasis on ensuring that there are no losses or complications to operations once the cuttings have been injected into subsurface shale. CRI is an industry standard approach to cuttings disposal and BP have successfully undertaken up to 40 deep CRI applications worldwide. CRI is generally undertaken in mudstone or shale rich formations. The planned target for the injection of the drill cuttings in the Azeri field is the Sabunchi shale formation, which is present between depths of 2,001 m to 2,350 m below rotary table.

Prior to reinjection, the cuttings will be transferred from the shale shakers to a slurrification unit on the rig (see **Figure 3.8**). The slurrification process involves milling the cuttings to a mean particle size of about 300 microns or less in the presence of seawater. Small particle sizes are necessary to prevent blocking of either the reinjection annulus or disposal fracture in the near-well region. It is anticipated that a viscosifier, oxygen scavenger and/or biocide will be added to the slurry to improve its handling characteristics and to minimise corrosion.

On completion of the slurry conditioning process the resulting waste slurry is pumped under high pressure into subsurface fractures within the disposal formation. The subsurface fractures are initially created by injecting a slug of water into the formation. Once the fracture has been created, its size and geometry will be controlled by the downhole flow rate, injection pressure and the properties of the injected slurry. Waste slurry can be injected either continuously or batch wise.

If practicable, cuttings will be injected in batches to promote the development of a more compact domain of smaller multiple fractures close to the wellbore. The batch process consists of intermittent injection of roughly the same volumes of slurry and shutting in the well after each injection. This allows the disposal fracture to close onto the waste and to dissipate any build-up of pressure in the disposal formation. The presence of the cuttings within the fracture will increase the pressure at which the fracture will theoretically close. As a consequence of this higher fracture closure pressure and dependant on the tensile strength of the rock, a further reinjection will create a new fracture at a slightly different direction. This process can continue to create a network of induced fractures radiating out from the wellbore. Batch sizes may range from 75 to 4,000 barrels and are dictated primarily by the volume of the slurry-holding tank and the cuttings generation and slurry injection rates. Each batch injection may last from a few hours to several days, depending upon the batch volume and the injection rate. Injection rates are usually 2 to 10 barrels per minute.

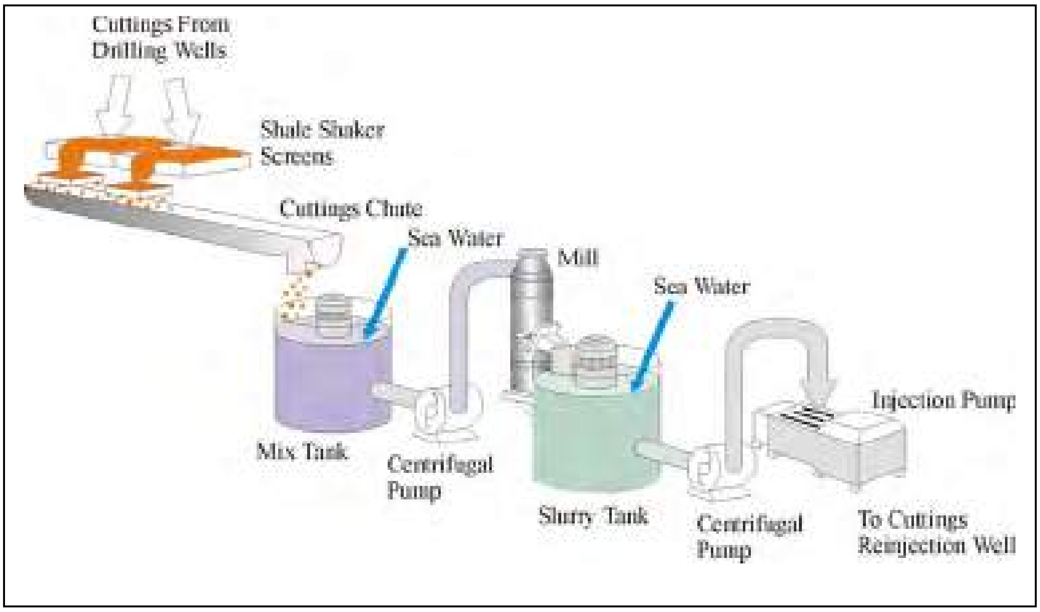


Figure 3.8: Cuttings Reinjection System

Ship-to-shore

If the CRI unit is not available while drilling the sections below 26" section, the cuttings will be contained and transported to the shore for treatment and disposal. If ship-to-shore option is used, the cuttings will be pumped from CRI unit into the designated containment at the platform, comprising six tanks each of 14 m^3 capacity. Then the cuttings will be transported to the shore by means of marine vessels.

Cementing

Following the drilling of each hole section, down to the $8^1/_2$" hole section, a casing is inserted and cemented into place (other than the 30" conductor which is driven and will not need to be cemented). The cementing programme for the platform wells will be finalised following the results of the template well drilling programme.

Well Completion

After each well is drilled to a total depth it will be completed and hydrocarbon flow stimulated. Completion operations begin with circulating a clean completion fluid that will displace the mud remaining in the hole. The wells will be completed ‘open hole’, that is, no casing will be run for the $8^1/_2$" hole section. A gravel pack liner will be installed, and then gravel will be circulated around the liner for sand filtration purposes. Completion tubing for flow of oil from the reservoir to surface will then be installed.

The cleaning or pre-flush fluids can be circulated and filtered a number of times to remove solids from the well and minimise the potential damage to the formation. The fluids used apply sufficient hydrostatic head to ensure that the formation fluids are unable to flow to surface during completion operations. Based on the defined average well it is estimated that there will be 1,000 bbls of completion fluids used in each of the development wells. All completion fluids will be contained at surface and backloaded to shore for recycling except any additional volume displaced by the steel volume of the completion and the surface working volume, which will be stored for use in later wells.

Based on sand production experience at Chirag-1 wells, downhole sand control is required for all wells, with open-hole gravel packs (OHGP) as the base-case choice of sand face completion for all well types. The gravel pack installation may be sequenced as follows:

- run a cleanup assembly, displace casing to filtered brine;
- run screens into the open hole and circulate mud in open hole to a level above the screens;
- activate the crossover type tool, circulate above the screens; and
- perform gravel pack and isolate the formation.

The drilling fluid used for the $8^1/_2$” hole section will also coat the well bore. The gravel pack will contain an enzyme system that destroys this coating, allowing oil from the reservoir to flow up the completion tubing and onto the platform.

3.2.3 Utility Systems

The PDUQs are fitted with a range of utility systems, which support the above production and drilling activities. These include:

- fuel gas system
- diesel fuel system
- power generation
- flare systems
- cooling medium system

- seawater system
- fresh water system
- drainage systems
- sewage treatment system
- galley waste system
- sand separation package
- chemical injection

These systems are described below.

Fuel Gas System

Fuel gas is used on each platform primarily for power generation in the gas turbine generators and as purge and pilot within the HP and LP flare systems. A small amount of gas may also be required in the glycol regeneration package for stripping purposes. This, however, has yet to be confirmed.

The fuel gas is taken from the 22" dehydrated gas export line. The gas is firstly passed through a knockout drum to remove any entrained liquids, heated via electric element heaters, and filtered before being distributed to the above users. The design fuel gas flow rate per platform is approximately 8,200 Sm^3/hr.

It should be noted that, at the present time, the likely concentration of H_2S within the fuel gas is not known: confirmation of this issue is dependent upon the outcome of an ongoing drilling programme, which is due for completion. Nevertheless, it is not the intention to sweeten the fuel gas offshore due to the weight, cost and logistical constraints highlighted in Chapter 4. Any H_2S present within the fuel gas will therefore be converted to SO_2 within the above combustion sources, and discharged to atmosphere. (**Chapter 5**).

Diesel Fuel System

Diesel is used on each platform in a number of areas: as a backup fuel supply to the gas turbine generators during outage of the fuel gas supply (an event which is likely to be infrequent and of relatively short duration), and as a primary fuel supply to the emergency generator, the cranes, life boats, and firewater pumps.

The diesel is transferred from a supply vessel and is stored in two 103 sm^3 diesel storage tanks located within the crane pedestals. It is pumped, as needed, to the diesel users via a diesel treatment package, which removes water and solid particles.

Power Generation

There are three sources of electrical power on each of the PDUQs:

- The principal electrical power source is a single Rolls Royce RB211 gas turbine generator rated at 28.8 MW under ISO conditions (giving 22.2 MW generating capacity at 35°C). On both platforms the turbines will be dual-fuel fired (fuel gas with a diesel backup supply) and for this reason will not be fitted with Low NOx burners. (See Chapter 4).
- Electrical backup power to each platform is supplied by means of a subsea cable from the C&WP.
- Emergency power for essential services will be provided by a 1.0 MW diesel fired generator. However, the provision of a power cable backup should enable platform restart without recourse to the emergency generator.

Flare Systems

The PDUQs are both fitted with two flare systems:

- low pressure (LP) flare system; and,
- high pressure (HP) flare system.

Each of the systems is designed to collect gaseous releases from around the platforms and convey them, via a header and flare drum, to a flare tip where the gas is burned and the products of combustion discharged to atmosphere. The sources of the gaseous releases are summarised in **Table 3.4**.

Table 3.4: LP and HP Flare System Gaseous Release Sources

LP Flare System	HP Flare System
• Cooling Medium Expansion Drum • Flash Gas Compressor Discharge Coolers • Fuel Gas Package • Gas Pipeline Pig Launcher • Gas Turbine Generator • Glycol Regeneration Package • HP Gas Cooler • Methanol Drum • MOL Pumps • Oil Booster Pumps • Produced Water Treatment Package • Sand Separation Package	• Flash Gas Compressor Discharge Coolers • Flash Gas Compressor Suction Scrubbers • Fuel Gas KO Drum • Fuel Gas Package • Gas Turbine Generator • Glycol Contactor • HP Separators • Ignition Package • LP Separators • Oil Booster Pumps • Test Separator

The flare systems are emergency relief devices and only receive releases from the above sources under the abnormal conditions of start up, shutdown, and equipment failure/emergency. Under *normal* operational conditions, therefore, there will be no continuous flaring at either platform subject to the following exceptions:

- The Glycol Regeneration Package vents continuously into the LP flare header;
- The flare systems are continuously purged with fuel gas to prevent ingress of oxygen and the build-up of an explosive atmosphere; and,
- Each of the flare tips is provided with a fuel gas-fired pilot light to ensure ignition of any gaseous releases.

These three gaseous streams are each burnt at the flare tips. It should, however, be noted that the gas flow rates, even in aggregate, are relatively minor and between one and two orders of magnitude lower than the gas release rates associated with emergency flaring as shown in **Table 3.5**.

Table 3.5: Gas Flow Rates to PDUQ Flares

Flow	LP Flare	HP Flare
Maximum design gas relief rate (mmscfd)	50	350
Purge gas flow rate[1] (mmscfd)	0.003	0.016
Pilot gas flow rate (mmscfd)	0.005	0.005

Note. 1. Includes gas flow from Glycol Regeneration Package.

Both the LP system and the HP system share the same flare boom with the flare tips both being situated at a height of 66 m above the platform weather deck. The flare tips are of a 'smokeless design'. The gas flow rates to both the LP flare tip and the HP flare tip are metered.

Cooling Medium System

Each PDUQ is fitted with a closed circuit cooling medium system. The cooling fluid is a 20% wt. aqueous solution of TEG, which is dosed with a proprietary corrosion inhibitor. The cooling fluid operates over a design temperature range of 19°C to 35°C, and is itself cooled against seawater within two Cooling Medium Coolers.

The cooling medium system provides cooling to the gas turbine generator lube oil systems, the air compressor package, the MOL pump bearings, the Flash Gas compressor trains, the HP gas cooler, and the Glycol Regeneration Package.

Seawater System

Seawater is lifted at each PDUQ and used for the following purposes:

- cooling of the cooling medium system;
- use as firewater;
- use in the sand jetting package;
- use in HVAC plant and living quarters;
- as feed-stock to the fresh water maker; and,
- for drilling purposes.

The seawater is abstracted from two seawater lift pump caissons, which terminate at a depth of –101 m; the abstraction point within the caisson is at a depth of –71 m. The normal seawater abstraction flow rate is approximately 1,700 m^3/hr, and the maximum 2,100 m^3/hr.

In order to prevent the build-up of organic matter within the seawater system a proportion of the lifted seawater is electrochlorinated in an antifouling package and the treated seawater, containing 50 ppbv of free chlorine and 5 ppbv copper, is returned to the caisson at the depth of the lift pump inlets (the location of the dosing point maximises the distribution of the antifoulant throughout the system). However, the dosing operation is only carried out for one minute in every five and the *average* concentrations of these chemicals within the seawater system are therefore one fifth of the above level, namely 10 ppbv free chlorine and 1 ppbv copper. After dosing the seawater is filtered to remove any solids (98% of 150 µ or greater) and then delivered to the above users.

After use, part of the seawater (approximately 660 m^3/hr) is returned to the Caspian, via the Seawater Discharge Caisson, at a temperature of around 25°C[5]. Seawater forwarded to the drilling module is discharged via the Cuttings Caisson or, where used within the drilling mud system, via the Cuttings Reinjection System.

Fresh Water System

On each PDUQ fresh water is produced from seawater (taken from the seawater System) in the Fresh Water Maker. There are two such units per platform, one duty and one standby, and each is rated at 5m^3/hr of fresh water product. The fresh water is piped to the Fresh Water Storage Tank from where it is subsequently distributed.

The Fresh Water Maker is based on reverse osmosis technology and produces a saline effluent stream, which is returned to the Caspian via the Seawater Discharge caisson. The discharge rate of this effluent stream is around 15 m^3/hr.

Drains Systems

There are three open drains systems on each of the PDUQs[6];

- Non-hazardous Open Drains;
- Hazardous Open Drains; and,
- Drilling Open Drains

Non-hazardous Open Drains

The Non-hazardous Open Drains collect water and hydrocarbons from areas, which are designated as 'non-hazardous'; the hydrocarbons will generally be limited to diesel fuel or drilling base oil. The drains convey the fluids to the Non-hazardous Open Drains Tank from where they are pumped to the Oily Drains Tank and thence to the CRI system or, when this system is inoperative, the Open Drains Caisson.

Hazardous Open Drains

The Hazardous Open Drains collect water and hydrocarbons from areas, which are designated as 'hazardous'. These include;

- chemical handling and diesel storage within hazardous areas;
- process areas including production separators, boosters and MOL pumps, flash gas compressors, pig receivers and launchers and associated piping.; and,
- utility areas including fuel gas and flare systems.

The Hazardous Open Drains convey the fluids to the Open Drains Caisson. Oil collecting within the caisson will be pumped out (on level control) and sent to the LP Flare Knock-out Drum for recycle into the process.

Drilling Open Drains

The Drilling Open Drains, which are segregated into hazardous and non-hazardous systems, convey fluids to the Drilling Oily Drains Tank from where they are transferred to the CRI system for reinjection. The tank is fitted with an overflow, which drains to the Open Drains Caisson. The Non-hazardous Drilling Open drains collect diesel, base oil, completion fluid and wash-down and rainwater from the Drilling Support Module and the Drilling Equipment Set. The mud tanks and well completions unit drains via

[5] At the point of discharge there will be a temperature differential between the discharged cooling water and the receiving water body of approximately 15°C. The significance of this point relates to the ACG Phase 2 Project's HSE Design Standard for Cooling Water Discharges.

[6] Closed drains systems on the PDUQs recycle fluids back to the process and do not therefore result in environmental releases to the marine environment, etc. They have therefore been excluded from this description.

the hazardous system.

Sewage Treatment System

On each PDUQ sewage arises from the Drilling Support Module and the Accommodation Block. The sewage is collected via the sewer system and treated in a Sewage Treatment Package. The package has a maximum capacity of 56 m^3/day, consistent with the peak platform manning level of 300 personnel during hook-up and commissioning, and an average capacity of 47 m^3/day (an inlet surge tank is designed to accommodate diurnal variations in sewage production).

The Sewage Treatment Package operates on the principle of electrochlorination and maceration. The treated sewage is then diluted with warm seawater and untreated laundry grey water such that the residual chlorine discharge specification can be met, and discharged via the Sewage Caisson. The package will comply with the following discharge limits at entry to the caisson. **Figure 3.6** presents the sewage discharge limits for a number of parameters from a PDUQ.

Table 3.6: PDUQ Sewage Discharge Limits

Parameter	Discharge Limit
TSS	< 150 mg/l (average) < 150 mg/l (peak day)
pH	6 to 9
Residual chlorine	1 mg/l
Faecal coliforms	< 200 MPN/100 ml

Galley Waste System

Organic food waste from the platform galley will be macerated to a MARPOL standard of <25 mm and discharged to the Sewage caisson.

Sand Separation Package

The Azeri reservoir is relatively unconsolidated in nature, and the abstraction of well fluids is likely to result in the deposition of significant quantities of sand within the HP, LP and Test separators, the LP Flare/Closed Drains drum, and the Produced Water Degasser. Preliminary estimates suggest that for each platform the sand collection rate is likely to be of the order of 1 te/day. In order to ensure ongoing effective operation of the topsides process the sand must be removed, and this is affected by the sand separation package, which is designed to remove sand from these vessels whilst they are online.

The sand is recovered from the process vessels in the form of a slurry. It is passed through a desanding hydrocyclone where it is washed. The sand is removed from the hydrocyclone and sent to the drilling module where it is disposed of via the cuttings reinjection system. If the CRI system is unavailable the separated sand can be diverted to a bag filter where excess water is drained. The drained sand is retained in the bag and returned to shore for disposal.

Water from the sand separation package is de-oiled within a de-oiling hydrocyclone and returned to the production separators. Recovered oil is sent to the closed drains system. Hydrocarbon gases released during the sand separation process are routed to the LP flare system.

Chemical Injection

The production process requires the addition of certain chemicals to facilitate production, aid the separation process, and protect process equipment from corrosion.

The following are required:

Methanol	Methanol will be injected into the well for pressure equalisation across the downhole valve, and to prevent hydrate formation on start up. It will also be used as a back up to the dehydration system: during outage of this system methanol would be injected into the wet gas to prevent hydrate formation during its export to the C&WP.
Antifoam	An antifoam agent will be injected upstream of the HP, LP and Test Separators to prevent foaming during the separation process.
Demulsifier	Demulsifier will be injected upstream of the HP, LP and Test Separators to achieve reasonable oil/water separation at the anticipated operating temperatures.
Corrosion Inhibitor	Corrosion inhibitor will be injected into the outlet oil lines from the LP separators.
Reverse Demulsifier	Reverse emulsion breaker will be injected upstream of the produced water hydrocyclones to aid oil/water separation.
Wax Inhibitor	If necessary, wax inhibitor will be injected at the MOL pump inlets to prevent build-up of wax deposits within oil export pipelines.

These chemicals are stored within tanks in the Chemical Injection Skid on the topsides of each platform. The volumes of each chemical type stored on each platform is summarised in **Table 3.7**.

Table 3.7: Platform Chemical Storage and Usage1

Chemical	Volumes Stored (m^3)[2]
Methanol	c. 20
Antifoam	6.6
Demulsifier	24.0
Corrosion Inhibitor	4.8
Reverse Demulsifier	4.8
Wax Inhibitor[3]	12.0

Notes:

1. Details given are for one platform only.

2. Figures based on 14 day supply period.

3.2.4 Quarters

Each PDUQ is fitted with living quarters. These have been designed to accommodate a permanent workforce of 180 persons, and provide beds for 100 temporary construction workers for use during offshore hook-up and commissioning.

3.3 Compression and Water Injection Platform (C&WP)

The C&WP is designed to provide water injection and gas reinjection compression facilities sufficient to maintain the required reservoir pressures throughout Azeri, and thereby support the desired production profiles. The platform also supplies lift gas to the East, West and Central Azeri PDUQs to assist in production.

The C&WP is an un-manned platform which is bridge linked to the Central Azeri

PDUQ. The platform will be installed by the ACG Phase 1 Project approximately 10 months following the installation of Central Azeri. However, subject to the timing of sanction for the Phase 2 Project, the platform will be installed with the process plant necessary to meet the requirements of both Phase 1 and Phase 2.

3.3.1 Process Description

The C&WP performs three principal functions;

- it receives and compresses all of the associated gas from the Azeri field and forwards for reinjection, gas lift or onshore processing;
- it receives all of the produced water from the Azeri field, mixes it with seawater, pressure-boosts the combined stream, and returns it to the PDUQs for reinjection; and,
- it acts as the offshore electrical power hub, importing and exporting power to the East, West and Central Azeri PDUQs.

In order to carry out these operations the C&WP is fitted with the following principal process plant items;

- Reception facilities for the East Azeri, West Azeri and Chirag-1 gas lines
- 1 x 100% Gas Dehydration package
- 4 x gas turbine-driven Gas Compression Trains
- 1 x 100% electric motor driven Gas Compression Train for Chirag-1 gas
- Export gas pipeline pigging facilities
- Produced water reception facilities for the East Azeri and West Azeri produced water lines
- 2 x 50% Seawater De-aeration facilities
- 4 x gas turbine-driven Reinjection Water Pumping Trains (See Note)
- 3 x seawater lift pumps
- Reinjection water pipeline pigging facilities
- 2 x gas turbine generators.

Note: Space will be provided for a fifth turbine.

An isometric drawing showing the layout of the C&WP is presented in **Figure 3.9**. Whilst the C&WP acts as the integrated processing hub for the ACG FFD the supply of the above process plant items falls within the individual scopes of the Phase 1 and Phase 2 projects. **Table 3.8** summarises which items will be supplied by which projects and what further items will be installed on the platform once it has been fully developed.

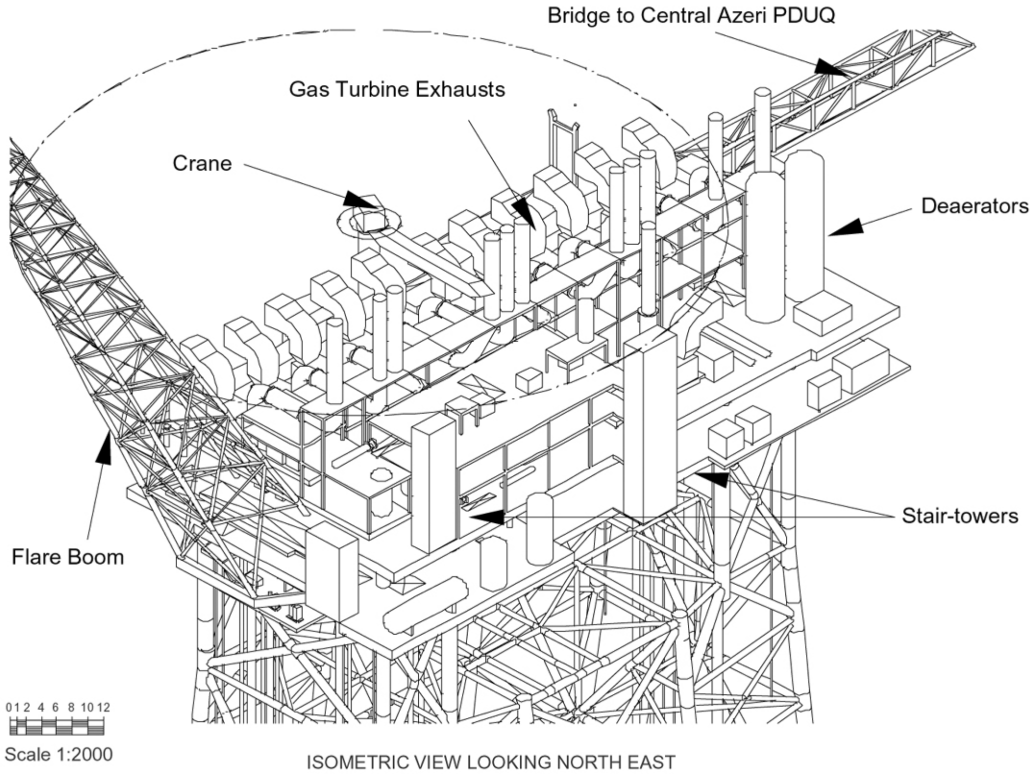


Figure 3.9: Isometric Diagram of a Typical C&WP

Table 3.8: C&WP Plant Supply by Project Phase

	Individual Unit Rating	**Phase 1**	**Phase 2**	**Future**	**Total**
Electrical Power Generators	28.8 MW (iso)	1	1	-	2
Gas Injection Compressor Trains	250 mmscfd	2	2	-	4
Chirag-1 Gas Compressor Train	140 mmscfd	1	-	-	1
Gas Export Compressor Train[1]	-	-	-	1	1
Water Injection Pumps	250 mbwpd	1	3	1	5[2]
Gas Dehydration Package	485 mmscfd	1	-	-	1
Seawater De-aeration Facilities	400 mbwpd	1	1	-	2
Seawater Lift Pumps	2,895 m^3/hr	3	2	-	5
EA/WA/Chirag-1 Gas Reception Facilities	-	1	-	-	1
Export Gas Pipeline Pigging Facilities	-	1	-	-	1
EA/WA Produced Water Reception Facilities	-	1	-	-	1

Reinjection Water Pipeline Pigging Facilities	-	1	-	-	1
HP&LP Flare Systems	-	1	-	-	1

Notes

1. Expected to be included as part of Phase 3

2. A possible future fifth water injection pump would provide flexibility in reservoir pressure maintenance.

Gas Compression

Gas is received at the C&WP from following sources:

- dehydrated gas is received from Chirag-1 via subsea pipeline;
- wet gas is received from Central Azeri via bridge-link pipeline; and,
- dehydrated gas is received from East Azeri and West Azeri via subsea pipelines.

The gas compression process is illustrated in **Figure 3.10**. The processing operations are described in more detail thereafter.

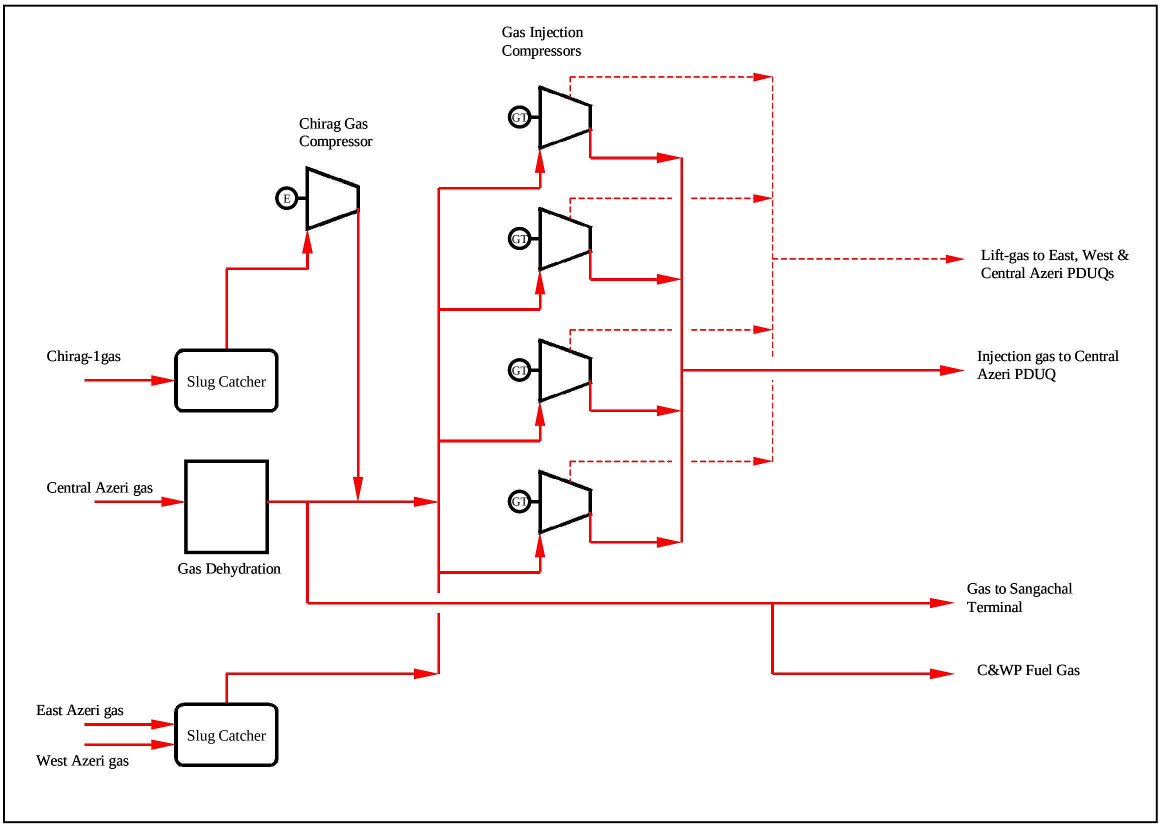


Figure 3.10: C&WP Gas Compression Process

Chirag-1 Gas

Chirag-1 gas arrives at the C&WP via a dedicated slug catcher where any condensed liquids in the gas pipeline are removed. These liquids are pumped across to the LP Separators on the Central Azeri PDUQ where they are returned to the process.

The gas is then compressed (from around 24 barg to around 59 barg) in a 1 x 100% electric motor driven centrifugal compressor (rated at 140 mmscfd), cooled and combined with the dehydrated Central Azeri gas downstream of the export gas pipeline tie in. In this way the Chirag gas is preferentially routed to the Gas Injection Compressors.

The Chirag-1 gas compression process (and subsequent reinjection) is designed to alleviate the gas handling problems currently being experienced on the Chirag-1 platform, which result in a substantial degree of flaring (approximately 30 mmscfd).

Central Azeri Gas

The Central Azeri gas is taken from the HP Separators and Flash Gas Compressors on the PDUQ, and piped across the bridge to the C&WP where, as an initial operation, it is dehydrated, in a single 100% dehydration package, to meet the pipeline export gas specification. The dehydration package, which is rated at 485 mmscfd, is identical in operation to the units on the PDUQs described in the previous section. Off gas from the regenerator is sent to the LP Flare header.

Downstream of the dehydration package a proportion of the dehydrated gas is diverted to the gas export and fuel gas systems. The remaining gas is combined with Chirag-1 gas and is routed to the Gas Injection Compressors.

East and West Azeri Gas

The East Azeri and West Azeri gas arrives at the C&WP by subsea pipelines and is routed to the process via a dedicated Phase 2 Slug Catcher where any condensed liquids/slugs in the gas pipeline are removed (the liquids are combined with those from Chirag-1 and sent to Central Azeri PDUQ). Gas from the slug catcher is then combined with Chirag-1/excess Central Azeri gas and routed to four parallel Gas Injection Compressor Trains[7].

Gas Handling

The Gas Injection Compressors are of a two-stage design and are each sized for a maximum gas flow rate of 250 mmscfd. The first compression stage raises the pressure of the gas from around 55 barg to 187 barg, and the second stage raises it to a final pressure of 384 barg. The gas is cooled downstream of each compression stage.

A proportion of the gas is bled off after the first compression stage and is piped to East, West and Central Azeri for use as lift-gas. However, the bulk of the gas is subject to both stages of compression and is then piped to Central Azeri via the bridge-link between the two platforms and injected into the reservoir.

The Gas Injection Compressors are each driven by a Rolls Royce RB211 gas turbine (rated at 28.8 MW under ISO conditions). The turbines are fired on fuel gas only. They are not fitted with Low NOx burners see **Chapter 4.**

In order to ensure independence of operation the C&WP will have a dedicated 28" gas riser tied-into the 28" subsea gas export pipeline from the Central Azeri PDUQ. Thus the two platforms will be able to flow gas to Sangachal Terminal, albeit with the primary gas flow being off the C&WP. In the event that the C&WP is not operational gas can be transferred to the terminal from Central Azeri. In this circumstance the gas will be wet and will require the injection of methanol to prevent hydrate formation. The arrangement also allows gas to be piped to the terminal without the Central Azeri PDUQ's being in operation. This arrangement thus ensures security of gas supply to the

[7] A fifth compressor train, the Gas Export Compressor Train, may be installed in the future. However, the requirement for this compressor has yet to be confirmed.

terminal.

Water Injection

Produced water, recovered at the East, West and Central Azeri PDUQs, is transferred to the C&WP where it is mixed with de-aerated seawater, pressure-boosted, and piped back to the outlying platforms for reinjection into the reservoir. The water injection scheme is illustrated in **Figure 3.11** overleaf.

The de-aeration of seawater to a residual oxygen content of 5 ppb, is carried out in two 50% vacuum de-aerator towers, each rated at 400 mbwpd. The required volume of injection seawater is taken from the seawater system (see below), dosed with an antifoaming agent and fed to the towers where a continuous vacuum is applied by the Water Injection Vacuum Package. The reduced pressure causes the air (oxygen) within the seawater to come out of solution; the gas is discharged to atmosphere via a vent. An oxygen scavenger is also injected into the bottom of the de-aerator towers to ensure that the residual oxygen content specification is met.

De-aerated seawater is pumped, by electric motor driven Water Injection Booster Pumps, from the de-aerator towers to the inlet manifold of the Water Injection Pumps, where it is co-mingled with produced water from the PDUQs. The pressure of the combined stream is then raised to the reinjection pressure of 450 barg and the water is piped to the platforms for reinjection into the reservoir.

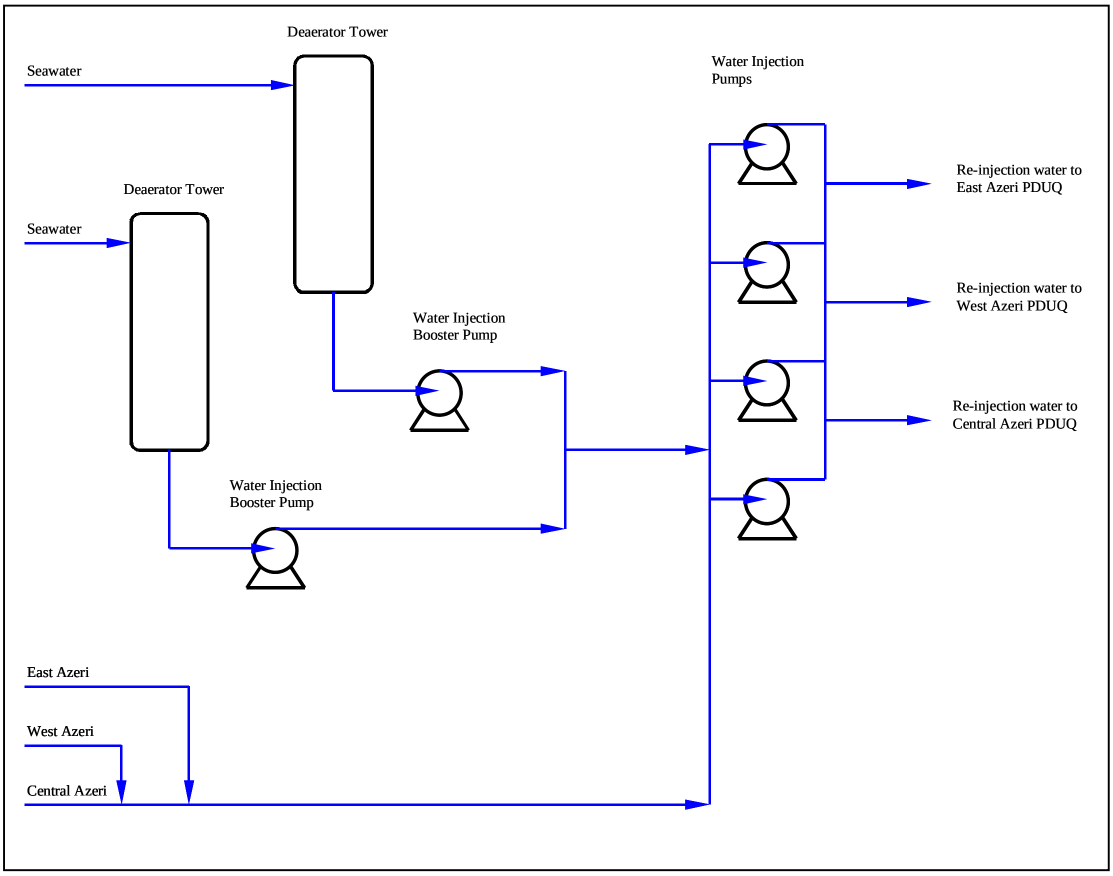


Figure 3.11: C&WP Water Injection Process

There are four Water Injection Pumps configured in a parallel arrangement (a fifth may be added at a later date). Each of the pumps is driven by a Rolls Royce RB211 gas turbine (rated at 28.8 MW under ISO conditions). The turbines are fired on fuel gas only. They are not fitted with Low NOx burners see **Chapter 4**.

Power Generation

Electrical power is generated on the C&WP via two Rolls Royce RB211 gas turbine generators each rated at 28.8 MW (under ISO conditions). The turbines are fired on fuel gas only. They are not fitted with Low NOx burners.

Distribution of electrical power to East and West Azeri platforms by means of a subsea cable.

3.3.2 Utility Systems

The C&WP is fitted with a range of utility systems, which support the above gas compression and water reinjection activities. These include;

- fuel gas system;
- diesel fuel system;
- flare systems;
- cooling medium system;
- seawater system;
- drainage systems; and,
- chemical injection.

These systems are described below.

Fuel Gas System

Fuel gas is taken from the 28" gas export line passed through a knockout drum to remove any entrained liquids, heated via electric element heaters, filtered, and distributed to the following users/uses;

- Power Generation gas turbines;
- Injection Gas Compressor gas turbines;
- Gas Export Compressor gas turbine (Future);
- Water Injection Pump gas turbines;
- Flare purge and pilots;
- Tank purging; and,
- Stripping gas within Glycol Regeneration Package.

For the reasons described earlier under the PDUQ fuel gas system it is not the intention to sweeten the fuel gas on the C&WP. Any H_2S present within the gas will be discharged to the atmosphere as SO_2 along with the other products of combustion.

Diesel Fuel System

Diesel is required on C&WP for crane operations only. There will be no dedicated diesel storage or pumping facilities on C&WP: it will be piped across the bridge from the Central Azeri PDUQ.

Flare Systems

The C&WP is fitted with two flare systems;

- low pressure (LP) flare system; and,
- high pressure (HP) flare system.

Following its installation the C&WP's flare systems will be tied into those of the Central Azeri PDUQ and will take flare relief from both platforms. The PDUQ flare will essentially be taken out of service but maintained and ready to be placed back into operation for periods of time when the C&WP is down or out of service.

Each of the systems is designed to collect gaseous releases from around the platform and convey them, via a header and flare drum, to a flare tip where the gas is burned and the products of combustion discharged to atmosphere. The sources of the gaseous releases are summarised in **Table 3.9**.

Table 3.9: LP and HP Flare System Gaseous Release Sources

Flare System Gaseous Release Sources	
LP Flare System	**HP Flare System**
• Gas Compressor Seals • Gas Compressor Gas Turbines • Glycol Regeneration Package • Water Injection Pump Gas Turbines • Gas Turbine Generators • Cooling Medium Expansion Drum • Gas Compressor Discharge Coolers • Fuel Gas Package • Flash gas Compressor Discharge Coolers • Gas Pipeline Pig Launcher • HP Gas Cooler • Methanol Drum • MOL Pumps • Oil Booster Pumps • Produced Water Treatment Package • Sand Separation Package	• Fuel Gas KO Drum • Fuel Gas Package • Gas Compressor Discharge Coolers • Gas Compressor Gas Turbines • Gas Compressor Suction Scrubbers • Gas Pipelines • Gas Slug Catchers • Gas Turbine Generators • Glycol Contactor • Ignition Package • Pig Receivers & Receivers • Water Injection Pump Gas Turbines • Flash Gas Compressor Discharge Coolers • Flash Gas Compressor Suction Scrubbers • HP Separators • LP Separators • Oil Booster Pumps • Test Separator

Like the flare systems previously described for the PDUQs, those for the C&WP also only receive releases from the above sources under the abnormal conditions of start up, shutdown, and equipment failure/emergency. Under *normal* operational conditions, therefore, there will be no continuous flaring subject, once again, to the following exceptions;

- The Glycol Regeneration Package vents continuously into the LP flare header;
- The flare systems are continuously purged with fuel gas to prevent ingress of oxygen and the build-up of an explosive atmosphere; and,
- Each of the flare tips is provide with a fuel gas-fired pilot light to ensure ignition of any gaseous releases.

These three gaseous streams are each burnt at the flare tips. It should, however, be noted that the gas flow rates, even in aggregate, are relatively minor and between one and two orders of magnitude lower than the gas release rates associated with emergency flaring. This fact is illustrated in **Table 3.10**.

Table 3.10: Gas Flow Rates to C&WP Flares

Flow	LP Flare	HP Flare
Maximum design gas relief rate (mmscfd)	70	700
Purge gas flow rate[1] (mmscfd)	0.003	0.033
Pilot gas flow rate (mmscfd)	0.004	0.004

Note. 1. Includes gas flow from Glycol Regeneration Package.

Both the LP system and the HP system share the same flare boom with the flare tips both being situated at a height of 80 m above the C&WP weather deck. The flare tips are of a ‘smokeless design’. The gas flow rates to both the LP flare tip and the HP flare tip are metered.

Cooling Medium System

The C&WP is fitted with a closed-circuit cooling medium system. The cooling fluid is a 20% wt. aqueous solution of MEG. The cooling fluid operates over a design temperature range of 19°C to 38°C, and is itself cooled against seawater within six Cooling Medium Coolers (four for Phase 1 and two for Phase 2).

The cooling medium system provides cooling to the gas turbine generator lube oil systems, the air compressor package, the Glycol Regeneration Package, the Water Injection pumps, the Gas Injection compressors and discharge coolers, the Chirag-1 gas compressor and discharge cooler, and (once installed) the Export Gas Compressor and discharge cooler.

Seawater System

Seawater is lifted at the C&WP and used for the following purposes;

- cooling of the cooling medium system;
- water injection;
- use as firewater;
- use in HVAC unit; and,
- use in various utility stations.

The seawater is abstracted from five seawater lift pump caissons, which terminate at a depth of –101 m; the abstraction point within the caisson is at a depth of –15.5m. The seawater abstraction flow rate will vary throughout the project life, as production profiles change. At plateau it is expected to be 11482 m^3/hr. The maximum design abstraction rate is 11804 m^3/hr.

Before delivery to the above users the seawater will be treated in an antifoulant package and then filtered. The operation of the antifoulant package and filter will be identical to the units on the PDUQs, which have already been described in the previous section.

After use, part of the seawater is returned to the Caspian, via the Seawater Discharge Caisson, at a temperature of around 25°C. Under Normal operating conditions, i.e. with the water injection system at full capacity, approximately 5,230 m^3/hr of seawater will be returned to the Caspian. During part-outage of the reinjection system (i.e. shutdown of one de-aerator only) this figure increases to 7,900 m^3/hr; with total outage (i.e. shutdown of both de-aerators) the discharge will be a maximum of 10,500 m^3/hr. However, it should be noted that the increased seawater return rates are likely to be of relatively short duration: if the reinjection system outage is prolonged the seawater lift rate will be reduced.

Open Drains Systems

The C&WP is fitted with two segregated open drains systems;

- Non-hazardous open drains; and,
- Hazardous open drains.

Non-hazardous Open Drains

The Non-hazardous Open Drains collect water and hydrocarbons from areas, which are designated as ‘non-hazardous’. The drains convey the fluids to the Non-hazardous Open Drains Tank from where they are pumped to the Open Drains Caisson.

Hazardous Open Drains

The Hazardous Open Drains collect water and hydrocarbons from areas, which are designated as ‘hazardous’. These include;

- glycol regeneration package; and,
- produced water and gas pig receiving

The Hazardous Open Drains convey the fluids directly to the Open Drains Caisson. Oil collecting within the caisson will be pumped out (on level control) and sent to the LP Flare/Closed Drains Drum on Central Azeri PDUQ for recycle into the process.

Chemical Injection

The water injection process requires the addition of the following chemicals:

Antifoam	An antifoam agent will be injected into the injection seawater upstream of the De-aerator.
Scale Inhibitor	Scale inhibitor will be injected into the Water Injection Pump Suction Manifold.
Corrosion Inhibitor	Corrosion inhibitor will be injected into the Water Injection Pump Suction Manifold.
Biocide	Biocide will be injected into the de-aerated seawater downstream of the De-aerator.
Oxygen Scavenger	Oxygen scavenger will be injected directly into the De-aerator.

These chemicals are stored within tanks in the Chemical Injection Skid on the topsides of the C&WP. The volumes of each chemical type stored on the platform is summarised in **Table 3.11**.

Table 3.11: C&WP Chemical Storage and Usage

Chemical	Volumes Stored (m^3)[1]
Antifoam	4
Scale Inhibitor	27
Corrosion Inhibitor	30.5
Biocide	36
Oxygen Scavenger	18

Notes

1) Figures based on 14 day supply period.

3.4 Pipelines

3.4.1 Overview

The ACG Phase 2 project will design fabricate and install a number of subsea pipelines within the project area to link both East Azeri and West Azeri to the C&WP and Sangachal Terminal. The pipelines will enable;

- the export of partially stabilised crude oil from the PDUQs to the terminal; and,
- the inter-field transfer of associated gas, produced water, and reinjection water between the PDUQs and the C&WP.

The pipelines are described below.

Oil

There is a pre-existing 30" oil export line from Central Azeri PDUQ to Sangachal terminal. The pipeline, which was laid as part of the ACG Phase 1 project, incorporates a subsea wye and a check valve in the vicinity of the Central Azeri platform. As part of the Phase 2 project a 30" in-field oil pipeline will be laid from West Azeri to tie in with the existing 30" export line at the wye. West Azeri will then export its oil to Sangachal via the Phase 1 30" export line.

Under ACG Phase 2 a new 30" oil export line will be laid from the Central Azeri PDUQ platform to Sangachal Terminal. This pipeline will also include a subsea wye, which will enable East Azeri to tie in via a new 30" in-field oil pipeline. East Azeri will thus export its oil to Sangachal via the new 30" export line.

Gas

Associated gas will be piped from West Azeri to the C&WP via a new 22" in-field gas pipeline. Lift gas will be returned from the C&WP to West Azeri via a new 6" in-field gas pipeline. This pipeline will piggyback on the 14" in-field produced water line from C&WP to West Azeri (see below).

Associated gas from East Azeri will be piped to the C&WP via a second new 22" in-field gas pipeline. Lift gas will be returned from the C&WP to East Azeri via a new 6" in-field gas pipeline. This pipeline will piggyback on the 14" in-field produced water line from C&WP to East Azeri.

Produced Water

Produced water will be piped from West Azeri to the C&WP via a new 14" in-field produced water pipeline.

Produced water will be piped from East Azeri to the C&WP via a new 14" in-field produced water pipeline.

Reinjection Water

Reinjection water will be piped from the C&WP to West Azeri via one (1) new 18" in-field reinjection water pipelines.

Reinjection water will be piped from the C&WP to East Azeri via two (2) new 16" in-field reinjection water pipelines.

The dimensions of the above pipelines are summarised in **Table 3.12**.

Table 3.12: Phase 2 Pipelines' Dimensional Data

Service	Nominal Diameter (inches)	From	To	No. of Pipelines	Internal Diameter (mm)	Length (km)
Oil	30	Central Azeri	Sangachal	1	720.8	187.0
Oil	30	East Azeri	Subsea Wye	1	720.8	9.3
Oil	30	West Azeri	Subsea Wye	1	720.8	1.6
Gas	22	East Azeri	C&WP	1	527.0	9.3
Gas	22	West Azeri	C&WP	1	527.0	4.6
Lift Gas	6	C&WP	East Azeri	1	150.9	9.3
Lift Gas	6	C&WP	West Azeri	1	150.9	4.6
Produced Water	14	East Azeri	C&WP	1	327.0	9.3
Produced Water	14	West Azeri	C&WP	1	327.0	4.6
Reinjection Water	16	C&WP	East Azeri	2	339.2	9.3
Reinjection Water	18	C&WP	West Azeri	1	382.4	4.6

A schematic of the new pipeline system is shown in **Figure 3.12**.

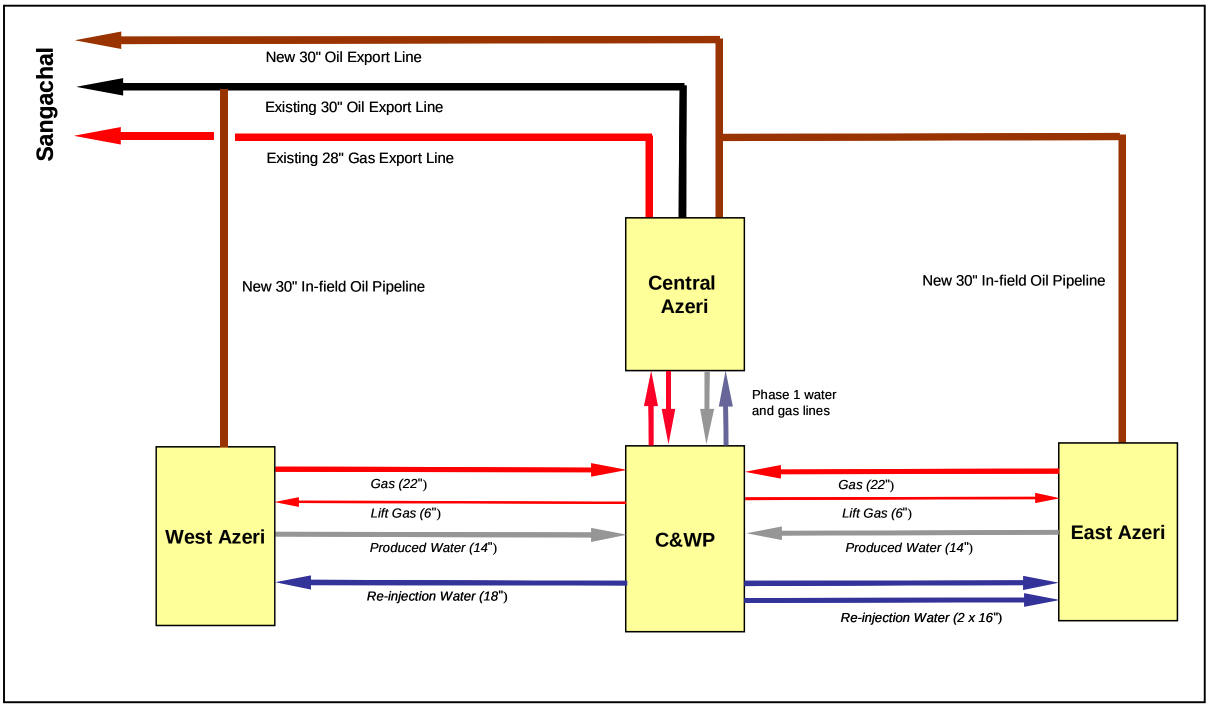


Figure 3.12: Schematic of Phase 1/Phase 2 Pipeline System

3.4.2 30" Oil Export Pipeline Route

In the immediate vicinity of Central Azeri the Phase 2 30" oil pipeline runs to the north of the Phase 1 oil line. Due north of Chirag the pipelines converge and follow the existing 24" pipeline route from Chirag-1 to Sangachal.

Selection of the existing EOP 24" and Phase 1 30" pipeline corridor route for the new export pipeline. Previous surveys have been conducted along the route to evaluate the geotechnical data, seabed morphological features, platform approaches and other design criteria. Environmental baseline information for the seabed conditions along the route has also been collated. The pipeline route is illustrated in **Figure 3.13**.

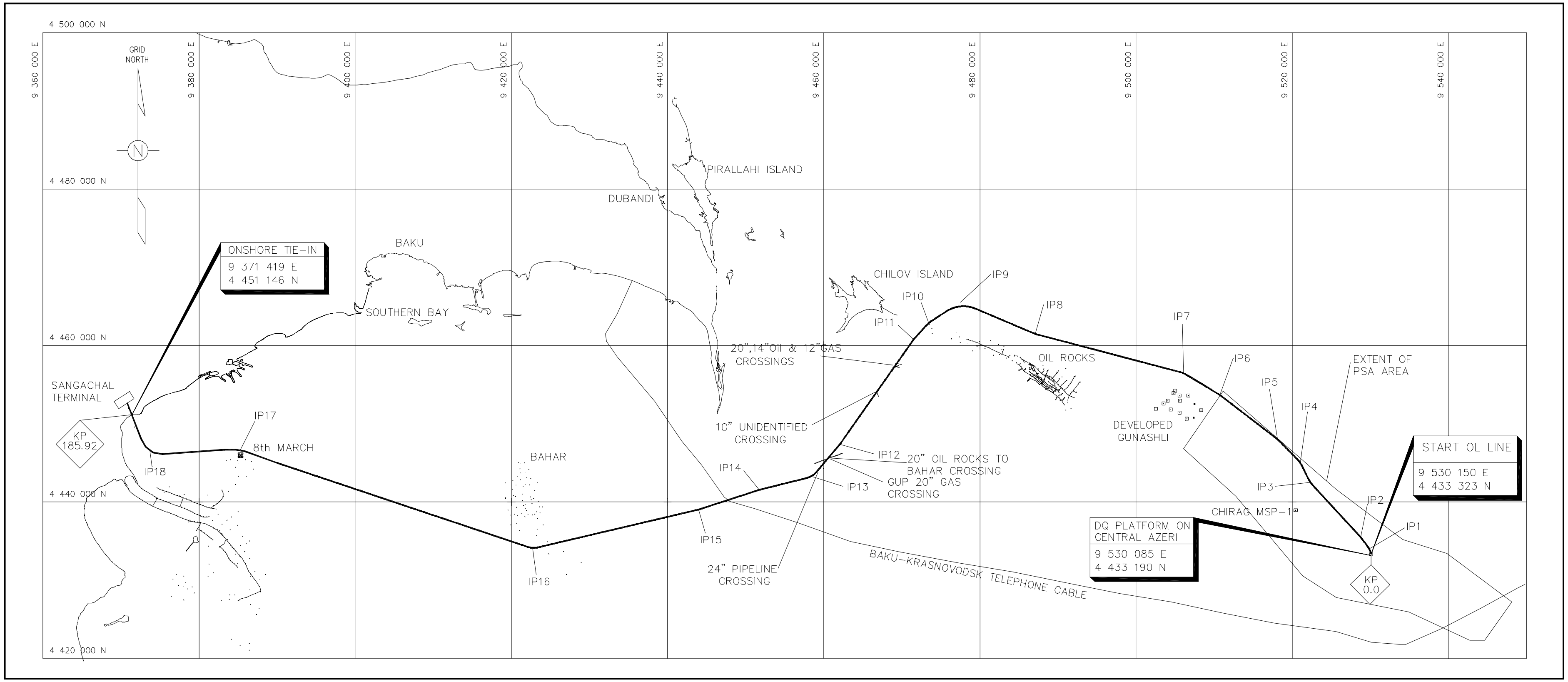


Figure 3.13: 30" Oil Pipeline Export Route

3.4.3 Pipeline Landfall

On arriving at the landfall the pipeline route will run in a 200 m corridor directly to the terminal facility over a distance of approximately 1.7 km. It will cross the following existing facilities;

- one crossing of the road (Baku to Astara highway);
- one crossing of the railway; and,
- multiple crossings of third party pipelines / service lines (various diameters) and facilities.

3.4.4 Inter-field Pipelines

The inter-field pipelines within the contract area are shown schematically in **Figure 3.12** and described in **Section 3.4.1**.

3.4.5 Pigging Operations

30" Oil Export Pipeline

The 30" Phase 2 Oil Export Pipeline will be pigged once every three days from the offshore platforms to Sangachal Terminal. The pig will be launched from the East Azeri and Central Azeri platforms on an alternate basis, resulting in the pigging of the 30" in-field oil pipeline tie in section (i.e. from the platform to the subsea wye) once every six days[8].

The pig arrives at Sangachal Terminal in the Oil Pipeline Pig Receiver. Oil is drained from the receiver and sent to the Off-spec Crude Oil Tank via the Closed Drains System. The waxy solids within the receiver are then removed manually and sent for disposal.

22" Gas Pipelines

The East Azeri 22" gas line will be pigged from East Azeri to C&WP once every 10 days. Pigging wastes are captured in the East & West Azeri Gas Slug Catcher and are transferred, via the Chirag Gas Slug Catcher, to the LP Separators on the Central Azeri PDUQ. There is no direct release of pigging wastes to the environment.

The West Azeri 22" gas line will be pigged relatively infrequently. However, the pigging process will be identical to that for the East Azeri line, and does not result in releases to the environment.

6" Lift Gas Pipelines

There will be no pigging of the 6" Lift Gas pipelines.

14" Produced Water Pipelines

The East Azeri and West Azeri Produced Water pipelines will each be pigged once per month. Pigging will be carried out alternately, with only one pipeline being pigged at any one time.

Early Life

During early field life (when there will be insufficient produced water to drive a pig) each Produced Water pipeline will be pigged from the C&WP to the relevant platform (i.e. counter to the normal direction of flow). On arrival at the platform the pigged water will be routed into the produced water-degassing drum where solids knockout will occur. The pigging water and any produced water arising at the platform during the

[8] A similar *modus operandi* is in place for the pigging of the Phase 1 30" Oil Export Pipeline.

pigging operation (which in early field life will be relatively small) will then be sent to the Open Drains caisson for disposal. This arrangement is illustrated in **Figure 3.14**.

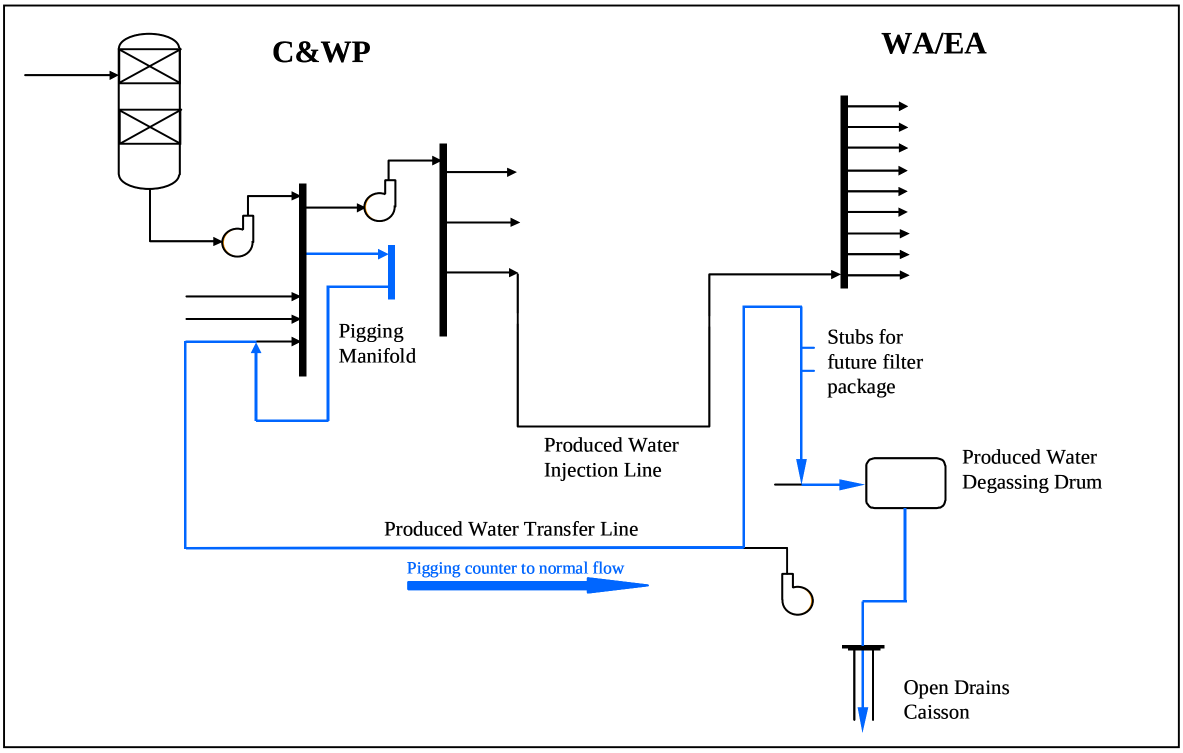


Figure 3.14: Pigging of the Produced Water Transfer Lines from C&WP to East and West Azeri

It is anticipated that the volumes of pigging solids produced during each operation will be relatively small. However, the design will allow for the retrofit of a filter package should a higher solids removal capacity be required.

Later Life

Later in field life, when there will be sufficient produced water to drive a pig, the Produced Water pipeline will be pigged in the normal direction, i.e. from East/West Azeri to the C&WP (**Figure 3.15**). The bulk of the pigging water will be directed into the water reinjection system via a filter basket within the pig receiver, and returned to the platforms for reinjection into the reservoir. As the pigging operation is completed the solids will be captured within the receiver, and during this final operation the filtered pigging water will be discharged to the C&WP's Seawater Discharge caisson.

Once again the design will allow for the retrofit of a dedicated filter package should the volumes of recovered pigging solids prove greater than currently anticipated.

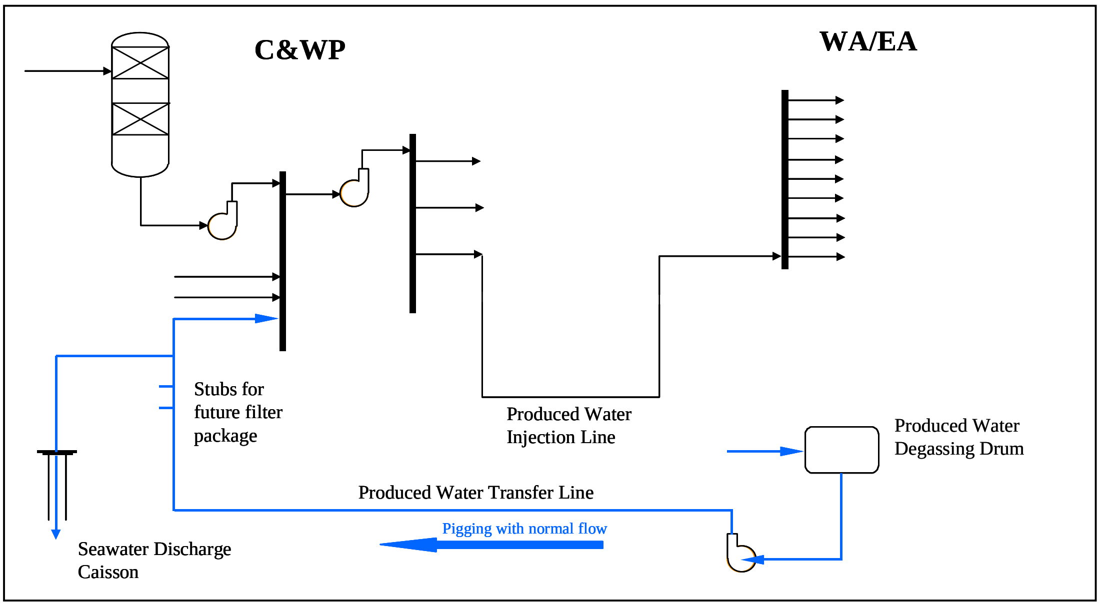


Figure 3.15: Pigging of the Produced Water Transfer Lines from East and West Azeri to C&WP

16" & 18" Reinjection Water Pipelines

Each of the Reinjection Water pipelines will be pigged once every three months. The pigging will be carried out from the C&WP to the platforms (i.e. with the normal direction of flow). The current intention is to pig at full pressure and direct the pigging water and all pigging solids into the reinjection system for disposal within the reservoir. This scheme is illustrated in **Figure 3.16**.

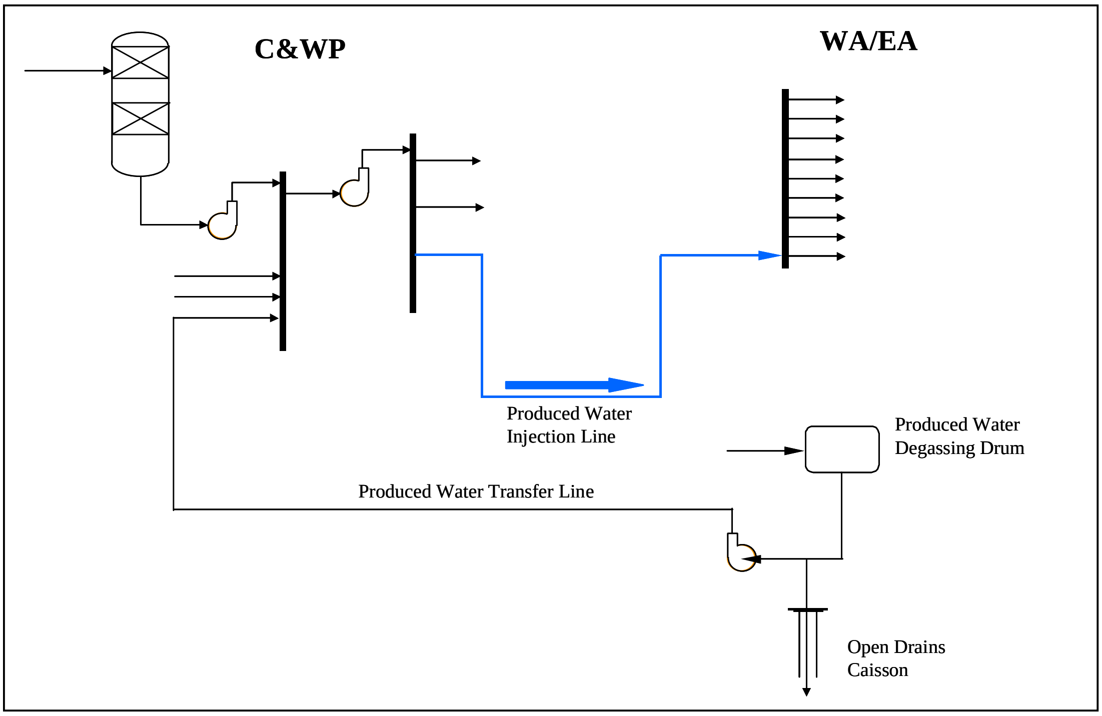


Figure 3.16: Pigging of the Reinjection Water Lines Base Case (Reinjection)

There is the possibility (albeit a low one) that the above scheme could cause problems with the reinjection system due to blockage, etc. Should this situation arise an alternative pigging scheme will be adopted. In the second scheme, which is illustrated in **Figure 3.17**, pigging is carried out at booster pump pressure.

On arrival at the platform the pigged water will be routed into the produced water-degassing drum where solids knockout will occur. The pigging water and any produced water arising at the platform during the pigging operation will then be returned to the C&WP, via the Produced Water pipeline, and transferred to the reinjection system for disposal downhole. Any pigging/produced water flows above the maximum handling capacity of the Produced Water pipeline will be disposed of via the Open Drains caisson on the PDUQ.

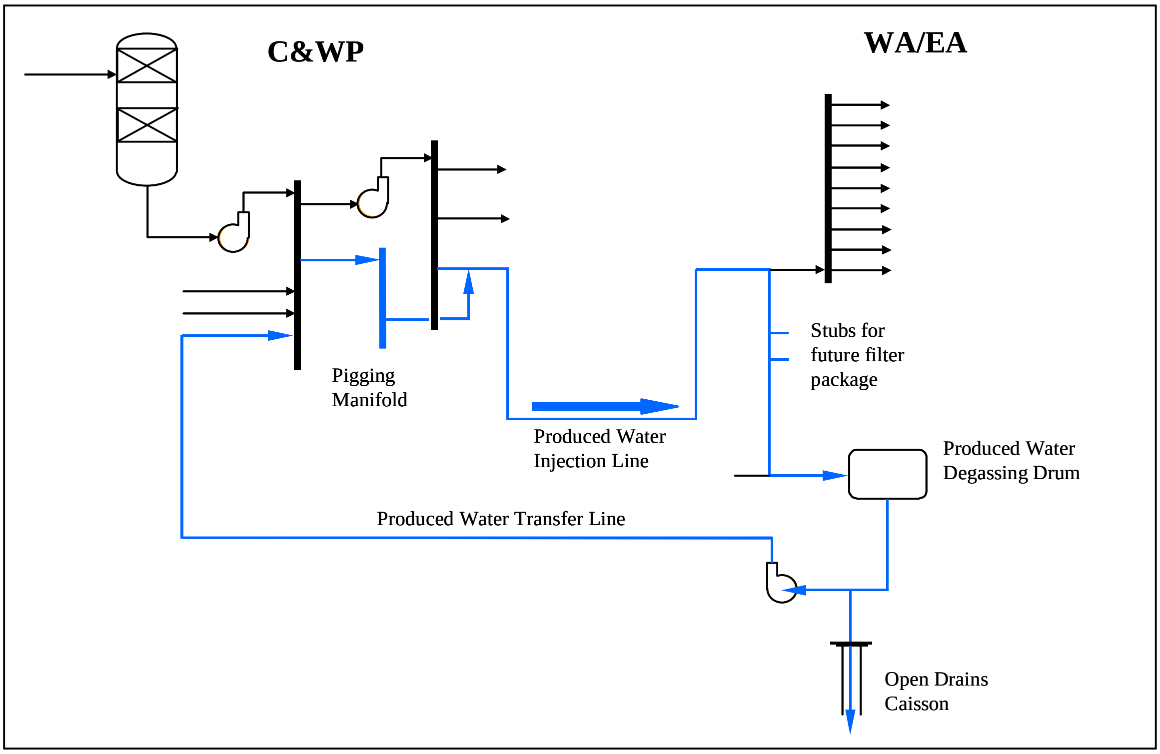


Figure 3.17: Pigging of the Reinjection Water Lines Backup Case

3.5 Sangachal Terminal

3.5.1 Process Description

Under the ACG Phase 2 Project Sangachal Terminal will be further expanded (the terminal was first developed for EOP and initially expanded for ACG Phase 1) to enable the processing of the partially stabilised crude oil (i.e. crude oil containing residual levels of produced water and associated gas) received via 30" pipelines from the offshore East and West Azeri platforms. At the terminal further dehydration and stabilisation will be carried out to meet the crude oil export specification; the oil will then be pumped to the Mediterranean tanker terminal at Ceyhan via the BTC export pipeline. Gas will be conditioned and supplied to SOCAR via pipeline

The terminal expansion will involve the installation of two new trains of crude oil and water separation and stabilisation plant, together with associated power and utilities systems. The two new trains will each have a nominal crude oil processing capacity of 175 mstdbpd, and will be designed to operate in parallel with the existing Phase 1 and EOP facilities.

In order to carry out the necessary crude oil separation and stabilisation operations the Phase 2 terminal expansion will involve the installation of the following principal process plant items;

- oil reception facilities;
- two separation and stabilisation trains, each comprising;
    - -Fuel-gas fired process heater
    - -MP separator
    - -LP separator
    - -Electrostatic coalescer
- two trains of flash gas compression;
- oil export booster pumps and oil export shipping pumps[9];
- off-spec crude oil tank; and
- produced water injection booster pumps and produced water injection pumps.

These items are shown on the terminal layout diagram presented in **Figure 3.18**.

[9] The oil export shipping pumps fall within the supply of the BTC project, not ACG Phase 2.

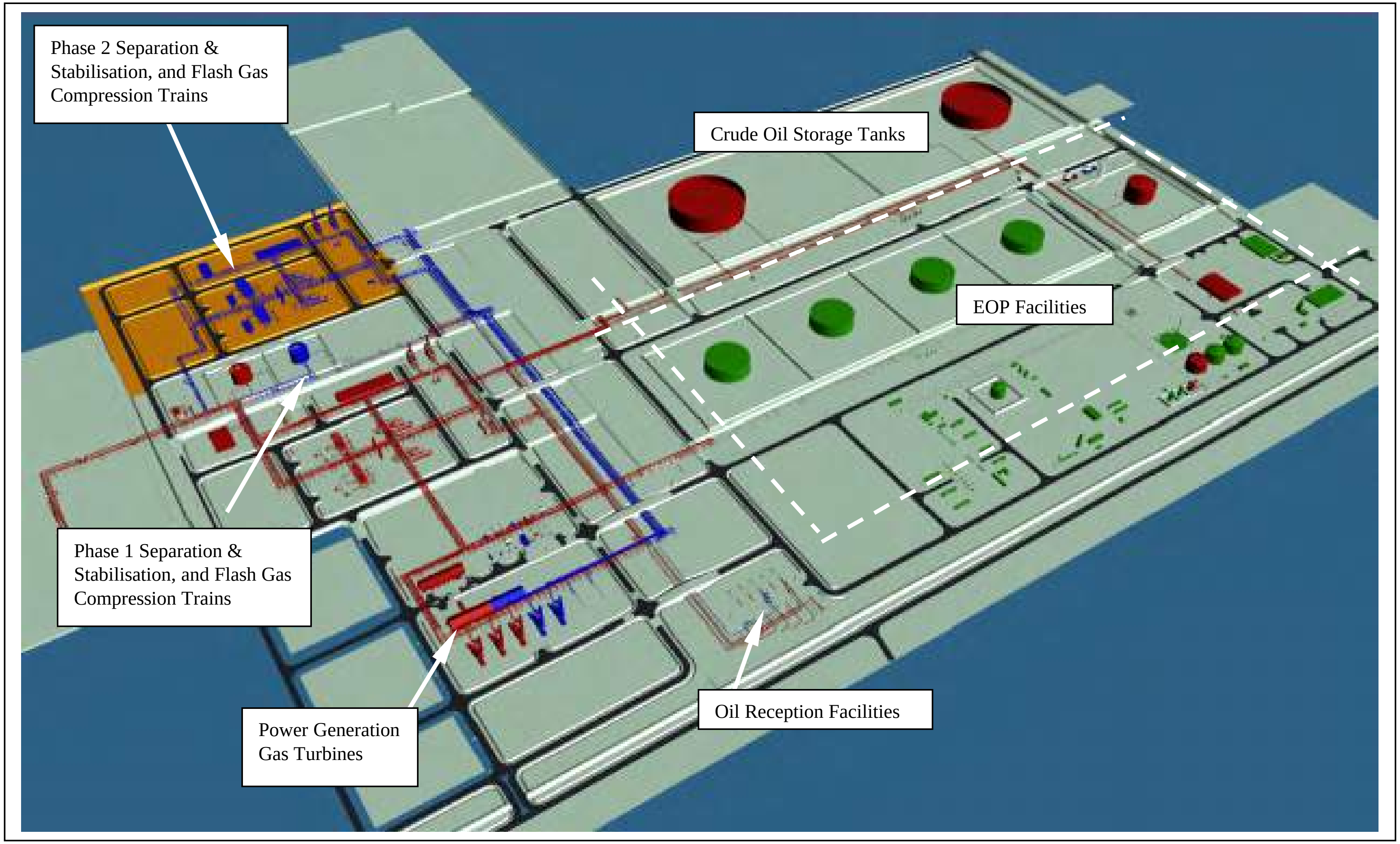


Figure 3.18: Sangachal Terminal Layout

The processing activities carried out at the terminal are described in the sections below. Simplified process diagrams are provided thereafter.

Oil

Partially stabilised crude oil enters Sangachal Terminal via new oil reception facilities. It is then piped to the process area where it enters the two separation and stabilisation trains. On entering the trains the oil is heated to a temperature of 75°C within crude oil heaters (one per train). Each heater is rated at 43 MW thermal output and is fired on sweet fuel gas. The heaters are fitted with Low NOx burners.

Following the process heating the oil is passed through two separation vessels, an MP separator and an LP separator, where gas is separated from the crude oil/water mix; demulsifier and antifoam agent are injected into the MP Separators to enhance the separation process. The gas is then forwarded to the flash gas compressors system (See **Figure 3.19**) and the degassed oil/water mix passed to the electrostatic coalescer.

The electrostatic coalescer is the final separation stage. It separates the produced water from the oil (and separates any residual levels of gas) to meet the required oil specification (maximum water content of 0.3% by volume in oil product). The produced water is sent for disposal and the crude oil is cooled to 46°C by means of a fin fan Run-down Cooler, one per train, each with a rated cooling duty of 13 MW, and sent to storage within the two crude oil storage tanks. Ultimately the oil is pumped from the tanks via the oil export booster pumps, transferred to the oil export shipping pumps and delivered to the BTC export pipeline.

Phase 2 will not install new crude oil storage tanks at Sangachal. The intention is to provide suitable crude oil storage by increasing the capacity of the two Phase 1 tanks from 500,000 bbls each, the figure stated in the Phase 1 ESIA, to 800,000 bbls each.

The storage of off-spec crude oil is provided by two 30,000 bbl storage tanks, not shown in **Figure 3.19** below, a pre-existing Phase 1 tank and a new Phase 2 tank. Both tanks can receive oil from;

- the oil pipelines;
- the oil export systems downstream of the Run-down Coolers; and,
- closed drains drums.

Oil is recycled from the tanks to the processing trains upstream of the oil heaters.

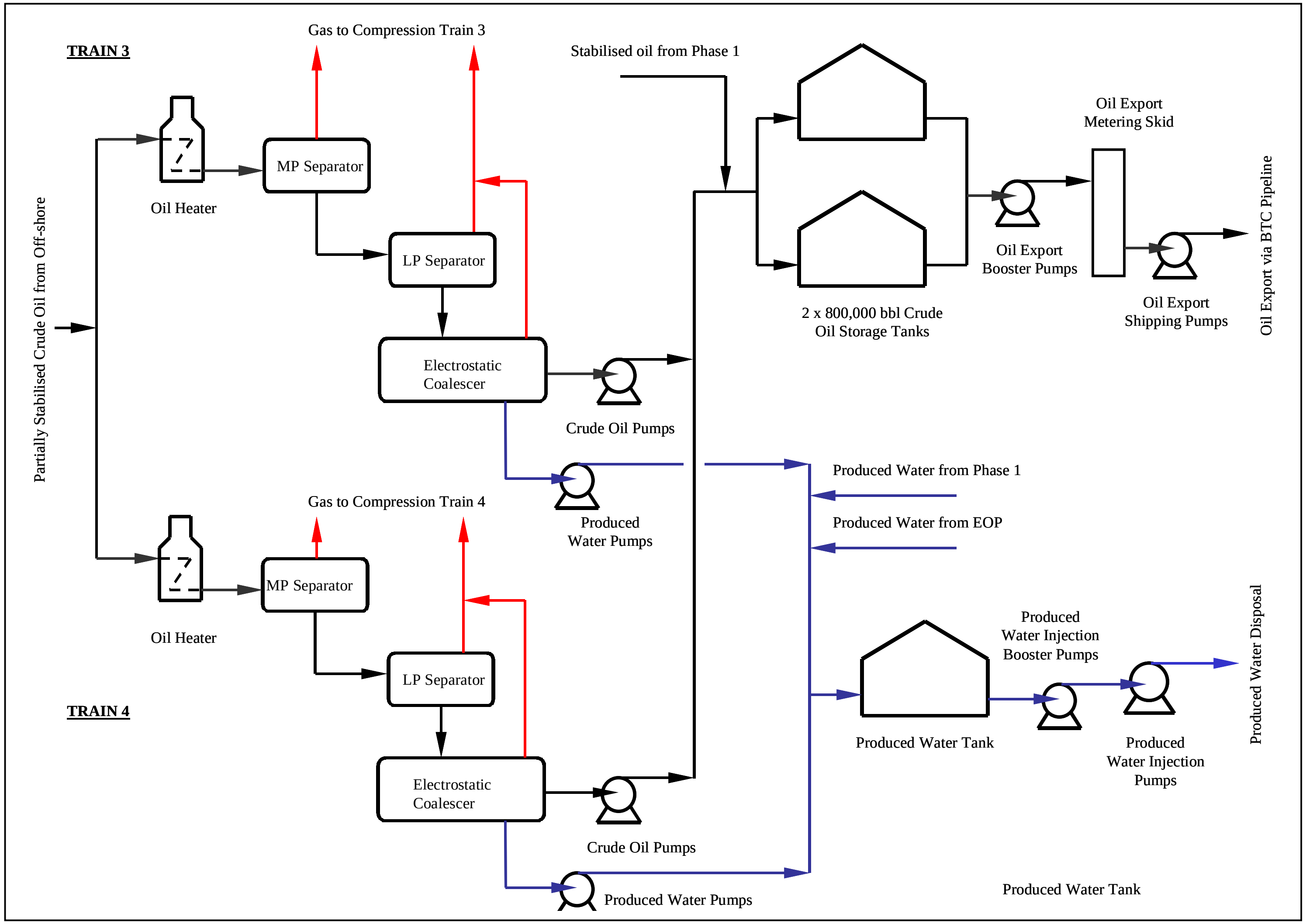


Figure 3.19: Crude Oil Processing at Sangachal Terminal

Produced Water

Produced water is recovered from the electrostatic coalescer within each of the Phase 2 process trains. The Phase 2 produced water is then combined with that from Phase 1 and EOP and sent to storage within the Produced Water Tank. Ultimately, this volume of produced water will require a suitable disposal solution, the alternatives are currently being evaluated and a subsequent option will be forthcoming. The volume of Phase 2 produced water requiring disposal throughout the project lifetime is detailed in **Table 3.13** and illustrated in **Figure 3.20**.

Table 3.13: ACG Phase 2 Produced Water for Disposal at Sangachal Terminal

Year	Produced Water Discharge		Year	Produced Water Discharge	
	(mbpd)	(mb/annum)		(bpd)	(mb/annum)
2005	0	0	2015	9.2	3,358
2006	0	0	2016	8.9	3,249
2007	0	0	2017	7.4	2,683
2008	12.0	4,380	2018	5.5	1,989
2009	22.2	8,085	2019	4.6	1,661
2010	20.6	7,501	2020	4.9	1,770
2011	20.2	7,373	2021	4.9	1,789
2012	20.1	7,337	2022	3.5	1,278
2013	18.5	6,734	2023	1.4	493
2014	12.1	4,398	2024	0.7	237

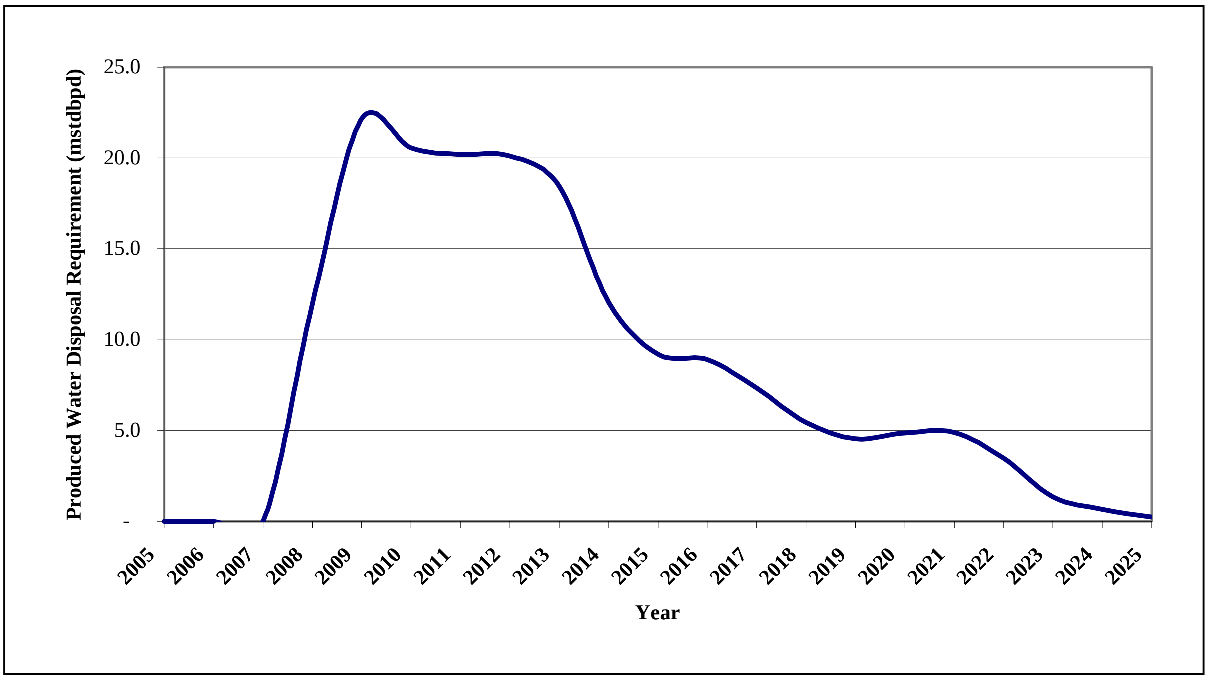


Figure 3.20: ACG Phase 2 Produced Water for Disposal at Sangachal Terminal

The Produced Water Tank will be installed by Phase 1, primarily for its own project needs: the tank will be designed to provide five days' water storage during temporary outage of the produced water disposal system. An equivalent storage tank may or may not be required by Phase 2, depending upon the performance of the offshore separation process, but would not in any case be installed at the start up stage: the ramp-up of Phase 2 production will provide sufficient time for the need for a Phase 2 tank to be evaluated. Nevertheless, Phase 2 will install pumps designed to accommodate produced water flow rates consistent with maximum oil production rates and a water cut of 5%.

Gas

Within each process train flash gas from the MP and LP production separators is processed by a three-stage electric motor driven flash gas compressor train. At each compression stage the gas is cooled, by means of fin fan coolers, and compressed to effect condensation of water and hydrocarbon liquids. These liquids are removed in a series of scrubber vessels in which they collect, and are recycled to the process via the closed drains drum, LP separator or MP separator, depending upon pressure.

After compression the gas from the Phase 2 trains is combined, and then co-mingled with the gas from ACG Phase 1 and gas received via the 28" subsea pipeline from Central Azeri DQ. The combined gas stream is forwarded to a pre-existing Dewpointing package and then delivered to SOCAR via pipeline. A proportion of the gas is bled from the SOCAR export pipeline and used as fuel gas throughout the terminal.

The Gas Dewpointing Package will be installed by Phase 1, and is designed to condition the gas to the following delivery specification;

- hydrocarbon dewpoint: -10° C +/- 5° C at any pressure at or below 40 barg; and,
- maximum water content: 4 lb/mmscf.

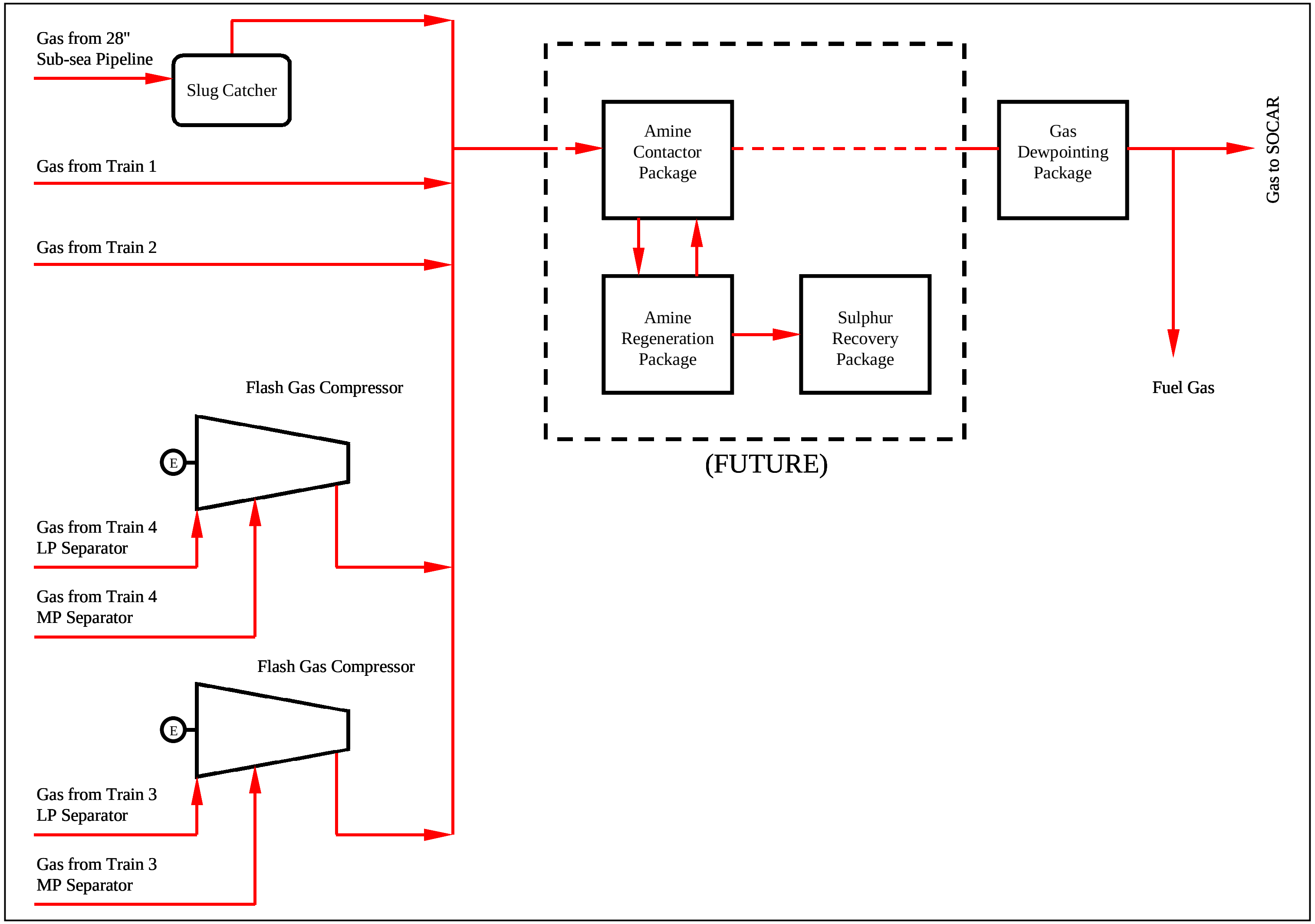


Figure 3.21: Gas Processing at Sangachal Terminal

The package comprises a mechanical refrigeration process with a glycol dehydration unit (this unit is similar in design to those previously described for the PDUQs and C&WP). Recovered C_{4+} liquids are stabilised and blended with the crude product from the oil trains upstream of the crude storage tanks. Off gas from the glycol regenerator (approximately 0.5 mmscfd) is routed to the LP flare system (see Utilities).

Depending upon the concentration of H_2S within the gas it may be necessary to install gas sweetening upstream of the Dewpointing Package: the feed gas to the package is limited to a maximum H_2S content of 4 ppmv. However, information on the sourness of the gas has yet to be confirmed and the gas sweetening plant (comprising an Amine Contactor, Amine Regenerator and Sulphur Recovery Package) is therefore indicated as 'Future' in **Figure 3.21**.

3.5.2 Utility Systems

Sangachal Terminal has installed a range of utility systems, which support the above processing activities. These include;

- fuel gas system;
- diesel fuel system;
- power generation
- flare systems
- contaminated open drains systems;
- sewage treatment system;
- sand separation package;
- chemical injection; and,
- tankage.

Fuel Gas System

Phase 2 will extend the pre-existing Phase 1 fuel gas system by installing a new Fuel Gas Package. Gas will be taken from the gas export line, downstream of the Hydrocarbon Dewpointing Unit, passed through a knock-out drum to remove any entrained liquids, heated via electric element heaters, filtered, and then distributed.

Phase 1 and Phase 2 have a common fuel gas distribution system. The system users are summarised in the **Table 3.14**.

Table 3.14: Sangachal Fuel Gas Users

Phase 1	Phase 2
• Phase 1 Off-spec Crude Oil Tank • Blanket gas • Phase 1 Crude Oil Heaters • Gas Dewpointing Package • Flare pilot, ignition & header • Produced water system • Shah Deniz • Phase 1Gas Turbine Generators • EOP Fuel Gas Header	• Phase 2 Off-spec Crude Oil Tank • Blanket gas • Phase 2 Crude Oil Heaters • Phase 2 Gas Turbine Generators

Diesel Fuel System

Phase 2 will tie into the diesel system installed by Phase 1. The system comprises a diesel storage tank, a diesel treatment package (which removes water and solid particles), a diesel transfer pump, and supply pipework. The diesel is supplied to the following users;

- Phase 1 dual-fuel gas turbine generators (the system has been sized to enable diesel-firing of one of gas turbine generators for a period of 48 hours);
- Phase 1 stand-by generator;
- Phase 2 emergency generator;
- Phase 1 oil pig receiver;
- Shah Deniz facilities; and,
- EOP facilities.

Power Generation

Phase 2's onshore electrical power requirements, including the power requirements of the new BTC oil export shipping pumps, will be met by two Rolls Royce RB211 gas turbine generators, each of which is rated at 28.8 MW under ISO conditions. The turbines are fuel gas-fired and are fitted with Low NOx burners.

The two Phase 2 generators will operate in an *N+1* configuration with the three existing Phase 1 generators: the spare main power generator installed during Phase 1 will be used as a common spare between the two phases.

Emergency power for Phase 2 will be supplied from the 1.8 MW emergency diesel generator installed during Phase 1.

Flare Systems

Phase 2 will tie into the two flare systems installed at Sangachal Terminal by Phase 1, namely;

- Low Pressure (LP) flare system; and,
- High Pressure (HP) flare system.

The flares systems have been designed for Full Field Development and will not require further expansion on the part of Phase 2. The LP system is rated at 70 mmscfd, and the HP system at 100 mmscfd.

LP Flare System

The LP Flare System comprises a flare header, an LP flare drum, an LP flare gas recovery package, and a flare tip complete with fuel gas-fired pilot lights. The system is illustrated in **Figure 3.22**.

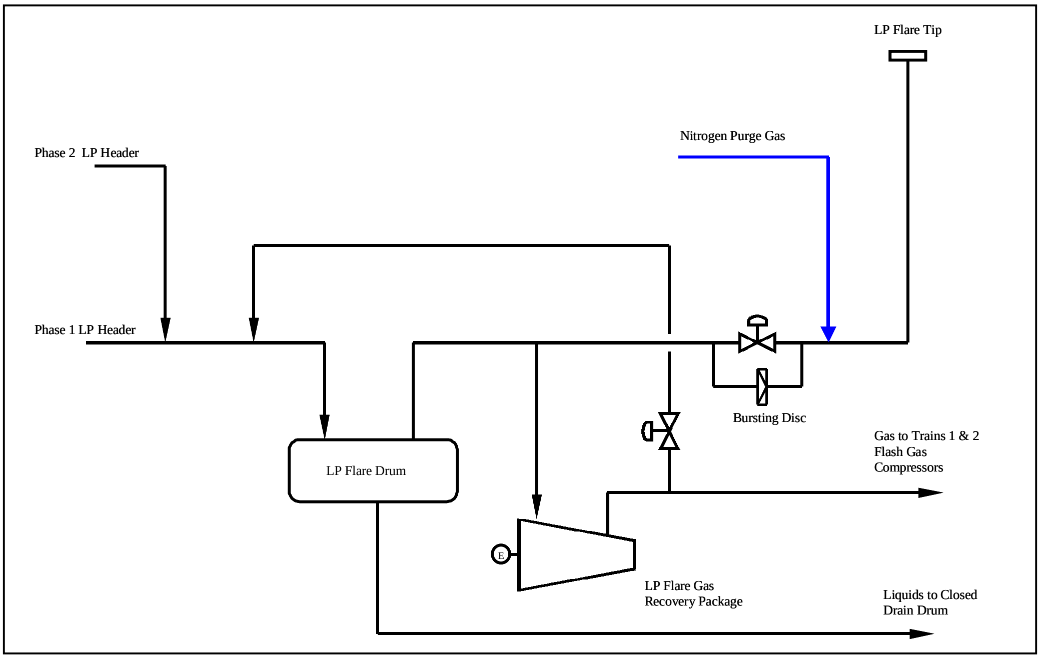


Figure 3.22: LP Flare Gas Recovery

The flare system collects gaseous releases from the sources listed below and conveys them, via the header system, to the LP Flare Drum;

- Phase 1/2 Fuel gas system;
- Phase 1 & Phase 2 Flash Gas Compression trains;
- Phase 1 & Phase 2 Off-spec Crude Oil Tanks;
- Phase 1 & Phase 2 Sand Separation Packages;
- Phase 1 & Phase 2 LP & MP Separators; and,
- Phase 1 & Phase 2 Closed Drains Drums.

The LP Flare Gas Recovery Package (comprising an electric motor driven compressor) is situated downstream of the flare drum. It recovers up to 1 mmscfd of gas from the flare header, typically arising from gas purge and small leakages from around valves, etc, and recycles it to Phase 1's Flash Gas Compressor Trains 1 and 2.

Any gas flows above the maximum 1 mmscfd recovery rate pass through a valve arrangement to the LP flare tip where they are combusted, and the products of combustion discharged to atmosphere. There is a bursting disc fitted in parallel with the valve to protect the system against over-pressure.

In order to prevent ingress of air into the LP system downstream of the recovery package the system is continuously purged with nitrogen.

HP Flare System

The HP flare system collects gaseous releases from the sources listed below and conveys them via a header system to the HP Flare Drum;

- Fuel gas system;
- Flash Gas Compression trains; and,
- Gas Turbine Generators.

HP flare system is designed to enable flare gas recovery. Under normal operation small volumes of gas pass from the flare drum to the Phase 1 Flash Gas Compressor Trains 1 and 2, as per the LP system. Under conditions of high gas flow the valve downstream of the flare drum opens (**Figure 3.23**) so allowing the gas to pass to the HP flare tip where it is combusted and the products of combustion discharged to atmosphere.

In order to prevent ingress of air into the HP system downstream of the valve arrangement the system is continuously purged with nitrogen.

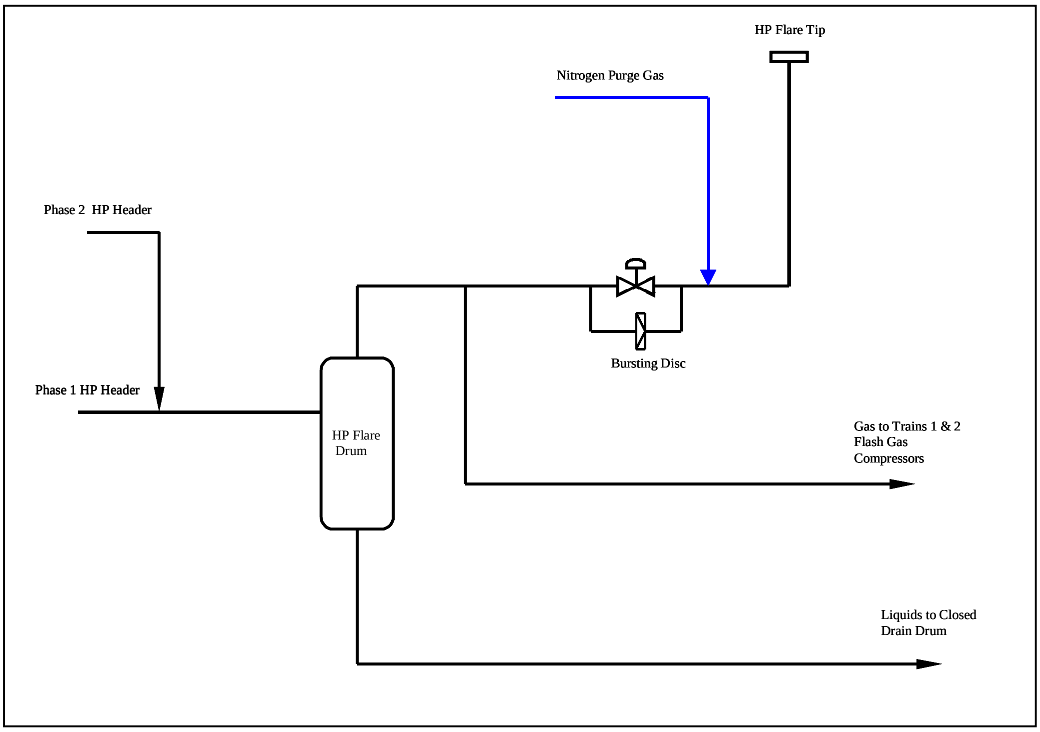


Figure 3.23: HP Flare Gas Recovery

Contaminated Open Drains Systems

The Contaminated Open Drains System receives and disposes of open drainage water from all paved areas of the Phase 2 facility[10], including;

- process area;
- Off-spec Oil Tank area; and,
- Produced Water Tank area.

The system is illustrated in **Figure 3.24.**

[10] Collection and disposal of the open drainage from the Phase 2 utility area, crude oil booster pumps and produced water booster and injection pumps, and the Phase 2 pig receiving area has already been included in the scope of work for the Phase 1 project.

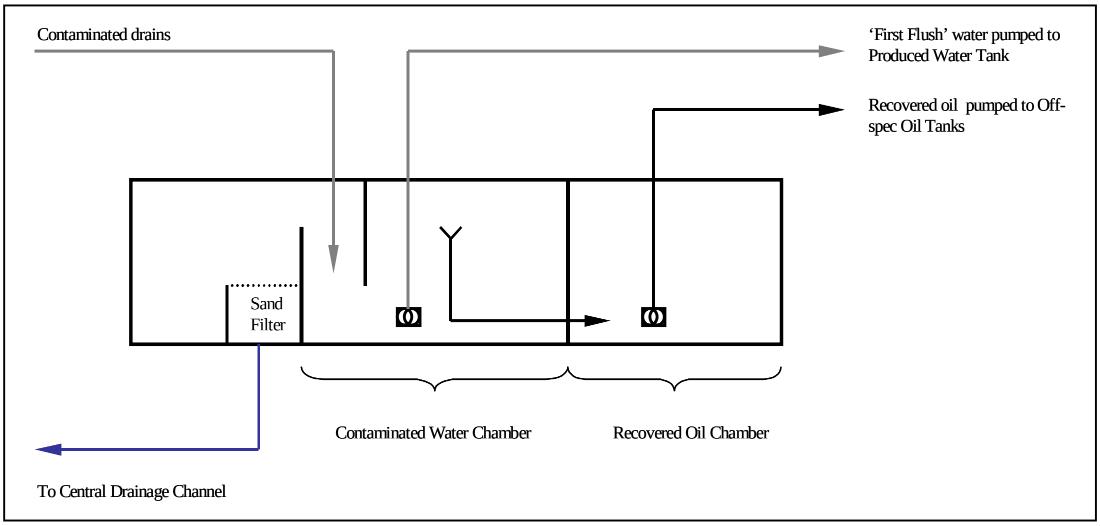


Figure 3.24: Contaminated Open Drains System

Contaminated open drainage from the above areas is routed to the Oily Water Sump (shown above). The sump is sized to contain the first 10 minutes' of rainwater falling onto all paved areas at a design rate of 25 mm/hr. This 'first flush' water is considered to be contaminated. As it arrives in the sump it passes under a weir into the contaminated water chamber. It is then disposed of by pumping to the produced water collection manifold, and ultimately to the Produced Water Tank.

The contaminated water chamber is installed with a floating skimming device, which skims off oil from the surface of the contaminated water and routes it to the recovered oil chamber. From this chamber the oil is pumped to either the Phase 1 or Phase 2 Off-spec Oil Tanks.

Water arriving at the sump after the 'first flush' is considered to be clean non-contaminated water and flows over a weir, through 2 x 100% Oily Water Sump Sand Filters and into the Non-contaminated Open Drains. With high flow due to heavy rain or firewater the flow will be routed to the Non-contaminated Open Drains are routed to the central drainage channel from where the water is disposed of to land. The sand filters are designed to reduce the oil-in-water content of the non-contaminated drainage water to less than 10 mg/l as a monthly average and less than 19 mg/l on a daily basis.

Drains Philosophy

Flows into the Contaminated Open Drains System will be subject to the following management philosophy to minimise the impact of spilled oil;

- process equipment bunded areas will be permanently open to the contaminated open drains system to prevent pool fire escalation;
- utility equipment bunded areas will be permanently open to the Contaminated Open Drains System;
- bunded areas containing chemicals will be isolated from the Contaminated Open Drains System by a normally-closed valve in the drain line. Large spills will be pumped out to portable storage containers for treatment and disposal. Other spills will be mopped up and any residual material will be flushed into the Contaminated Open Drains System. Rain water collecting in the bund will be sampled prior to its release into the Contaminated Open Drains System; and,
- storage tank bunds will be isolated from both the Non-contaminated Drains and the Contaminated Drains by normally closed valves located outside of the bund

area. Rainwater will be sampled before its release: if clean it will be directed to the Non-contaminated Drains, and if dirty the Contaminated Drains.

Sewage Treatment

Sewage from the Phase 2 Local Equipment Room will be routed to a dedicated septic tank. The contents of the tank will be disposed of periodically by a road tanker, which will transport the sewage to the main sewage treatment facility installed by Phase 1.

Phase 1 will install a wastewater treatment package of sufficient capacity to treat the wastewaters arising from the construction camp and the terminal at maximum full field development manning levels. It has been estimated that at its fullest development the construction camp will accommodate 1,000 people, and the terminal at FFD manning levels will house 100. The treatment package has thus been designed to treat up to 210 m^3/day of wastewater.

The treatment package comprises two parallel trains of stabilisation ponds. Within each train there are three open ponds constructed in series. Macerated effluent is discharged into the initial pond and over weirs into the second and then third ponds before draining into a collection sump. The treated effluent is then pumped from the sump and used for irrigation of trees and shrubs around the terminal site and construction camp, and for dust suppression.

Over a period of time sludge will collect in the stabilisation ponds. Once a pond becomes significantly burdened with sludge it will be back-filled and replaced.

When the construction camp is removed it will no longer be feasible to operate the treatment package due to the greatly reduced wastewater flow rates. Therefore at this time the package will be decommissioned and replaced with a smaller package unit.

Sand Separation Package

The sand separation package is required to;

- de-sand the two MP Production Separators and the Closed Drains Drum whilst the vessels are online; and,
- remove oil from the recovered sand such that cleaned sand can be disposed of to an approved landfill.

The estimated sand accumulation rate for ACG Phase 2 is 0.015 te/day.

The sand is recovered from the process vessels in the form of a slurry, and is passed through a desanding hydrocyclone where it is washed. The sand is then removed from the hydrocyclone and sent to a bag filter where excess water is drained. The drained sand is sent for disposal. See **Chapter 12**.

Produced water, taken from the Produced Water Storage Tank, is used for both the sand removal 'jetting', and sand washing operations. After use the water is returned to the storage tank without any further treatment. Hydrocarbon gases releases during the sand separation process are routed to the LP flare system.

Chemical Injection

The separation and stabilisation process carried out at Sangachal requires the use of certain chemicals:

Methanol	It may be necessary to inject methanol into the flash gas compressor trains to prevent hydrate formation under certain shutdown/blow-down scenarios. This will be confirmed at a later date following a detailed design study.
Antifoam	An antifoam agent will be injected upstream of the MP

	Separators to prevent foaming during the separation process.
Demulsifier	Demulsifier will also be injected upstream of the MP Separators to achieve reasonable oil/water separation at the anticipated operating temperatures.
Corrosion Inhibitor	The injection of corrosion inhibitor at Sangachal Terminal may not be necessary as the bulk of this material is injected offshore. However, the capability for onshore corrosion inhibition will be retained.
Reverse Demulsifier	[FUTURE]
Wax Inhibitor	If necessary, wax inhibitor will be injected into the crude oil line to prevent build-up of wax within the process trains.
Scale Inhibitor	Scale inhibitor will be required later in field life when produced water breaks through.

These chemicals are stored within the Phase 2 Utilities Area. The volumes of each chemical type stored are summarised in **Table 3.15**.

Table 3.15: Sangachal Terminal Chemical Storage and Usage

Chemical	Volumes Stored (m^3)[1]
Methanol	N/A
Antifoam	2.3
Demulsifier	9.0
Corrosion Inhibitor	1.5
Reverse Demulsifier	[FUTURE]
Wax Inhibitor	30.0[2]
Scale Inhibitor	1.0

Notes 1. Based upon 7 days' supply.

2. Based upon 2 days' supply.

Tankage

The hydrocarbon and Produced Water storage capabilities at Sangachal Terminal are summarised in **Table 3.16**. As stated earlier the Crude Oil tanks are a shared Phase 1/Phase 2 resource.

Table 3.16: Hydrocarbon and Produced Water Storage at Sangachal Terminal

Ref No	Material Stored	Working Capacity	Tank Design	Installation by Phase
T-01	Crude Oil	125,000 m^3	• Floating roof tank	1
T-02	Crude Oil	125,000 m^3		1
T-03	Off-spec Crude Oil	4,770 m^3	• Conical fixed-roof tank. • Tank blanketed with N_2 and vented to the flare system	1
T-04	Off-spec Crude Oil	4,770 m^3		2
T-05	Produced Water	21,000 m^3	• Conical fixed-roof tank. • Tank blanketed with N_2 and vented to the flare system	1
T-06	Diesel Storage Tank	400 m^3	• Conical fixed-roof tank. • Tank blanketed with N_2 and vented to the flare system	1

All of the above tanks are bunded to protect against the release of any spills. The bunds are sized on 110% of each tank's working capacity. Any rainwater collecting within the bunds is periodically drained to the Contaminated Open Drains.

3.6 (PART B) PROJECT IMPLEMENTATION

This section of the Project Description outlines those actions necessary to implement the Phase 2 project, namely construction & installation activities, and pre-drilling. The implementation of Phase 2 will be very similar to that of Phase 1, which has already been described, at some length, within Section 5 of the document '*Environmental & Socio-economic Impact Assessment, Azeri, Chirag & Gunashli Full Field Development Phase 1*', URS, February 2002. For this reason the following section is abbreviated. For further information the reader is directed to the Phase 1 ESIA.

3.7 Project Schedule

The schedule for the main stages of the Phase 2 development are shown in

Figure 3.25. The dates provided are based on the project schedule at the time of writing. They are, potentially, subject to change.

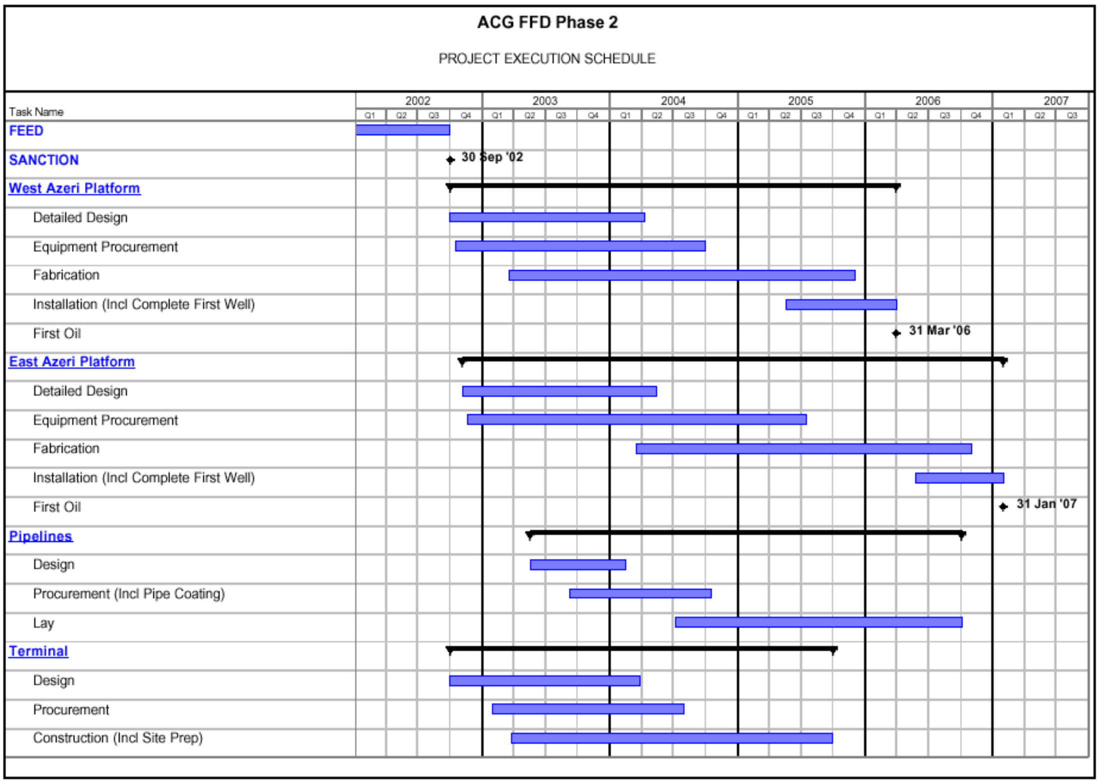


Figure 3.25: ACG Phase 2 Project Schedule

3.8 Construction, Installation and Pre-drilling Activities

3.8.1 Scope

The construction, installation and pre-drilling activities associated with the development of the Phase 2 project are described in brief below. The key similarities and differences between Phase 1 and Phase 2 are summarised in **Table 3.17.**

3.8.2 Rig-based Pre-drilling

Drilling Template

The initial stage of the Phase 2 development will entail the drilling of 6 'template wells' at East Azeri and 10 at West Azeri from the *Dada Gorgud* semi-submersible drilling rig. In order to carry this out the templates themselves must firstly be constructed and secured to the seabed at the platform locations.

Figure 3.26: Phase 1 Template Installation

Two 12 slot (4 x 3) templates will be constructed within an Azeri fabrication yard[11]. They will then be transported to the platform locations by a transportation barge, and lifted and lowered to the seabed by a crane barge (**Figure 3.26**). The templates will then be secured to the sea floor by means of piles.

[11] At the time of writing a decision has yet to be made regarding, which fabrication yard(s) will carry out Phase 2 construction activities. There are a number of options within the Baku area. These include the Zykh, Fels and Amec Azfen yard (near Fels). Once selected the yards will need upgrading to meet AIOC requirements. The details of these upgrades will be the subject of future studies.

Table 3.17: Comparison of Phase 1/Phase 2 Construction Activities

Area	Construction Activities	
	ACG Phase 1	**ACG Phase 2**
Drilling	• Construction & installation of a subsea 12 slot drilling template at Central Azeri. • Pre-drilling of 9 wells at Central Azeri via the *Dada Gorgud*.	• Construction & installation of two 12 slot subsea drilling templates, one at East Azeri and one at West Azeri. • Pre-drilling of 6 wells at East Azeri and 10 wells at West Azeri, in both cases via the *Dada Gorgud*.
Offshore Platforms	• Construction & installation of 2 offshore platforms: • Central Azeri PDUQ • C&WP	• Construction & installation of 2 offshore platforms: • East Azeri PDUQ • West Azeri PDUQ
Pipelines	• Installation of 30" Oil Export Pipeline from Central Azeri to Sangachal Terminal. • Installation of 28" Gas Pipeline from Central Azeri to Sangachal Terminal.	• Installation of second 30" Oil Export Pipeline from Central Azeri to Sangachal Terminal. • Tie in of East Azeri and West Azeri to Oil Export Pipelines. • Installation of in-field Gas, Lift-gas, Produced Water and Reinjection Water pipelines between East/West Azeri and C&WP.
Sangachal Terminal	• Construction of 2 x trains of crude oil separation & stabilisation trains, and 2 x trains of flash gas compression. • Construction of terminal utility systems. • Construction of Gas Dewpointing package. • Construction of Gas Sweetening package (if necessary). • Construction of 2 x 800,000 bbl crude oil storage tanks. • Construction of Workforce Construction Camp. • Construction of Sewage Treatment Plant for Construction Camp. • Construction of Produced Water Treatment/Disposal system.	• Construction of 2 x trains of crude oil separation & stabilisation trains, and 2 x trains of flash gas compression. • Construction/expansion of terminal utility systems.
Other Activities		• Construction of new 18,000 te transport barge.

Pre-drilling

Pre-drilling will be carried out from the *Dada Gorgud* (**Figure 3.27**) that will be towed to the platform/drilling locations by two anchor handling tugs. A third vessel will accompany the tow and assist with the positioning of the rig and its anchors.

Figure 3.27: The Dada Gorgud Semi-submersible Drilling Rig

On arrival at each drilling location the rig will be positioned above the template using its anchor system, an activity that takes typically four days to complete. The rig will then be ready to commence drilling.

The Phase 2 drilling operations will be based on Phase 1's. Full details, including information on mud types and compositions, rig utilities, waste generation and management, drilling hazards, drill stem testing, and well suspension and rig removal, can be found in Section 5.2 of the Phase 1 ESIA.

3.8.3 Platform Construction & Installation

Jackets

Steel components for the PDUQ jacket structures will be pre-fabricated by suppliers in Europe or the Far East. They will then be transported to Azerbaijan for assembly, painting and commissioning. **Figure 3.28** shows the various stages of jacket fabrication.

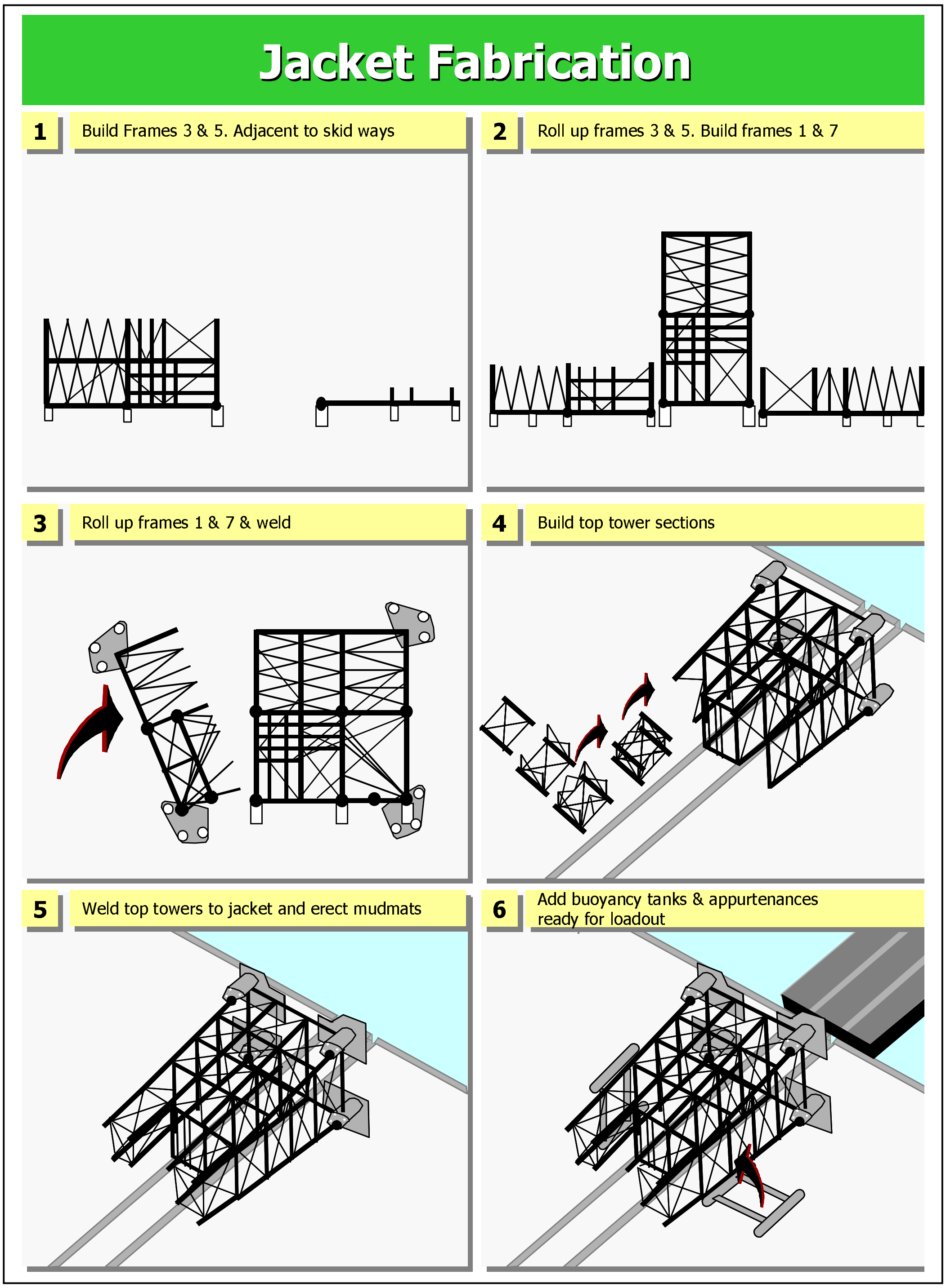


Figure 3.28: Various Stages of Jacket Fabrication

Once completed and certified, the jackets will be skidded onto an STB1 barge and sea-fastened. The barge will be towed to each platform location by three tugboats. On location one end of the barge will be flooded and submerged to slide the jacket into the water. Floatation chambers will right the jacket above the seabed, and allow accurate positioning over the template (**Figure 3.29**). A crane barge will drive 12 piles through the jacket pile sleeve clusters to secure the East Azeri jacket to the seabed. Soil conditions dictate that there will be 16 piles for West Azeri. A pipe-lay vessel will complete the subsea tie ins between the jackets' risers and the in-field and export pipelines (see **Figure 3.29** below).

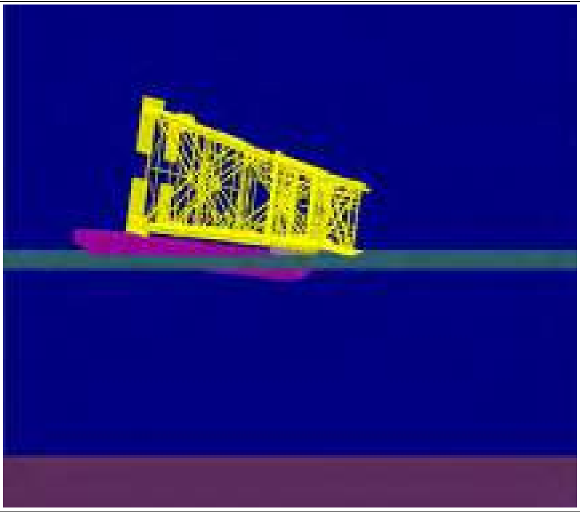
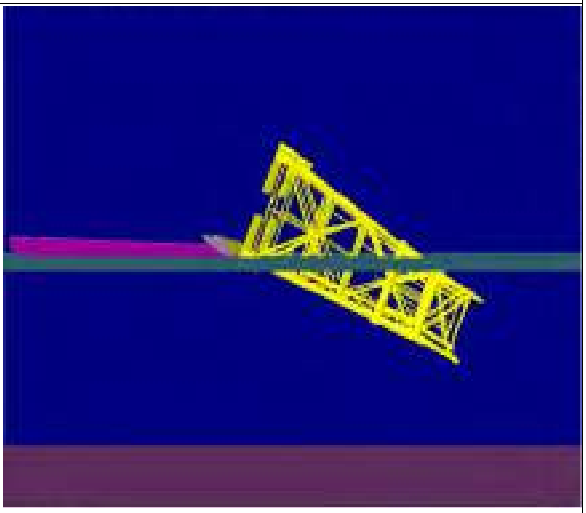
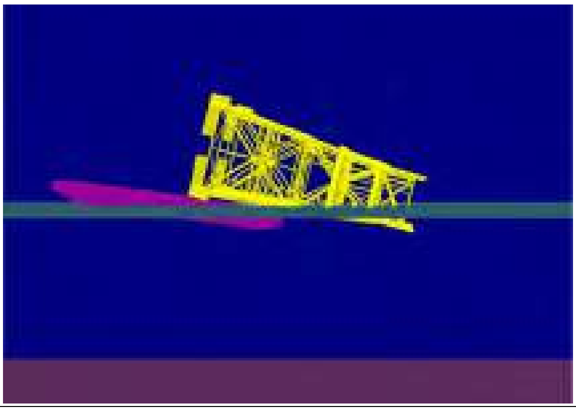
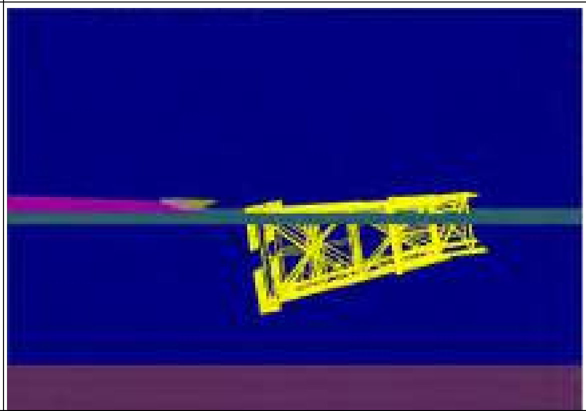
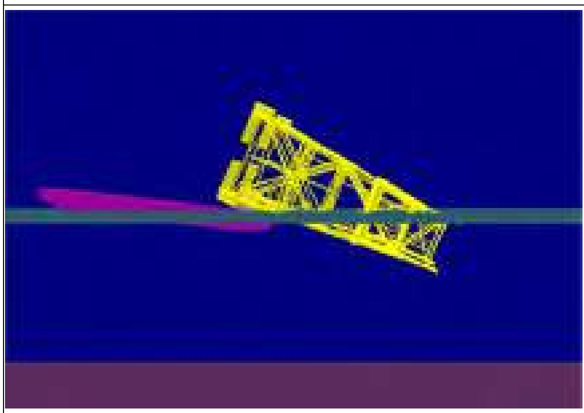
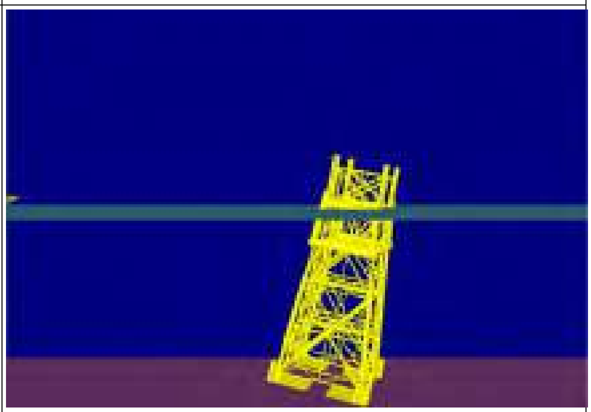
Stage 1	**Stage 4**
	
Stage 2	**Stage 5**
	
Stage 3	**Stage 6**
	

Figure 3.29: Jacket Installation

Topsides

The PDUQ topsides comprise a sequence of decks (Weather Deck, Mezzanine Deck, Cellar Deck, and Underdeck), which support the following modules;

- Accommodation Module;
- Power Generation Pallet;
- Drilling Support Module;
- Drilling Equipment Set;
- Separation Module;
- Compressor/Pig Launcher Pallet;
- Manifold;
- Flare Boom;
- MOL Pump Module;
- Wellbay Module;
- LER Module;
- Switchroom Module; and,
- Utilities Module.

The deck(s) will be fabricated in an Azeri yard. The topsides modules will be constructed and tested out of country and will then be delivered to Azerbaijan where they installed on the deck and hooked up to power and piping. Onshore, process equipment will be tested further, and tanks and lines hydro-tested and commissioned. **Figure 3.30** shows the various stages of deck fabrication.

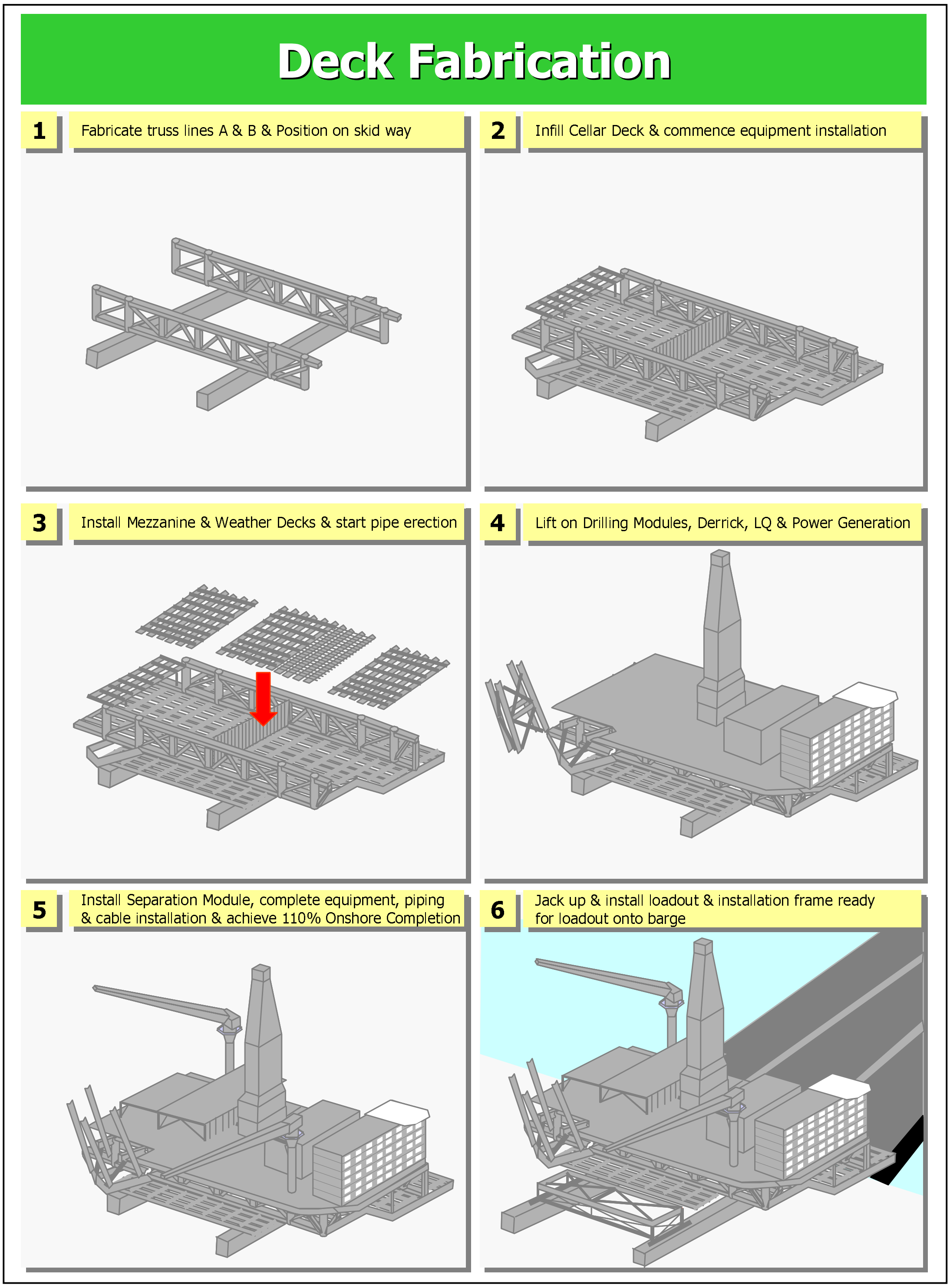


Figure 3.30: Various Stages of Deck Fabrication

Both of the PDUQs are based on a 'float-over' concept. Three tugboats will tow the commissioned topsides to the jacket locations on a transport barge. The floating barge will be manoeuvred between the jacket legs, so that the topsides are correctly positioned above the jacket. The barge will be ballasted to lower the topsides onto the jacket. With the topsides mated to the jacket, the barge will be further ballasted and towed out from the platform.

Transport Barge

An option that is under consideration for the Phase 2 Project is the construction of new transport barge with 18,000 te carrying capacity (the maximum carrying capacity of the existing installation barge is 14,000 te). The new barge confers a number of advantages;

- it minimises the time required for the offshore installation and commissioning of the platforms. Topsides can be transported offshore with the maximum amount of equipment installed and with liquid inventories in place; and,
- the new barge would be used to transport topsides whilst the existing STB1 barge would be used for jacket transport. Thus it would alleviate the possibility of delays resulting from conversion of the STB1 from topsides to jacket transport and back again.

The new transport barge is planned to have a length of 150 m, a breadth of 45 m and a side depth of 13 m, giving a draught of approximately 12 m. It will have no accommodation and will be without its own propulsion, such that it will need to be moved with the aid of tugs.

It is planned that the barge will be built in three sections which if necessary could be transport down the Volga-Don canal into the Caspian. The construction tender for this work is at present in the pre-qualification stage and it is unknown whether the new barge will be built in Azerbaijan or at another location.

3.8.4 Pipeline Installation

Phase 2 pipeline installation falls into three categories;

- Landfall (or ‘Beach-pull’) of 30" Oil Export Pipeline;
- Offshore pipeline installation (30" oil line and in-field pipelines); and,
- Onshore installation of 30" Oil Export Pipeline.

These areas of activity are described below.

30" Oil Export Pipeline Landfall

The initial operation in the construction of the 30" oil line is the ‘beach-pull’, in which the pipeline is pulled, by a shore-based winch, from an offshore pipe-lay vessel through a trench excavated along the shoreline approach. The activity involves the following;

- construction of a ‘finger pier’ to enable excavation of the trench;
- nearshore trench construction;
- pipeline winching; and,
- restitution work.

A Phase 2 finger pier will be built in Sangachal Bay parallel with the pipeline route. It will allow access for the excavator and other vehicles necessary to carry out the trenching work. The pier will be installed in the nearshore by dumping aggregate in the shallow marine zone. It will be around 4 m to 5 m wide and will extend to a distance of between 250 m and 300 m offshore (i.e. to a water depth of approximately 2.5 m).

Following construction of the finger pier, a trench will be mechanically excavated up to the 2 m water depth mark. Beyond this point, up to a water depth of 5 m (approximately 650 m offshore[12]) the trench will be formed by high-pressure water

[12] The full extent of the trenching has yet to be confirmed. Caspian water level trends indicate that trenching may be required for up to 3,500 m offshore.

jetting. The resulting shoreline approach of the pipeline is illustrated in **Figure** 3.31.

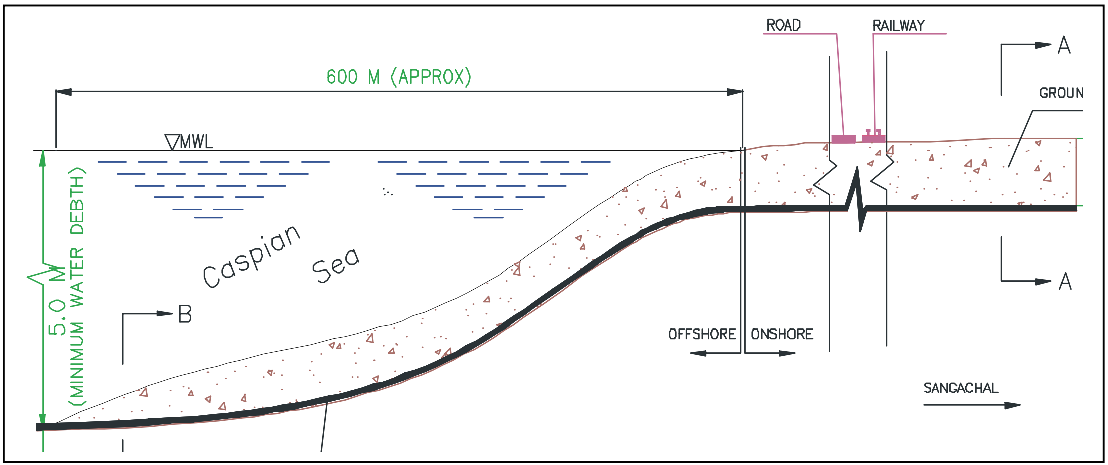


Figure 3.31: Typical Pipeline Shore Approach

The pipeline will be pulled from the pipe-lay vessel from winch emplacements built onshore. The pipeline lengths will be welded and tested on the vessel, and winched ashore along the line of the trench. Floatation pontoons will keep the pipeline afloat. The vessel will be anchored at minimum operating depth (8m water) some 3 km from the shore in Sangachal Bay.

When the pipe end has been pulled as far inshore as possible, the trench will be sealed by constructing a cofferdam at the shoreline. Offshore, the trench will be left to back-fill by natural silting. It is presently the intention to remove the finger pier after installation of the pipeline.

BP is currently assessing the opportunities for the concurrent nearshore pipe laying of the various ACG FFD and Shah Deniz pipelines as a means of minimising environmental impacts within Sangachal Bay. This issue is described in **Chapter 10**: Cumulative Impacts.

Offshore Pipe-laying

Following the initial beach-pull exercise the 30" oil line will be laid from Sangachal Bay towards Central Azeri[13]. The pipeline will be installed by the pipe-lay vessel *Israfil Guseinov* (**Figure 3.32**). The pipe-lay vessel will move along the pipeline route, maintaining tension on the pipeline and welding on additional lengths of pipe. The pipeline will be lowered to the seabed as the pipe-lay vessel pulls itself along the planned route by means of its anchors, which are periodically repositioned. The pipe-lay vessel has three anchor handling tugs to lay the anchors, and a survey vessel to inspect the route. Pipe is supplied to the pipe-lay vessel from four barges towed by tugs. Pipe-laying operations are supported by diving operations from a saturation unit on the pipe-lay vessel, and from an air diving vessel, when required.

At the jacket tie in location, a lay-down head will be attached to a recovery cable, and

[13] The pipe-laying will be a discontinuous activity if the Phase 2 beach-pull is carried out early, during the laying of the Phase 1/Shah Deniz lines. In this case a Phase 2 pipeline 'stub' (an 8 km to 10 km length) will be left on the seabed until such time as the Phase 1/Shah Deniz pipe laying is complete. The pipe-lay vessel would then recover the Phase 2 line from the seabed and continue laying towards Central Azeri, as described.

the pipeline will be lowered to the seabed. The cable will be marked by a buoy. The pipeline will be hydro-tested and left flooded with water (treated with additives to protect from internal corrosion) until the jacket is installed and tie in and commissioning can commence.

In field pipelines will also be installed by the *Israfil Guseinov*. Pipe-laying techniques will be similar to the above.

Figure 3.32: The Pipelay Vessel, *Israfil Guseinov*

Onshore Pipe-laying

Onshore, the 30" oil line will be trenched and buried to a minimum depth of 1 m below grade over its entire route from the beach to Sangachal Terminal. The pipeline will pass under the Baku to Alyat highway and the railway line, and will cross various existing utility lines.

3.8.5 Tie in and Commissioning

Hook-up activities will be carried out on each platform once the topsides have been installed on the respective jackets. The offshore pipelines will be tied-in to the pre-installed risers on the jacket structure, and the jacket riser to the topsides riser/well heads.

Once the pipelines are connected the entire system will be hydrotested. Following the hydrotesting the lines will be pigged to expel the water. The disposal routes for hydrotest waters are currently the subject of a Best Practicable Environmental Option (BPEO) assessment. The disposal of hydrotest water from in-field pipelines is also subject to a similar BPEO assessment.

3.8.6 Phase 2 Construction Activities at Sangachal Terminal

All Phase 2 civil activities at Sangachal Terminal will be carried out within the existing terminal boundaries: the development of Phase 2 will not result in an increased land-take. Furthermore, the early civil works for the Phase 2 project will be completed as part of Phase 1. The Phase 1 activities have already been described in two earlier ESIAs that have been approved by the MENR.

Phase 2 construction will involve foundation work (for process plant and utilities, etc), the installation of the necessary process plant and utility items, and the routing of the oil pipeline through the terminal. The installation of the Phase 2 equipment is planned in such a way that it will not cause any disruption to the Phase 1 production.

Phase 2 Commissioning activities will result in the generation of approximately 800,000 bbls of hydrotest water at the terminal. The disposal route for this effluent is currently the subject of a BPEO assessment.

3.8.7 Logistics

During the construction period, steel components of the jackets, platform modules and pipe sections for the pipelines may be ordered on the world market and require transport to Azerbaijan. During the drilling programme, tubulars, drilling fluid chemicals and ancillary drilling material will be imported to Azerbaijan.

Shipping goods to the Caspian requires transhipment to CIS flagged carriers for navigation of CIS waterways, typically at Rostov for cargoes coming via the Mediterranean and Black Sea route. Transit of the Don-Volga canal system usually takes 9 to 11 days. Cargoes following the Baltic Sea route would be transhipped at St. Petersburg and transit the Baltic-Volga system in 13 to 15 days. These routes are not available during the ice season (November-April).

Viable rail links are available from Poti, Georgia (4 to 8 days) and Riga, Latvia. There are road connections from Europe through Turkey and Georgia (2 to 3 weeks) and from Bandar Abbas, Iran (12 days) (**Figure 3.33**).

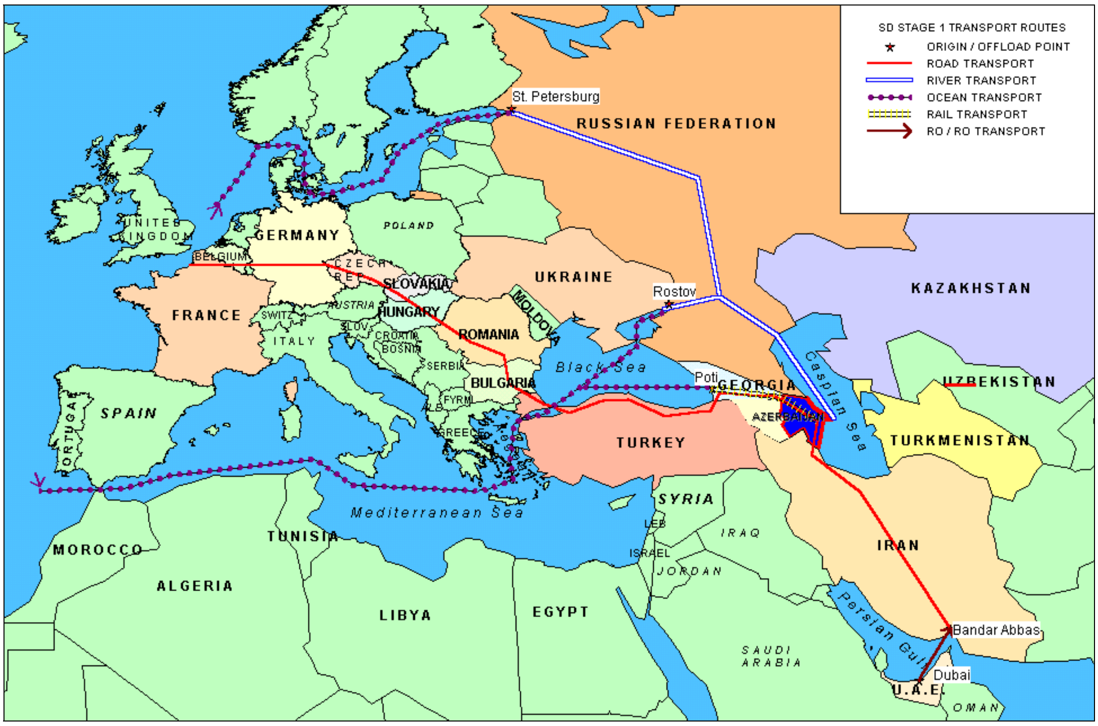


Figure 3.33: Import Routes to Azerbaijan

Drilling and production supplies will be delivered to the platforms by supply ships operating from Baku.

Expatriates in the offshore labour force will typically access Azerbaijan through connections from London and Frankfurt to Baku International Airport. Routine platform crew changes will be performed by helicopter.

3.9 Decommissioning

In accordance with the PSA, AIOC will produce a field abandonment plan one year before 70% of the identified reserves have been produced. The decommissioning plan will give details of the strategy for required measures including;

- plugging and abandoning all wells;
- preparing PDUQ and C&WP topsides for removal;
- removal, dismantling and disposal of PDUQ and C&WP topsides;
- preparing jackets for removal;
- removal, dismantling and disposal of jackets;
- pipeline decommissioning; and,
- terminal decommissioning.

4. OPTIONS ASSESSED

4.1 Introduction

This chapter of the ESIA presents a summary of the engineering options evaluated by ACG Phase 2 during the early design stages of the project. It explains briefly both how and why particular options were either adopted or rejected, and thereby seeks to demonstrate that, within the project's engineering and financial constraints, the current design represents the Best Practicable Environmental Option (BPEO).

The information set out within this chapter summarises the findings of a raft of environmental studies undertaken to date by both Phase 1 and Phase 2. In all cases the studies have been prepared in accordance with "BP Amoco Upstream Environmental Performance Guidelines for New Projects and Developments" with the aim of ensuring that the selection of the final development concept and the chosen technical solutions are made in the most cost-effective manner.

4.1.1 Approach

The evaluation of Phase 2's engineering design options was generally carried out by means of a three-stage process:

i) identification of potential control measures/technology options;

ii) quantification of emissions reduction/reduction in environmental impact which could be achieved by the implementation of each of the feasible options; and,

iii) evaluation of options.

For this last stage each of the options was assessed against a set of evaluation criteria to determine its suitability for incorporation within the project design. The evaluation criteria are listed in **Table 4.1** below.

Table 4.1: Evaluation Criteria

Criterion	Description
Impact on Safety	Would implementation of the option have a significant negative impact on safety? If yes, then the option is not acceptable.
Legislation	Does the option breach any current legislation or any legislation anticipated within the next five years? If yes, then it is not acceptable, as it would contravene BP's Environmental Policy.
Company/Partner Policy	Does the option breach BP's business policies or any policy requirements of its Partners? If yes, then the proposal is unlikely to be acceptable.
Good Engineering Practice	Does the option breach the principles of good engineering practice? If yes, then the proposal is not acceptable.
Operability and Maintenance	Is the option realistically operable and maintainable? If no, then it is not acceptable.

Criterion	Description
Cost/Benefit Factors	The costs of the option should be evaluated in the context of the environmental benefits/disbenefits and BACT (Best Available Control Technology). Most of the environmental issues will need to be considered from a local/regional point of view, but would be expected to reference environmental quality standards using established impact assessment procedures. For Carbon Dioxide and Methane emissions covered by the internal BP emissions trading scheme a planning price or price range will apply.
Reputation Issues	Are there reputation issues involved with the option? If yes, then it may be unacceptable. In this context, reputation issues include public/NGO/government interest, impact on third parties, etc.

4.1.2 Focus Areas

The evaluation of project options focussed on the following key areas;

- Combustion gas emissions and energy efficiency;
- Flaring;
- Venting;
- Fugitive emissions;
- Discharges to sea;
- Ozone depleting chemicals;
- Drilling Discharges; and,
- Pipeline Installation.

The options evaluation is presented in the sections below. For each of the above focus areas a short introduction is provided of the issues involved. The outcome of the evaluation is then presented in a tabulated format, highlighting why an option was adopted or rejected, or where assessment/design work is still on going.

4.2 Options Assessed

4.2.1 Combustion Gas Emissions

Combustion gas emissions are the waste products, which result from the burning of fossil fuels (in this case fuel gas and diesel) to generate power or heat. They include carbon dioxide (CO_2), carbon monoxide (CO), oxides of nitrogen (NOx), unburned hydrocarbons, particulates, and, if sulphur is present in the fuel, oxides of sulphur (SOx).

With the exception of flaring – which is treated as a separate topic in the section hereafter – the Phase 2 combustion emissions arise principally from gas turbines (used for gas compression, water re-injection, and electrical power generation) and fired heaters at Sangachal Terminal.

There are five principal approaches by which combustion gas emissions (or particular components within the combustion gases) can be eliminated or, at least, minimised.

These are by:

i.) sequestering the CO_2 produced by conventional power generation technology in some form of a 'reservoir';

ii.) deploying alternative means of power generation which do not result in the production of combustion gases. Such alternative means encompasses renewable energy resources;

iii.) maximising the efficiency of energy usage across the project and thereby minimising the amount of combustion gases produced by MW of power generated (electrical and/or mechanical);

iv.) adopting combustion technology which minimises the generation of atmospheric pollutants. This technique relates principally to the use of Low NOx technology; and,

v.) removing the source of pollution from the fuel gas before combustion or from the products of combustion thereafter. This technique relates principally to SOx.

The options for the abatement of combustion gas emissions are described in **Table 4.2**.

Table 4.2: Summary of Combustion Emission Abatement Options

Table 4.2: Summary of Combustion Emission Abatement Options			
Option	**Potential Advantages of Option**	**Potential Disadvantages of Option**	**Outcome / Basis for Decision**
CO_2 Recovery and Sequestration	• This technology is based upon the recovery of the CO_2 released from gas turbine generators and crude oil heaters (by means of flue gas scrubbing, gas compression and liquefaction), and its subsequent sequestration within a sub-surface reservoir. The technology provides a long-term sink for the disposal of CO_2. • CO_2 recovery and sequestration has the potential to abate around 85% of CO_2 emissions from turbines and heaters.	• Relatively novel technology and untried on gas turbines in the offshore environment. • High cost of CO_2 disposal ($40 to $60 per te) up to six times BP's current CO_2 budget trading price ($10/te). • Presence of suitable geological disposal reservoirs within the Caspian is presently unknown. • Little is known about the behaviour of CO_2 injected into a geological disposal reservoir (an aquifer). A development would therefore require geological / geophysical characterisation of an aquifer to quantify its suitability for storage purposes. Detailed geological mapping from core/seismic data would be essential, as would be surveys and monitoring of injection wells. • There are safety risks associated with CO_2 leakage from a disposal reservoir, and associated liabilities. • The technology reduces the thermal efficiency of a gas turbine from 35% to around 31%. It thus increases fuel gas consumption for the project. • Potential weight penalty of additional scrubbing and re-injection plant.	Not adopted due to reasons of weight penalty, safety implications, technological novelty, and adverse economics.
Solar Thermal power generation	• Technology based upon the (partial) elimination of combustion gas emissions by the displacement of fossil fuel-derived energy with that derived from renewable (solar) energy. • In principle a scheme could raise high temperature steam to drive a steam turbine and generate electrical or mechanical power.	• Scheme incapable of making significant contribution to Project energy requirements without necessitating impractically large solar collection areas (approximately 13,000 m^2/MW). • High costs of CO_2 abatement (c.$120/te). • Diurnal energy fluctuations would in any case necessitate back-up gas turbines or significant battery storage capacity.	Not adopted due to technical impracticality/limited contribution to energy requirements, and poor economics.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Solar Photovoltaic power generation.	• Technology based upon the (partial) elimination of combustion gas emissions by the displacement of fossil fuel-derived energy with that derived from renewable (solar) energy. • Scheme would result in direct generation of electrical power.	• Scheme incapable of making significant contribution to Project energy requirements without necessitating impractically large solar collection areas (see above). • High capital costs (onshore: \$4,000/kW_{elec} to \$8,000/kW_{elec}). • High costs of CO_2 abatement (c.\$100/te). • Diurnal energy fluctuations would necessitate back-up gas turbines or significant battery storage capacity. • Possible use in small-scale low power generation applications, but overall of limited applicability. Typically used for minor duties on unmanned platforms.	Not adopted due to technical impracticality/limited contribution to energy requirements, and poor economics.
Wind power generation.	• Technology based upon the (partial) elimination of combustion gas emissions by the displacement of fossil fuel-derived energy with that derived from renewable (wind) energy. • Scheme would result in direct generation of electrical power.	• Very limited application offshore due to structural and safety considerations (offshore a wind turbine would either need to be located on a purpose-designed platform – at prohibitive cost – or would need to be sited on the Phase 2 production platforms. In this latter case the rotating blades of the wind turbine would represent a significant safety issue). The technology is thus limited to onshore or near-shore applications. • High capital costs (\$1,100/kW_{elec} to \$1,500/kW_{elec}). • Marginal economics of CO_2 abatement (c.\$14/te to \$140/te depending upon 'capacity factor'). • Diurnal energy fluctuations would necessitate back-up gas turbines or significant battery storage capacity.	Not adopted due to technical impracticality/limited contribution to energy requirements, safety concerns, and poor economics.
Wave power	• Technology based upon the (partial) elimination of combustion gas emissions by the displacement of fossil fuel-derived energy with that derived from renewable (wave) energy. • Scheme would result in direct generation of electrical power.	• Technology not sufficiently mature. There is presently no medium to large-scale industrial application for wave power: the limited number of existing schemes throughout the world are generally aimed at providing power to relatively remote communities. • Local wave energy in Caspian is relatively low, which would necessitate an unfeasibly large development.	Not adopted due to technical novelty, relatively low energy wave environment, and consequential limited contribution to project energy requirements.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Centralised onshore power generation	• This option involves the generation of power onshore (at Sangachal Terminal) and its transmission via a sub-sea cable to the offshore platforms. • Onshore power generation does not eliminate combustion gas emissions but offers the opportunity of minimising emissions per MW_{elec} by increasing the efficiency of generation through the use of larger, more efficient turbines and combined cycle.	• Feasibility studies carried out to date (‘*Caspian Phase 2 Power from Shore Options*’, BP Power & Energy Upstream Technology Group, 15/10/01) have focused on power supply to offshore from an onshore power generation facility at Sangachal. The schemes evaluated included replacement of all offshore generators, and also replacement of the turbine drivers on the offshore injection pumps and compressors on C&WP with electric motors. • All schemes were found to be economically adverse. Furthermore, the potential CO_2 emissions savings are predicted to be very modest due to the high energy losses (c. 10%) associated with electrical power transmission via sub-sea cable over a distance of 180 km. • There was also a significant technical concern regarding the size and weight of the high voltage DC/AC converter module offshore (40m x 30m x 18m and 1,200 te).	Not adopted due to size and weight concerns, and unfavourable economics.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Combined Heat & Power – Onshore	• This option involves the recovery of waste heat from the gas turbine generators at Sangachal Terminal, and its subsequent use for process heating. The scheme minimises combustion gas emissions per $MW_{heating}$ by reducing the process heating duty of the fuel gas-fired crude oil heaters. • A detailed study was undertaken of waste heat recovery (WHR) at Sangachal Terminal ('*Review of Phase 2 Process Heating Options at Sangachal Terminal*', BP-2GZZZZ-EV-REP-0004 A1, BP, 12/04/02). A number of heating options were identified, from an independent stand-alone scheme based upon fired heaters – effectively a copy of the ACG Phase 1 design – through to a fully integrated terminal-wide WHR system. • The most favourable WHR scheme is one, which recovers waste heat from all of the ACG Phase 1 and Phase 2 gas turbine generators, with additional top-up heat being provided, when required, by a 30 MW direct-fired heater. The scheme would enable Phase 2's entire process heating demand to be met via waste heat recovery for most of the project life, with only a small short-fall being predicted between 2010 and 2015 when the fired heater would be required. The heater would also provide supplementary heat during downturn of the power generation system associated with outage of the BTC crude oil export pumps. • The scheme would reduce fuel gas usage by 26,400 mmscf over the project lifetime, and reduce total CO_2 emissions over the same period by 1,885 kte.	• Notwithstanding that the combined ACG Phase 1 and Phase 2 WHR scheme is the most favourable its overall economics are relatively adverse. For BP, a payback period of nine years (on a capital outlay of $ 4.55 M) is not attractive. From the position of Partners (who would be required between them to fund $8.8 M of the total investment cost of $13.35 M), the prospect is worse as they do not operate GHG trading schemes which would go some way to off-set expenditure on a WHR system. In addition, no value is ascribed to fuel gas the saving of which would otherwise provide a mechanism for economic payback.	Not adopted due to unfavourable economics.
Combined Heat & Power – Offshore	Option not relevant: there is no significant requirement for process heating on the offshore platforms.		

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Combined Cycle Power Generation (CCPG) – Offshore	• In this scheme waste heat would be recovered from gas turbine exhaust(s) in a heat recovery steam generator (HRSG). It would then be used to raise steam to power a steam turbine (delivering mechanical power or generating electrical power). • Typically, the steam turbine will produce approximately a third of the power of the gas turbine feeding the unit. For example, two gas turbines operating at 25 MW will produce enough steam to give an additional 17 MW. Combined cycle therefore raises the overall thermal efficiency of a power generation unit to around 50%, thereby reducing combustion gas emissions per MW_{elec} or MW_{mech}. • A detailed study was made of CCPG on the C&WP (‘*Feasibility of Offshore Combined Cycle Power Generation on C&WP*’, BP, 26/11/01). The study concluded that from a technological view point, offshore CCPG on the C&WP is feasible: a) field-life electrical power balances indicate that there will always be a power surplus from the moment that combined cycle system comes on stream: the implementation of CCPG would not compromise field-wide power availability, b) feed-back from two operators of offshore CCPG systems indicates that the systems are reliable. • Depending upon the CCPG option selected, the implementation of this option could save between 134,000 te of CO_2 per annum and 180,000 te per annum as an average over the field life.	• Neither of the PDUQs have sufficient available waste heat or power demand to make implementation of CCPG economically feasible. Offshore CCPG is therefore specific to the C&WP. • The chief impediment to the adoption of combined cycle is the additional weight burdens, which the system would impose upon the C&WP and the consequential impacts upon CAPEX. It is estimated that a scheme comprising one 32 MW steam turbine generator plus HRSGs, bulks, structural strengthening, etc would add 1,500 te to the C&WP topsides dry weight, taking it well over the original float-over weight limit of 14,000 te. The scheme would require an additional CAPEX (when compared with the all-gas turbine Base Case) of between \$34.8 and \$64.1 million, depending upon the extent of offshore installation required.	Not adopted due to reasons of weight and unfavourable economics.

Table 4.2: Summary of Combustion Emission Abatement Options			
Option	**Potential Advantages of Option**	**Potential Disadvantages of Option**	**Outcome / Basis for Decision**
Gas turbine low NOx – Onshore	• DLN technology is currently capable of achieving a NOx concentration in turbine exhaust gases of around 25 ppmv at reference conditions 15% O_2, dry gas basis. This equates to a reduction in NOx emission *concentrations* of around 90% when compared with conventional machines. • DLN is considered to be Best Available Control Technology (BACT).	• DLN on RB211 gas turbines is currently only available for single fuel machines. However, the Phase 2 turbines at Sangachal fall within this category. • Rolls Royce has advised that its knowledge of the ability of DLN generators to accept and reject block loads (loads significant in terms of the overall rating of a unit) is currently incomplete: – Block load acceptance is not expected to present any problems. – 100% load rejection will cause a 'flame out'. – For rejections around the 70% load point the DLN system may not react fast enough to prevent a trip due to over-speed conditions being reached. This is the subject of on going test work. • Rolls Royce is currently recommending that where a mixture of conventional and DLN turbines exist (which is the case at Sangachal: the Phase 1 gas turbine generators – at least during early field life – will not be of a low NOx design) block load swings should be imposed on the conventional turbines and gradual load increase be applied to the DLN (Phase 2) turbines.	Ongoing. The outcome of this particular evaluation is classified as 'ongoing' because there is currently an investigation into the robustness of DLN under conditions of transitory load. Resolution of this issue is anticipated in the medium term future.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Gas turbine low NOx – Offshore	• See above.	• The gas turbine generators on the East and West Azeri PDUQs are dual fuel machines. RB211 DLN technology is not currently available for such machines. The PDUQ units will therefore be of a conventional design.	Not adopted. The gas turbines on the C&WP are single fuel-fired units and could therefore be fitted with DLN technology. However, it is not proposed to do so for the following reasons: Air dispersion modelling indicates that the combined offshore Phase 1 & Phase 2 emissions of NOx (from the C&WP and the three PDUQs) are well dispersed and diluted over the distance from the platforms to the mainland (186 km) and consequently have very little impact on air quality around the greater Baku area. Peak onshore annual average contributions of NOx from the platforms are predicted not to exceed 0.05$\mu g/m^3$ (approximately 0.1% of the air quality standard). The incremental cost for DLN on a new RB211 is approximately \$1.25M. At full expansion of the C&WP the adoption of DLN would therefore cost \$15M (i.e. there are 12 gas turbines on the platform). The expenditure of this amount of capital to achieve a 0.1% improvement in long-term air quality within Baku is not considered to be a cost-effective allocation of resources.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Other gas turbine NOx reduction options	• Alternative NOx reduction technology is capable of achieving emissions reductions comparable with DLN (see above). • Alternative technologies for NOx reduction from gas turbines include selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) which involve injecting a reducing agent (typically ammonia) into the exhaust gas stream at elevated temperatures.	• DLN is preferable due to established operating experience. • Offshore these alternative technologies would impose weight and special penalties. • Generates waste catalysts. • Some technologies not viable on dual-fuel machines.	Not adopted.
Heater low NOx	• Heater low NOx technology is capable of achieving a NOx concentration in the exhaust gases of around 40 ppmv at reference conditions 3% O_2, dry gas basis.		Adopted. Low NOx heater technology has been adopted by both Phase 1 and Phase 2 on the basis of BACT.
Offshore fuel gas H_2S removal by zinc oxide absorption	• Removal of H_2S from fuel gas prevents formation of SO_2 within gas turbine combustion gases.	• High cost of SO_2 removal ($5,100 to $19,200 per te). • Logistical implications of waste absorbent handling. • Possible absence of absorbent regeneration facilities leading to disposal in landfill.	Not adopted due to reasons of weight, waste management logistics, and adverse economics. Also, air dispersion modelling indicates little impact of offshore SO_2 emissions on air quality around the greater Baku area.

Table 4.2: Summary of Combustion Emission Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Offshore fuel gas H_2S removal by amine sweetening & sulphur recovery	• See above.	• The equipment is physically large and heavy. It would require a large deck area and would add a significant weight penalty to a platform design. • The system results in a waste material, which must be temporarily stored on the platform and subsequently transferred to shore. This issue has significant logistical and cost implications. • Acid gas from an amine unit is high in H_2S and its handling represents significant safety implications for the platform. In addition, the material can be hard to handle due to sulphur crystallisation and corrosion issues: the compressor would require very high levels of maintenance. • As of the present time no regional market has yet been identified which would enable recovered sulphur to be passed on for re-use. In the absence of a market the sulphur would have to be disposed of in a landfill.	Not adopted for reasons of safety, weight and space penalties, waste management logistics, and adverse economics.
Onshore fuel gas H_2S removal by amine sweetening & sulphur recovery	• Removal of H_2S from fuel gas prevents formation of SO_2 within gas turbine and crude oil heater combustion gases.	• Determination of potential disadvantages is ongoing.	Ongoing. Depending upon the concentration of H_2S within the gas it may be necessary to install gas sweetening up-stream of the Dew pointing Package (see Chapter 3 Description of Sangachal Terminal). However, information on the sourness of the gas has yet to be confirmed and the requirement for gas sweetening plant has therefore yet to be confirmed.
Low sulphur diesel	• SO_2 emissions from diesel fired units and dual fuel gas turbines operating on back-up fuel supply (i.e. on black start) can be further reduced by the use of low sulphur diesel fuels	• Determination of potential disadvantages is ongoing.	Ongoing. Availability/cost implications of low-sulphur diesel usage are currently under evaluation.

4.2.2 Flaring

BP's Environmental Expectation for Upstream developments is that all routine, non-emergency flaring will be eliminated with the exception of purges and pilots, which should be minimised. The design basis for Phase 2 is that all associated gas will be either re-injected into the reservoir to enhance oil recovery, delivered to SOCAR, or combusted in gas turbines and crude oil heaters to meet the necessary process heat and power requirements of the development.

In terms of 'normal' operation the project has focussed principally on the means by which 'permissible' flaring, i.e. via purge and pilots, can be minimised or eliminated. Emergency flaring during process-upset conditions will be governed by a Phase 1/2 flaring philosophy, which is still under formulation. The various options evaluated in pursuance of the flaring goal are summarised in **Table 4.3**. It should be noted a capability to flare under emergency situations is an essential safety requirement.

Table 4.3: Summary of Flaring Abatement Options

Table 4.3: Summary of Flaring Abatement Options			
Option	**Potential Advantages of Option**	**Potential Disadvantages of Option**	**Outcome / Basis for Decision**
Use soft-seat valves	• Hydrocarbon releases into the flare system from pressure control valves can be minimised by the use of soft-seat alternatives, which give a tighter shut-off.	• Soft seat valves have relatively higher wear rate than standard valves. • Potential maintenance implications need to be evaluated.	Ongoing. The issue will be reviewed during the detailed design stage.
Flare gas metering	• This technique enables the rate of purge gas flow within the flare systems to be optimised, thereby avoiding the combustion of unnecessarily large volumes of fuel gas.		Adopted. Flare gas metering has been adopted by both Phase 1 and Phase 2 on the basis of BACT. The number of meters and their operational range is an issue for detailed design.
Flare gas recovery & inert gas purging – Onshore	• Flare gas recovery systems enable the recovery of hydrocarbon vapours from the flare system and their return to the upstream process. The systems are commonly designed to handle normal gas leakage rates, with spare capacity to manage minor releases from blow-down/pressure safety valves. During larger releases, a valve in the flare line opens, so isolating the recovery equipment and allowing the vapours to pass through to the flare for combustion. • Flare gas recovery systems have implications for purge gas systems: in the absence of process gas passing through the flare system it is necessary to purge the system with an inert gas.		Adopted. Flare gas recovery & inert gas purging has been adopted by Phase 1/2 on the basis of BACT.

Table 4.3: Summary of Flaring Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Flare gas recovery & inert gas purging – Offshore	• See above.	• Increased weight and cost implications	Ongoing. Flare gas recovery offshore was initially rejected due to space and weight constraints on the platforms, and correspondingly marginal economics. This issue will be revisited during detailed design in light of the increased platform float-over weight conferred by the new transport barge.
Non-continuous pilot ignition systems – Onshore & Offshore	• Non-continuous pilot systems eliminate the requirement for continuous flare pilots. • Two systems were considered: a) an electronic ignition system, and b) an automatic (Umoe) ignition system.	• The electronic ignition system can be less reliable than conventional pilots. • The Umoe system has a CO_2 abatement cost of $23/te.	Not adopted. The electronic ignition system was rejected on the basis of its reliability, and the consequential implications for maintenance activities, increased purge gas flow rates (to avoid flame out conditions), etc. The Umoe system was rejected on the basis of adverse economics.

4.2.3 Venting

The environmental goal for the Phase 2 project is that there will be no venting. Here venting is taken to mean the intentional release of uncombusted hydrocarbons into the atmosphere from point or area sources as distinct from relatively minor leakages from process components such as valves, flanges, seals, etc. Emissions of this latter character are addressed in the section hereafter.

There are two principal potential sources of venting associated with the Project, namely:

i) off-gas venting from gas dehydration (both onshore and offshore); and,
ii) hydrocarbon emissions from crude oil storage (onshore only).

Venting abatement options are described in **Table 4.4**.

Table 4.4: Summary of Venting Abatement Options

Table 4.4: Summary of Venting Abatement Options			
Option	**Potential Advantages of Option**	**Potential Disadvantages of Option**	**Outcome / Basis for Decision**
Gas dehydration off-gas recovery – onshore	• Elimination of CH_4 and BTEX releases to atmosphere.		Adopted. Onshore, dehydration off-gas is recovered by means of the terminal's flare gas recovery package (see **Table 4.3**). This is BACT..
Gas dehydration off-gas recovery – offshore	• See above.		Ongoing. Off-gas recovery would be via the offshore flare gas recovery package the feasibility of which is still under evaluation (see **Table 4.3**).
Gas dehydration off-gas disposal via flaring – offshore	• Reduction of GHG emissions by oxidation of CH_4 in off-gas to CO_2 and water vapour.		Adopted. Pending the outcome of the offshore flare gas recovery feasibility study, the routing of dehydration off-gas to the LP flare system is considered to be the most environmentally acceptable disposal option.
Crude storage: External floating roof tank with basic fittings.	• Control of hydrocarbon gas releases to atmosphere and reduction in local ambient concentrations of these pollutants.	• Option not Best Available Control Technology.	Not adopted.
Crude storage: External floating roof tank with low loss fittings	• See above.	• Environmental economics comparable with vapour recovery option.	Adopted.
Crude storage: Internal floating roof tank with primary seal only	• See above.	• Option has lower fugitives control performance than EFRT with basic fittings.	Not adopted.
Crude storage: Internal floating roof tank with primary & secondary seal	• See above.	• Option has lower fugitives control performance than EFRT with basic fittings.	Not adopted

Table 4.4: Summary of Venting Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Crude storage: Internal floating roof tank with primary seal & vapour recovery system	• Improved control performance. • See above.	• Increased CAPEX and OPEX costs due to vapour recovery system.	Not adopted. Improved performance not justified by the extra CAPEX & OPEX required.

4.2.4 Fugitive Emissions

Fugitive hydrocarbon emissions arise from leaking flanges, valves and rotating equipment seals, etc. To achieve the goal of 'no fugitive emissions' all of the potential leak sources must therefore be eliminated or the leaking material recovered.

A range of technology options are available to control the release of fugitive hydrocarbon emissions both onshore and offshore. These are summarised in **Table 4.5**.

Table 4.5: Fugitive Emissions Control Technology Options

Item	Options
1	Utilise high non-leakage class valve with low FE gland packing.
2	Maximise use of welded joints.
3	Minimise valves and instrumentation.
4	Use of high efficiency dry gas seals on compressors.
5	Dry gas seal vent recovery.
6	Preventative maintenance to minimise fugitive emissions – Leak Detection and Repair campaigns.
7	Use of flange 'covers' to minimise emissions.
8	Replace safety valves with bursting discs.
9	Closed sample point tundishes.
10	Enclose sources of emission and tie to LP gas recovery system.
11	Use of approved manufacturers for valves.

The evaluation of the above fugitives control measures is a matter for detailed engineering design and will be addressed as Phase 2 passes through to the next design stage.

4.2.5 Discharges to Sea

The options available to the Project to minimise or, where possible eliminate, discharges to sea of oil or chemicals are summarised in **Table 4.6**. The table does not address discharges from drilling operations. These are covered the Drilling Discharges section.

Table 4.6: Summary of Options to Prevent Discharges to Sea

Table 4.6: Summary of Venting Abatement Options			
Option	**Potential Advantages of Option**	**Potential Disadvantages of Option**	**Outcome / Basis for Decision**
Offshore produced water disposal – Produced water re-injection	• Minimises produced water discharges to the Caspian by re-injection into the producing reservoir (discharges limited to outage of PWRI system). • Enhances oil recovery.		Adopted. Project Basis of Design.
Onshore produced water disposal – Produced water re-injection	• Long-term solution to the disposal of produced water arising at Sangachal Terminal. • Eliminates discharges to the surface environment (land, sea and air)	• Potential risk of re-injection water migrating to contaminate aquifers. • Potential risk of altering current pressure regimes in disposal reservoir with safety implications.	Ongoing. The base-case for the disposal of produced water on land is currently re-injection at Lokbatan. However, the suitability of this disposal route is the subject of an ongoing study. Issues to be resolved include: – the design of the disposal well(s) – the characteristics and capacity of the recipient formation/reservoir – the potential presence of migration pathways for any re-injection water, so presenting a risk of contamination migrating to any potable aquifers in the area Alternative sites to Lokbatan are currently under consideration.

Table 4.6: Summary of Venting Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Onshore produced water disposal – disposal at Garadagh cement plant.	• Alternative disposal option to the above.	• Potential volumes of produced water may exceed disposal routes capacity with operability and emergency storage issues.	Ongoing. This disposal route is currently being implemented by EOP after it was requested to cease disposal of treated produced water to Sangachal Bay. There are a variety of issues surrounding this disposal option which are currently being addressed: does the plant have the capacity to take all of the produced water from both Phase I and Phase II, how would outages at the cement plant be accommodated, etc. Studies are on going.
Onshore produced water disposal – treatment & irrigation.	• Second alternative to the onshore produced water disposal option.	• Increased treatment costs. • Unknown impacts from irrigation scheme.	Ongoing. The option involves the treatment of produced water to acceptable irrigation water quality standards. The water could then be used for crop irrigation in the general vicinity of the terminal. This option is at an early stage of evaluation and there are presently few specific details available. Further information will be forthcoming as studies progress.
Pigging of Re-injection Water Pipelines: Re-injection of pigging waters	• Pigging from C&WP to East/West Azeri at full pressure with pigging waters being re-injected at platforms. • Zero discharge of pigging waters to the marine environment.		Adopted. Option considered BACT.

Table 4.6: Summary of Venting Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Pigging of Re-injection Water Pipelines: Partial re-injection of pigging waters	• Alternative to the above in the event of a re-injection system blockage.	• Pigging from C&WP to East/West Azeri, and return of pigging waters via Produced Water Transfer line to Water Injection System. • Option results in the discharge to the marine environment of pigging/produced water flows above the maximum handling capacity of the Produced Water Transfer line. • Option will be used as a contingency measure to the above.	Ongoing.
Pigging of Produced Water Pipelines: Re-injection of pigging waters	• Minimal discharge of pigging waters to the marine environment.	• Option contingent upon there being sufficient produced water to drive a pig from East/West Azeri to the C&WP. The option will therefore only be adopted in later field life when this condition begins to prevail. • The operation results in a small discharge to the Caspian during the final stages of pigging.	Adopted. The option is considered BACT.
Pigging of Produced Water Pipelines: Discharge of pigging waters	• Expedient to the above during early field life.	• Pigging from C&WP to East/West Azeri. This mode of pigging will only be carried out during early field life when there would be insufficient water on the PDUQs to drive the pig. • The pigging water and any produced water arising at the platforms during the pigging operation will be discharged to the Caspian.	Adopted. As soon as circumstances allow pigging will revert to the above mode in order to minimise environmental releases.
Cooling water	• Offshore, seawater cooling is the project Basis of Design. Air cooling is not possible due to combination of cooling demand, limited availability, and restrictions on weight allowance. • Offshore cooling will be provided by sea-water lift. Post-cooling, a proportion of this water will be admixed with the produced water and re-injected, whilst the excess will be returned to sea.		Adopted.
Offshore Sewage Treatment: Maceration	• No use of disinfecting agents & no observable floating solids. • Treatment by natural degradation of sewage in marine environment.	• Not acceptable within Caspian. • Option not BACT.	Not adopted.

Table 4.6: Summary of Venting Abatement Options

Option	Potential Advantages of Option	Potential Disadvantages of Option	Outcome / Basis for Decision
Offshore Sewage Treatment: Electro-chemical Treatment	• Alternative to the above. The option involves maceration and chemical addition (sodium hypochlorite) to disinfect the sewage. • There is no requirement to return sewage sludge to an onshore facility. • The basic package is certified to meet the US Coastguard specification.	• 1 mg/l chlorine discharge concentration can only be met by means of dilution with grey water and seawater return.	Adopted.
Offshore Sewage Treatment: Biological Treatment	• Alternative to the above.	• The system requires a large bio-reactor, resulting in weight and spatial penalties on the platforms. • The effluent to the bio-reactor must be carefully balanced to avoid shock loads which could otherwise impair or disable biological activity. • Requirement to return sewage sludge to shore for disposal.	Not adopted.
Offshore Sewage Treatment: Membrane-biological Treatment	• Alternative to the above. This option involves a combination of bio-reaction and ultra-filtration. • The plant is much smaller (up to ten times) than the biological treatment unit.	• Sewage sludge must be periodically removed and returned to shore for disposal.	Not adopted.
Offshore Sewage Treatment: Ozone Treatment	• Alternative to the above. • The use of ozone does not produce toxic by-products.	• Sewage sludge must be periodically removed and returned to shore for disposal. • Technology relatively untried in offshore environment.	Not adopted.

4.2.6 Ozone Depleting Chemicals

The project objective of ‘no use of ozone depleting substances’ will be achieved by the use of commercially available substitute chemicals.

Fire-fighting Systems

No halon fire suppressants will be used in fire-fighting systems. The following substances will be used instead;

- *Water Mist*. This increases the normal surface area of water by more than one thousand times to create an oxygen-depleted atmosphere, thus starving the fire;
- *Niagara Foam*. Niagara 3-3 is a high fluidity alcohol-resistant film-forming fluoro-protein (AR-FFFP) fire fighting foam concentrate. It is based on natural protein foaming agent and contains no harmful synthetic detergents, glycol ethers, alkyl phenol ethoxylates (APEs), totyltriazoles, or complexing agents. It is biodegradable and virtually non-toxic to aquatic organisms; and,
- *Aqueous Film-Forming Foam*. This is a mixture of seawater and fire-fighting foam sprayed as a foam on the fire to cool and smother it.

HVAC Systems

No refrigerants are used in offshore HVAC systems: sea water cooling is used instead.

Refrigerants are used onshore only in building split air-conditioning systems. The detail design will be done by local subcontractors who will be made aware of BP’s goal regarding ozone depleting substances.

R407C refrigerant has been used in the past by as an ozone-friendly alternative to R22.

4.2.7 Drilling Discharges

Different disposal strategies are currently proposed for the following hole sections;

i) Top hole section;

ii) 26" hole section; and,

iii) sub-26" hole sections.

These disposal strategies are discussed in Table 4.7 overleaf.

Table 4.7: Summary of Drilling Discharge Options

Table 4.7 – Summary of Drilling Discharge Options	
Hole Section	**Disposal**
Top Hole	• It is not technically feasible or safe to return the mud and cuttings from this section to the rig or platform, and therefore in accordance with normal safe drilling practice this material will be discharged directly to the seabed in accordance with the Production Sharing Agreement (PSA)
26"	• Drill cuttings disposal options for the 26 " hole have been the subject of an independent BPEO study (‘BPEO Study for the Disposal of Cuttings from 26" Hole Section for ACG and Shah Deniz’, MC-CDZZZZ-DR-RPT-0001 A1, URS Dames & Moore, 20/7/01). The study evaluated three alternative disposal options, namely: a) discharge overboard, b) cuttings re-injection (CRI), and c) ship-to-shore (for onshore treatment and disposal) in the context of environmental risk, risk to personnel, compliance with legislation, international best practice and BP standards, cost of alternatives, and technology and track record. • The conclusion is that BPEO for the 26" hole section is discharge to the marine environment. The conclusion is based on the following factors: – there is a paucity of marine fauna around the drill sites; – the drill sites are not located in areas important for fisheries; – the extent of the benthic impact resulting from overboard discharge is thought to be around 100 m; – overboard discharge has the lowest energy demand of all of the options and results in the least atmospheric emissions; – ship-to-shore for ACG Phase I and II will require considerable handling of cuttings and mud which have attendantly high health and safety risks; – the costs of CRI and ship-to-shore are much greater than overboard discharge; and, – CRI and land-based treatment rely on less proven or reliable technologies than overboard discharge.
Sub-26"	• Drilling cuttings and associated fluids from all sections below the 26" hole will be disposed of by CRI. During periods of CRI plant unavailability the cuttings and fluids will be returned to shore for treatment and disposal.

4.2.8 Pipeline Installations

There are three principal issues associated with the installation of the Phase 2 pipelines and their potential environmental impacts. These are;

i) the routing of the 30" main oil line from Central Azeri to Sangachal;

ii) the beach-pull of the 30" main oil line; and,

iii) the disposal of hydrotest waters from 30" main oil line and in-field pipelines.

These issues are discussed below.

Routing of 30" Main Oil Line

The Phase 2 30" main oil line will be routed along the existing EOP (and Phase 1) pipeline corridor. Alternative routes were evaluated by Phase 1 (these are described in the Phase 1 ESIA) but the existing corridor was concluded to be the preferred route. From an engineering perspective the EOP corridor is known to be geotechnically sound. It is also the shortest of the routes evaluated: an alternative route landing at the Absheron Peninsula was 43 km longer and had a total onshore length of 120 km. The environmental benefit of using the existing corridor is primarily that it restricts seabed disturbance to an already ‘developed’ area, and thereby does not give rise to additional impacts on a separate and distinct area of sea-bed.

Beach-pull

The Phase 1 and Phase 2 projects combined will require three beach-pull operations at Sangachal Bay: for the Phase 1 30" main oil line, the Phase 1 28" gas line, and the Phase 2 30" main oil line.

The pipeline beach-pulls will require considerable civil works at the shore-line (due to trenching, etc) which will inevitably impact upon the localised ecology within the bay. In order to minimise the overall environmental impact of the beach-pull operations it is the aspiration of Phase 2 to carry out the beach-pull of the 30" main oil line immediately after that of the Phase 1 28" gas line (the gas line in September 2003 and the oil line in October 2003).

Whilst it is acknowledged that this approach could not avoid impacts on the near-shore environment, it would limit disruption to a relatively short period of time, and would avoid further cycles of impact which would otherwise arise from subsequent beach-pulls. It is therefore considered to the Best Practicable Environmental Option.

Disposal of Hydrotest Waters

The disposal of Phase 2’s main oil line hydrotest waters, and the hydrotest waters from the testing of in-field pipelines is the subject of an ongoing BPEO study. Results will be forthcoming in the near future.

5 RELEASES TO THE ENVIRONMENT

5.1 Introduction

This section of the report presents information on the environmental releases, to air, the marine environment, and land, arising from the construction, installation, commission, and operation of the ACG Phase 2 project. The section is set out in three parts;

- Initially, a general summary is provided of the releases which occur from the various components of the project to the above three environmental media. The summary is qualitative in nature and is intended to provide a link between the project description presented in the foregoing section and the quantitative emissions estimates set out below.

For the purposes of classification the project ‘components’ have been aggregated into two general groups:

a) *Primary Long-term Production Operations*

This group includes, where relevant, all of the processing, drilling and storage activities associated with the on-going operation of;

1) East Azeri PDUQ;

2) West Azeri PDUQ;

3) C&WP;

4) Sangachal Terminal; and,

5) Central Azeri PDUQ[1].

As will be seen, these activities are responsible for the overwhelming majority of releases to the environment over the lifetime of the project.; and,

b) *Construction, Installation and Commissioning Activities*

This group includes those activities associated with the initial development of the project, and include;

1) Construction of the platforms and terminal;

2) Installation of the platforms;

3) Onshore and offshore commissioning;

4) Pipeline installation and hydrotesting;

5) Template well drilling; and,

6) Drill stem testing.

- The second part of the section lists all of the primary long-term sources of emission, and ascribes to each a unique reference number. Figures of the platforms and Sangachal Terminal are provided to illustrate, as far as possible, the physical locations of these sources.

[1] Central Azeri is a Phase 1 facility, and its emissions have already been quantified in the Phase 1 ESIA. However, the emissions from the platform have been included here as a means of contextualising the increase in emissions resulting from the development of Phase 2.

In the case of the atmospheric emissions sources, further information on the source release heights, physical dimensions, etc can be found within the air dispersion modelling report presented in chapter 10.

- The final part of the section presents an inventory of environmental releases from all of the project components. Where possible the inventory is given in the form of 'emissions profiles' covering the entire lifetime of the project from 2005 to 2024. Where there is presently insufficient information from which to develop a profile, or where an emission is inherently variable, the release has been given in the form of an average or maximum design limit, or similar.

5.2 Summary of Environmental Releases

This section of the ESIA provides a general description of the environmental releases from the various components of the Phase 2 project. The releases fall into four specific categories;

- ***Atmospheric Emissions***. These fall within two categories: a) combustion emissions, such as occur from gas turbines, flares, fired heaters, etc, and b) hydrocarbon emissions, such as breathing and working losses from storage tanks, etc.;
- ***Releases to the Marine Environment***. These are all offshore discharges: there are no releases to the Caspian (Sangachal Bay) from Sangachal terminal; and,
- ***Releases to the Terrestrial Environment***. This category covers process releases at Sangachal terminal, namely solid and liquid sewage effluent and the open drains system.

5.2.1 Solid and Liquid Wastes.

These are typically non-continuous waste streams or non-process waste streams generated at Sangachal or returned from offshore. They are currently held at the Serenja Waste Storage Facility.

A fifth and final category of waste stream, but one not addressed in this section, is that covering wastes which are disposed of by sub-surface reinjection, namely;

- drill cuttings, mud's, and produced sand reinjected off-shore via the CRI system;
- produced water reinjected off-shore via the water reinjection system; and,
- produced water reinjected onshore.

For the purposes of this section, these materials are considered waste streams or environmental releases in the event that the respective reinjection routes are not available.

The summary of environmental releases is set out in a series of tables, **5.1-5.6** below.

Table 5.1: Summary of Environmental Releases

Table	Project Component
5.2	East & West Azeri PDUQs
5.3	C&WP
5.4	Sangachal Terminal
5.5	Pre-drilling Operations
5.6	Construction, Installation & Commissioning Activities

5.2.2 East & West Azeri PDUQs

Table 5.2: Summary of Environmental Releases – East & West Azeri PDUQs

Atmospheric Emissions	Releases to the Marine Environment	Solid/Liquid Wastes Returned to Shore for Treatment/Disposal
• Combustion gas emissions from power generation (gas turbine generator and emergency diesel generator). • Combustion gas emissions from flaring during process upset conditions, and continuous purge and pilot. • Combustion gas emissions from operation of fire water pumps. • Combustion gas emissions from operation of crane diesel engines. • Combustion gas emissions from helicopters and support vessels. • Hydrocarbon fugitive emissions from process plant.	• WBM and cuttings from 26" hole. Possibly also from 30" hole is operational difficulties preclude use of a hydraulic hammer for driving the conductor pipe. • Seawater/cooling water discharges. • Hazardous open drains. • HVAC scrubber drains from the Drilling Support Module. • Non-hazardous open drains during non-availability of CRI system. • Overflow from Oily Drains Tank. • Overflow from Drilling Oily Drains Tank. • Overflow from Diesel Tank. • Overflow from Base Oil Tank. • Treated produced water during outage of the Produced Water Reinjection System on the C&WP. • Treated sewage from the Drilling Support Module and the Accommodation Block. • Produced water during pigging of produced water pipelines[3].	• Cuttings and mud's from sub-26" hole sections[1]. • Cleaned produced sand[2]. • Non-hazardous combustible solid waste (paper, wood, card). • Non-hazardous non-combustible waste (such as scrap metal). • Hazardous solid waste (such as paint cans and empty chemical containers). • Hazardous liquid wastes (such as oily wastes).

Notes: 1) The base case for both platforms is cuttings reinjection. These cuttings will only arise during prolonged outage of the CRI system.

2) Produced sand is normally reinjected with drill cuttings via the CRI system. Sand will only be returned to shore during outage of the CRI system.

3) Occurs during early field life.

5.2.3 C&WP

Table 5.3: Summary of Environmental Releases – C&WP

Atmospheric Emissions	Releases to the Marine Environment	Solid/Liquid Wastes Returned to Shore for Treatment/Disposal
• Combustion gas emissions from power generation gas turbine. • Combustion gas emissions from Water Injection gas turbines. • Combustion gas emissions from Gas Compression gas turbines. • Combustion gas emissions from flaring during process upset conditions, and continuous purge and pilot. • Combustion gas emissions from operation of crane diesel engines. • Hydrocarbon fugitive emissions from process plant.	• Seawater/cooling water discharges. • Non-hazardous Open Drains. • Hazardous Open Drains. • Produced water during pigging of produced water pipelines[1].	• Non-hazardous combustible solid waste. • Non-hazardous non-combustible waste. • Hazardous solid waste. • Hazardous liquid wastes.

Notes: 1) Very small volumes later in field life.

5.2.4 Sangachal Terminal

Table 5.4: Summary of Environmental Releases – Sangachal Terminal

Atmospheric Emissions	Releases to the Terrestrial Environment[2]	Solid/Liquid Wastes for Treatment/Disposal
• Combustion gas emissions from power generation (gas turbine generators and emergency diesel generator). • Combustion emissions from crude oil heaters. • Combustion gas emissions from flaring during process upset conditions, and continuous purge and pilot[1]. • Combustion gas emissions from operation of fire water pumps. • Hydrocarbon fugitive emissions from process plant and oil storage tanks.	• Non-contaminated open drains. • Treated sewage effluent. • Sewage sludge.	• Produced water[3] • Contaminated open drains. • Waxy pigging waste from MOL. • Non-hazardous combustible solid waste. • Non-hazardous non-combustible solid waste. • Hazardous solid waste. • Hazardous liquid waste.

Notes

1) Continuous purge and pilot on HP Flare system only. On LP Flare system the fuel gas purge is recovered in the Flare Gas Recovery package up to a flow rate of 1 mmscfd.

2) There will be no planned releases to the marine environment (i.e. Sangachal Bay).

3) The disposal of produced water is, at present, being studied and the results will be forthcoming.

5.2.5 Pre-drilling Operations

Table 5.5: Summary of Environmental Releases – Pre-drilling Operations

Atmospheric Emissions	Releases to the Marine Environment	Solid/Liquid Wastes Returned to Shore for Treatment/Disposal
• Combustion gas emissions from flaring during drill stem testing. • Combustion gas emissions from power generation. • Combustion gas emissions from helicopters and support vessels. • Hydrocarbon fugitive emissions.	• Seawater/WBM and cuttings from 36" top-hole and 26" hole sections. • Cooling water discharges. • Treated sanitary effluent and grey waters. • Machinery drains.	• Cuttings and muds from sub-26" hole sections • Galley waste. • Non-hazardous combustible solid waste. • Non-hazardous non-combustible waste. • Hazardous solid waste. • Hazardous liquid wastes.

5.2.6 Construction, Installation & Commissioning Activities

Table 5.6: Summary of Environmental Releases – Construction, Installation & Commissioning Activities

Atmospheric Emissions	Releases to the Terrestrial Environment	Releases to the Marine Environment	Solid/Liquid Wastes for Treatment/Disposal
• Combustion emissions from power generation. • Combustion emissions from marine vessels and land transportation. • Combustion emissions from earth-moving equipment, cranes, etc. • Dust emissions from construction activities.	• Treated sewage effluent. • Treated sewage sludge.	• Fresh water hydrotest waters. • Saline hydrotest waters. • Seawater/cooling water discharges. • Clean drainage water.	• Non-hazardous combustible solid waste. • Non-hazardous non-combustible waste. • Hazardous solid waste. • Hazardous liquid wastes.

5.3 Environmental Release Sources

5.3.1 East and West Azeri PDUQs

Figure 5.1, below illustrates the principal sources of environmental releases from the East and West Azeri PDUQs. These sources are listed in the tables (**5.7-5.10**) presented thereafter.

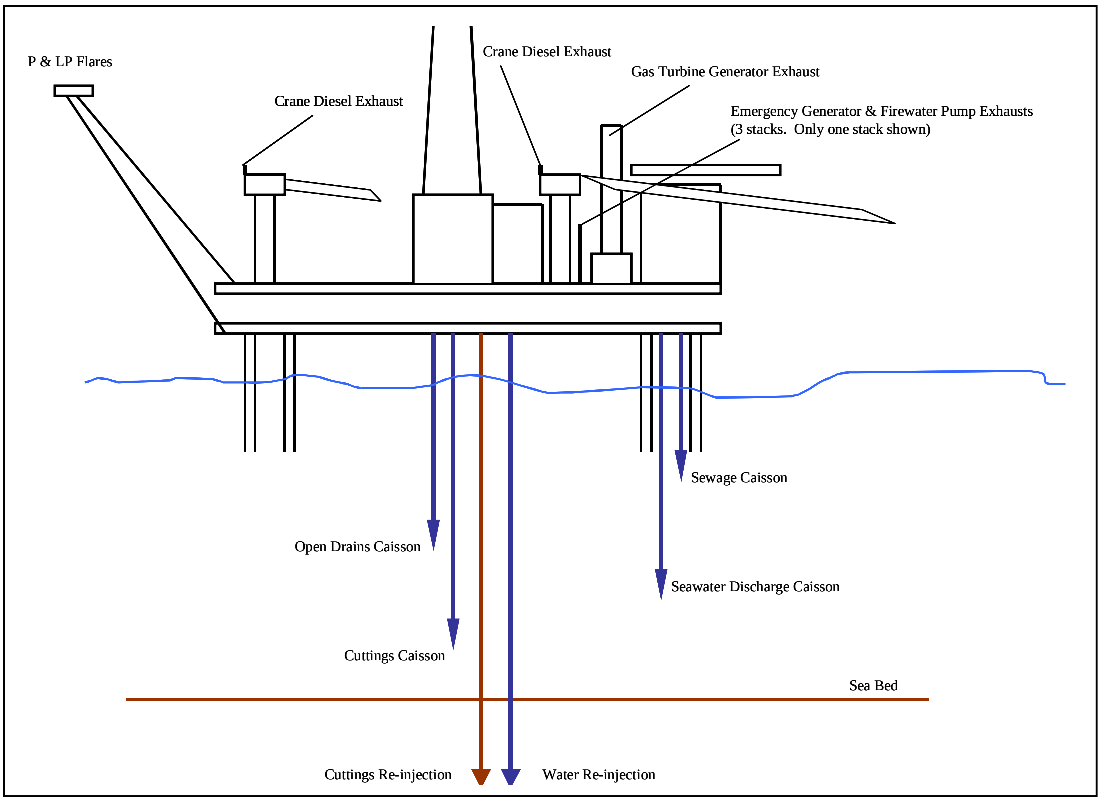


Figure 5.1: East & West Azeri PDUQs Environmental Release Sources

Table 5.7: East Azeri PDUQ - Principal Fixed Point Sources of Atmospheric Emissions

Ref No	Emissions Source	Emissions Type	Operation
EA-A-01	Gas Turbine Generator	Combustion gases – CO_2, NOx, CO, PM and UHC.	Continuous.
EA-A-02	Emergency Generator	Combustion gases	Intermittent.
EA-A-03	HP Flare	Combustion gases	Intermittent with continuous purge and pilot.
EA-A-04	LP Flare	Combustion gases	
EA-A-05	Fire Water Pump No.1 Diesel Engine	Combustion gases	Intermittent (tested for 30 minutes each week).
EA-A-06	Fire Water Pump No.2 Diesel Engine	Combustion gases	
EA-A-07	Crane No.1 Diesel Engine	Combustion gases	Frequent.
EA-A-08	Crane No.2 Diesel Engine	Combustion gases	

Table 5.8: West Azeri PDUQ - Principal Fixed Point Sources of Atmospheric Emissions

Ref No	Emissions Source	Emissions Type	Operation
WA-A-01	Gas Turbine Generator	Combustion gases.	Continuous.
WA-A-02	Emergency Generator	Combustion gases	Intermittent.
WA-A-03	HP Flare	Combustion gases	Intermittent with continuous purge and pilot.
WA-A-04	LP Flare	Combustion gases	
WA-A-05	Fire Water Pump No.1 Diesel Engine	Combustion gases	Intermittent (tested for 30 minutes each week).
WA-A-06	Fire Water Pump No.2 Diesel Engine	Combustion gases	
WA-A-07	Crane No.1 Diesel Engine	Combustion gases	Frequent.
WA-A-08	Crane No.2 Diesel Engine	Combustion gases	

Table 5.9: East Azeri PDUQ - Principal Fixed Point Sources of Release to the Marine Environment

Ref No	Source	Effluents Released	Discharge Depth	Diameter
			(m)	(m)
EA-L-01	Seawater Discharge Caisson	• Seawater return from the seawater distribution system. • Saline reject water from Fresh Water Makers.	- 67	0.8
EA-L-02	Open Drains Caisson	• Hazardous open drains. • HVAC scrubber drains from the Drilling Support Module. • Non-hazardous open drains during non-availability of CRI system. • Overflow from Oily Drains Tank. • Overflow from Drilling Oily Drains Tank. • Overflow from Diesel Tank. • Overflow from Base Oil Tank. • Treated produced water during outage of the Produced Water reinjection System on the C&WP. • Pigging water during early field life.	- 50	1.1
EA-L-03	Sewage Caisson	• Treated sewage from the Drilling Support Module and the Accommodation Block. • Macerated galley food waste.	- 15	0.6
EA-L-04	Cuttings Caisson	• Cooling water return from the Drilling Support Module. • MOL pump cooling water returns. • Drill cuttings and residual drilling fluids from drilling of 26" hole section.	- 97	0.9

Table 5.10: West Azeri PDUQ - Principal Fixed Point Sources of Release to the Marine Environment

Ref No	Source	Effluents Released	Discharge Depth (m)	Diameter (m)
WA-L-01	Seawater Discharge Caisson	• Seawater return from the seawater distribution system. • Saline reject water from Fresh Water Makers.	- 67	0.8
WA-L-02	Open Drains Caisson	• Hazardous open drains. • HVAC scrubber drains from the Drilling Support Module. • Non-hazardous open drains during non-availability of CRI system. • Overflow from Oily Drains Tank. • Overflow from Drilling Oily Drains Tank. • Overflow from Diesel Tank. • Overflow from Base Oil Tank. • Treated produced water during outage of the Produced Water reinjection System on the C&WP. • Pigging water during early field life.	- 50	1.1
WA-L-03	Sewage Caisson	• Treated sewage from the Drilling Support Module and the Accommodation Block. • Macerated galley food waste.	- 15	0.6
WA-L-04	Cuttings Caisson	• Cooling water return from the Drilling Support Module. • MOL pump cooling water returns. • Drill cuttings and residual drilling fluids from drilling of 26" hole section.	- 97	0.9

5.3.2 C&WP

Figure 5.2 below illustrates the principal sources of environmental releases from around the C&WP. Once again, the sources are listed in **Table 5.11** and **Table 5.12**, presented thereafter. The C&WP is a shared Phase 1/Phase 2 facility and for this reason the sources have been colour-coded within the tables. A white background indicates a Phase 2 source, a grey background a Phase 1 source, and a blue background a shared Phase 1/Phase 2 source.

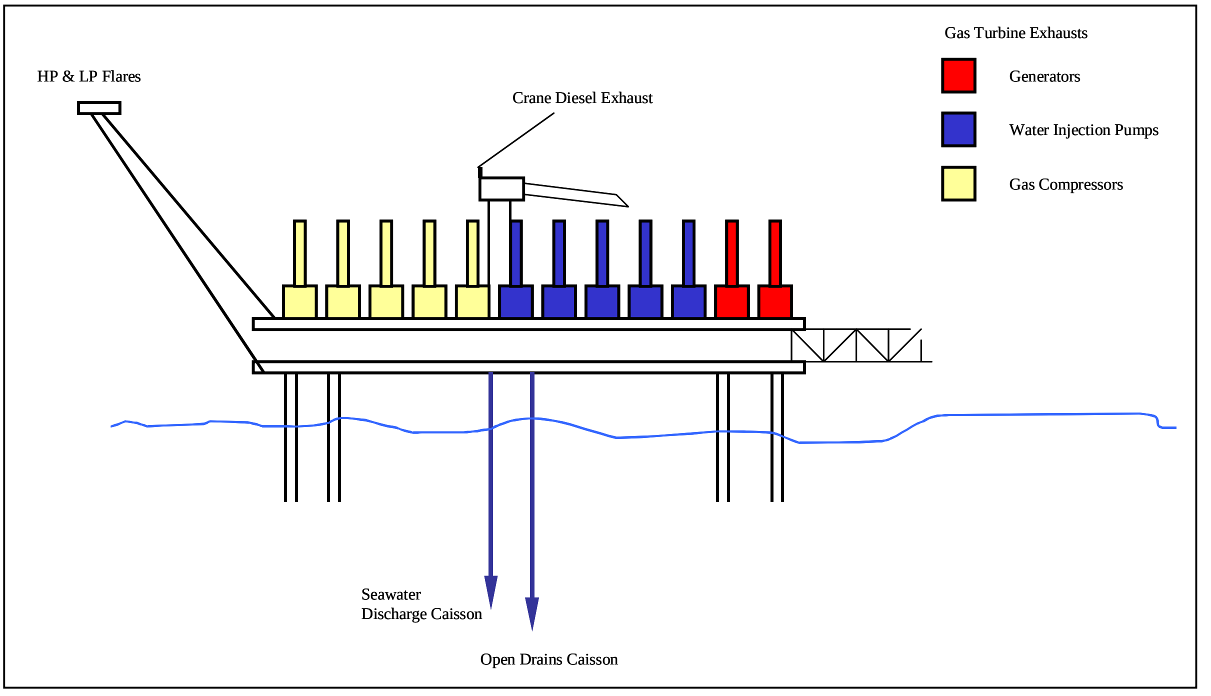


Figure 5.2: C&WP Environmental Release Sources

Table 5.11: C&WP - Principal Fixed Point Sources of Atmospheric Emissions

Ref No	Emissions Source	Emissions Type	Operation
C&WP-A-01	Electrical Generator No.1 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-02	Electrical Generator No.2 Gas Turbine Driver	Combustion gases.	Continuous[1].
C&WP-A-03	Water Injection Pump No.1 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-04	Water Injection Pump No.2 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-05	Water Injection Pump No.3 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-06	Water Injection Pump No.4 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-07	Water Injection Pump No.5 Gas Turbine Driver	Combustion gases.	FUTURE
C&WP-A-08	Gas Compressor No.1 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-09	Gas Compressor No.2 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-10	Gas Compressor No.3 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-11	Gas Compressor No.4 Gas Turbine Driver	Combustion gases.	Continuous.
C&WP-A-12	Export Gas Compressor Gas Turbine Driver	Combustion gases.	FUTURE
C&WP-A-13	HP Flare	Combustion gases	Intermittent with continuous purge and pilot.
C&WP-A-14	LP Flare	Combustion gases	
C&WP-A-15	Crane No.1 Diesel Engine	Combustion gases.	Frequent.

Notes

1. Assumes that the standby generator is located on Central Azeri PDUQ.

Table 5.12: C&WP - Principal Fixed Point Sources of Release to the Marine Environment

Ref No	Source	Effluents Released	Discharge Depth (m)	Diameter (m)
C&WP-L-01	Seawater Discharge Caisson	Seawater return from the seawater distribution system. Pigging water during later field life.	- 40	1.7
C&WP-L-02	Open Drains Caisson	Non-hazardous Open Drains. Hazardous Open Drains.	- 50	1.1

5.3.3 Sangachal Terminal

The environmental release sources for Sangachal Terminal, presented in **Table 5.13**, have been colour coded as per the C&WP: a white background indicates a Phase 2 source, a grey background a Phase 1 source, and a blue background a shared Phase 1/Phase 2 source. The locations of these sources are shown in **Figure 5.3**.

Table 5.13: ACG Phase 2 Principal Fixed Point Sources of Atmospheric Emissions

Ref No	Emissions Source	Emissions Type	Operation
S-A-01	Electrical Generator No.1 Gas Turbine Driver	Combustion gases.	Continuous.
S-A-02	Electrical Generator No.2 Gas Turbine Driver	Combustion gases.	Continuous.
S-A-03	Electrical Generator No.3 Gas Turbine Driver	Combustion gases.	Intermittent.
S-A-04	Electrical Generator No.4 Gas Turbine Driver	Combustion gases.	Continuous.
S-A-05	Electrical Generator No.5 Gas Turbine Driver	Combustion gases.	Continuous.
S-A-06	Oil Heater Train 1	Combustion gases.	Continuous.
S-A-07	Oil Heater Train 2	Combustion gases.	Continuous.
S-A-08	Oil Heater Train 3	Combustion gases.	Continuous.
S-A-09	Oil Heater Train 4	Combustion gases.	Continuous.
S-A-10	HP Flare	Combustion gases.	Intermittent with continuous purge and pilot.
S-A-11	LP Flare	Combustion gases.	
S-A-12	Crude Oil Storage Tank No.1	Hydrocarbons.	Continuous
S-A-13	Crude Oil Storage Tank No.2	Hydrocarbons.	Continuous
S-A-14	Off-spec Crude Oil Storage Tank No.1	Hydrocarbons.	Continuous
S-A-15	Off-spec Crude Oil Storage Tank No.2	Hydrocarbons.	Continuous
S-A-16	Fire Water Pump No.1 Diesel Engine	Combustion gases.	Intermittent (tested for 30 minutes each week).
S-A-17	Fire Water Pump No.2 Diesel Engine	Combustion gases.	

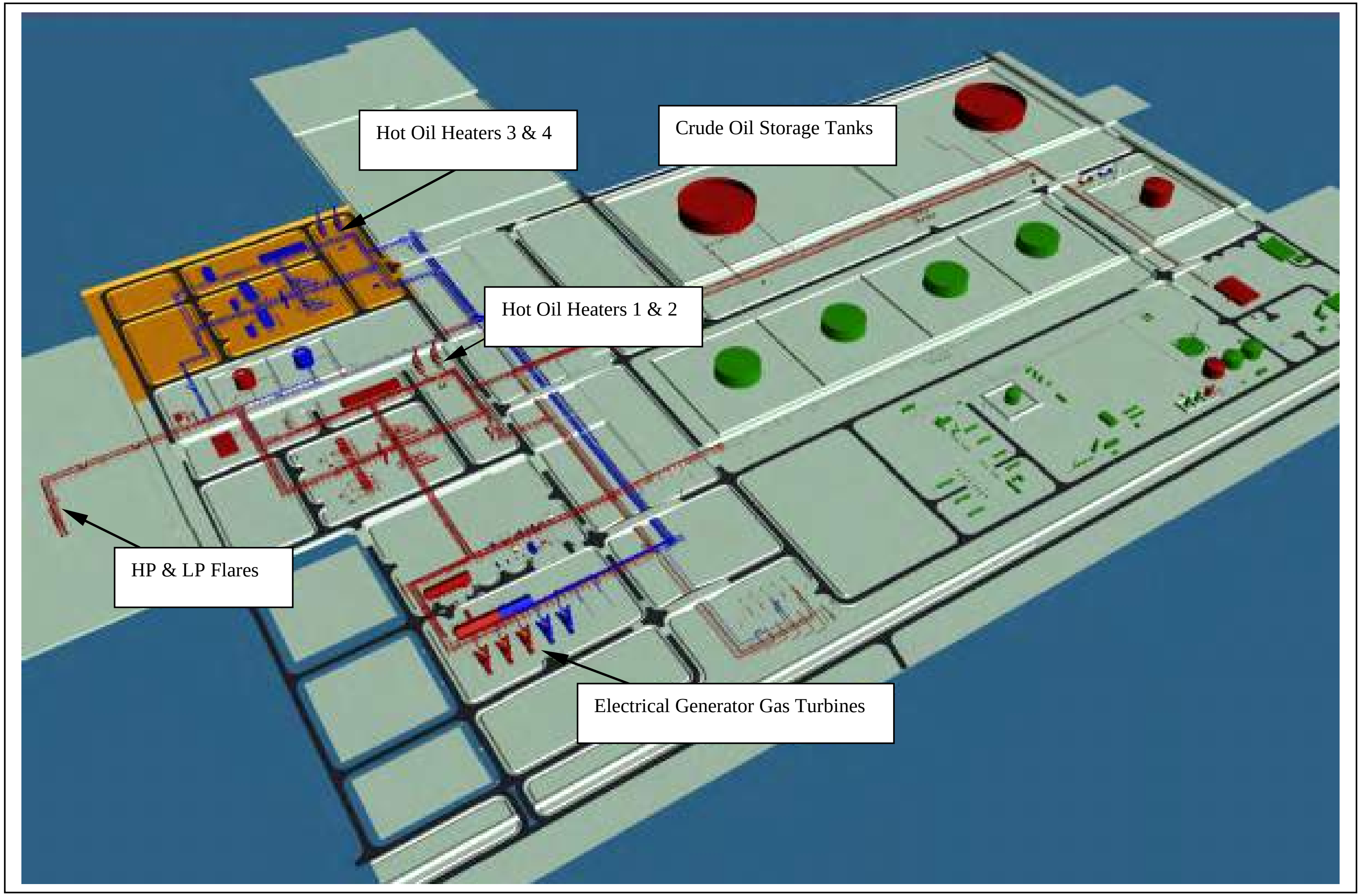


Figure 5.3: Sangachal Terminal Environmental Release Sources

Table 5.14: Sangachal Terminal - Principal Fixed Point Sources of Liquid/Solid Releases to the Terrestrial Environment

Ref No	Source	Liquid/Solid Wastes Released
S-L-01	Contaminated Open Drains System	Non-contaminated open drainage water.
S-L-02	Sewage Treatment System	Treated sewage effluent. Sewage sludge.

5.4 Inventory of Pollutant Releases

5.4.1 Atmospheric Emissions

The atmospheric emissions resulting from the ACG Phase 2 project are set out in a series of tables and graphs below.

Table 5.15: List of Atmospheric Emissions Inventories

Item	Inventory	Phase	Period
Table 5.17	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 2 Operations only excluding construction, installation, and commissioning.	2005 to 2024
Table 5.18	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 1 and Phase 2 Operations combined excluding construction, installation, and commissioning.	2005 to 2024
Figure 5.4	Graph of GHG Emissions	Phase 1 and Phase 2 Operations combined excluding construction, installation, and commissioning.	2005 to 2024
Table 5.19	CO_2 Emissions	Phase 1 and Phase 2 Operations combined *by area* (C&WP, East Azeri, West Azeri, Central Azeri & Sangachal Terminal) excluding construction, installation, and commissioning.	2005 to 2024
Figure 5.5	Pie-chart of CO_2 Emissions	Phase 1 and Phase 2 Operations combined *by area* (C&WP, East Azeri, West Azeri, Central Azeri & Sangachal Terminal) excluding construction, installation, and commissioning.	2005 to 2024
Table 5.20	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 2 Pre-drilling Activities.	Phase 2 Construction Installation & Commissioning
Table 5.21	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 2 Off-shore Platform Construction & Installation.	Phase 2 Construction Installation & Commissioning
Table 5.22	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 2 Off-shore Pipeline Installation & Commissioning.	Phase 2 Construction Installation & Commissioning
Table 5.23	Combustion Emissions (CO_2, CO, NOx, SOx, CH_4, NMVOC & GHG)	Phase 2 Sangachal Terminal Construction & Installation.	Phase 2 Construction Installation & Commissioning

Item	Inventory	Phase	Period
Figure 5.6	Pie-chart of CO_2 Emissions	Phase 1 and Phase 2 Operations combined *by area* (C&WP, East Azeri, West Azeri, Central Azeri & Sangachal Terminal) *including* construction, installation, and commissioning.	2005 to 2024

Estimation Methodology

Combustion Gas Emissions

The releases to atmosphere of combustion gases have been estimated by means of 'emissions factors'. These factors, published by UKOOA and reproduced in the table below, are correlated against both combustion source type, i.e. gas turbine, fired heater, etc, and fuel gas characteristics. In this latter regard a number of points should be noted;

- The likely sulphur content of the fuel gas used offshore is currently unknown. For this reason both the SO_2 emissions factor and the SO_2 emissions data given in the subsequent tables is identified as being on hold;
- The flares are assumed to have a combustion efficiency of 98% (i.e. 98% of the total fuel gas flared will be oxidized to CO_2 and water, leaving a residual 2% hydrocarbon emission by mass);
- The fuel gas is assumed to have a composition of 80% CH_4 and 20% non-methane hydrocarbon.; and,
- The NOx and CO emissions factors have been based upon 'standard' non-specific gas turbines, irrespective of gas turbine operating point, whereas the actual factors will be dependant upon both of these variables. However, given the present uncertainty regarding the likely power management regimes of the turbines both onshore and offshore, the standard factors are considered adequate for estimation purposes.

As a final point, a number of the following tables and figures provide estimates of greenhouse gas emissions (GHG) for the project. GHG estimates are calculated as 'CO_2 equivalents' on a mass basis according to the following equation:

$$GHG\ (te) = CO_2\ (te) + (21 \times CH_4\ (te))$$

Table 5.16: Atmospheric Emissions Factors

Pollutant	Emissions Factor (te/te gas burned)		
	Gas Turbines	**Fired Heaters**	**Flares**
CO_2	2.81	2.81	2.75
NOx	0.0067	0.0031	0.0015
SO_2	[HOLD]	[HOLD]	[HOLD]
CO	0.0027	0.0008	0.0087
CH_4	0.00042	0.00007	0.016
NMHC	0.000051	0.00062	0.004

Note: The H_2S concentration of associated gas is currently unknown, awaiting results from DST of pre-drilling programme. It is therefore not possible at this time to calculate a SOx emissions factor.

Hydrocarbon Emissions from Crude Oil Storage Tanks

Vapour losses from storage tanks occur during filling and emptying, and during standing. These losses are generally referred to as ‘working’ losses and ‘breathing’ or ‘standing’ losses. The external floating roof tanks used for the storage of crude oil are the most effective design in minimising these emissions. The tanks are equipped with a pan, or deck, which rests upon the fluid beneath and moves up and down as the level of the liquid rises and falls. Around its circumference the deck is sealed against the wall of the tank by a primary mechanical shoe seal, which bridges the annulus between the deck and the tank wall. A secondary seal is fitted to improve the sealing.

The working loses in floating roof tanks (‘withdrawal’ losses) occur when a wetted tank wall is exposed to atmosphere as the deck descends. They are typically relatively small. Standing losses are dependent upon the type and condition of the sealing system (‘rim seal’ losses) and the number of fittings on the deck roof (‘roof fitting’ losses). They are generally greater than the working losses.

Atmospheric emissions from the crude oil storage tanks were estimated using the Tanks4 programme, which has been developed, by the US Environmental Protection Agency's (USEPA's) Office of Air Quality Planning and Standards (OAQPS). It calculates emissions based on emissions factors developed by the American Petroleum Institute (API) and published in the Air Pollution (AP) 42 series documentation. In estimating the total annual hydrocarbon emissions the programme takes account of the size, colour and design of a tank, its physical condition, contents and product throughput.

Emissions Data

Table 5.17: Atmospheric Emissions from ACG Phase 2 Operations Only from 2005 to 2024 Excluding Construction, Installation, and Commissioning

Year	Pollutant Emissions						
	CO_2 (kte/yr)	CO (te/yr)	NOx (te/yr)	SOx (te/yr)	CH_4 (te/yr)	NMVOC (te/yr)	GHG (kte/yr)
2005	-	-	-	[HOLD]	-	-	-
2006	331	554	510		713	188	346
2007	990	1,219	1,833		1,084	299	1,012
2008	1,349	1,543	2,629		1,148	319	1,373
2009	1,432	1,626	2,827		1,165	321	1,456
2010	1,461	1,649	2,891		1,165	322	1,485
2011	1,401	1,608	2,780		1,162	315	1,425
2012	1,325	1,550	2,635		1,149	307	1,349
2013	1,334	1,576	2,666		1,177	310	1,359
2014	1,324	1,583	2,653		1,200	312	1,349
2015	1,152	1,443	2,308		1,167	295	1,176
2016	1,137	1,421	2,267		1,155	294	1,161
2017	1,037	1,319	2,054		1,108	281	1,061
2018	949	1,242	1,884		1,073	268	971
2019	909	1,210	1,808		1,061	263	931
2020	940	1,253	1,872		1,099	272	963
2021	968	1,289	1,925		1,133	280	992
2022	938	1,267	1,866		1,133	278	962
2023	891	1,237	1,779		1,133	274	915
2024	872	1,226	1,740		1,141	275	896
TOTAL	20,738	25,816	40,928		21,167	5,473	21,183

Note: The emissions rate for SOx are currently not available, see previous note.

Table 5.18: Atmospheric Emissions from Combined ACG Phase 1 and Phase 2 Operations from 2005 to 2024 Excluding Construction, Installation, and Commissioning

Year	Pollutant Emissions						
	CO_2 (kte/yr)	CO (te/yr)	NOx (te/yr)	SOx (te/yr)	CH_4 (te/yr)	NMVOC (te/yr)	GHG (kte/yr)
2005	446	656	781	[HOLD]	734	189	461
2006	1,109	1,482	1,992		1,503	398	1,141
2007	1,908	2,199	3,647		1,750	482	1,945
2008	2,375	2,603	4,674		1,812	504	2,413
2009	2,465	2,688	4,887		1,825	505	2,503
2010	2,497	2,714	4,954		1,829	508	2,535
2011	2,369	2,630	4,723		1,817	494	2,407
2012	2,259	2,550	4,509		1,805	484	2,297
2013	2,148	2,468	4,291		1,793	474	2,186
2014	2,001	2,357	3,998		1,777	463	2,038
2015	1,788	2,194	3,569		1,752	446	1,824
2016	1,769	2,174	3,520		1,749	447	1,805
2017	1,676	2,099	3,325		1,738	441	1,712
2018	1,601	2,037	3,165		1,729	436	1,637
2019	1,551	1,996	3,059		1,722	433	1,587
2020	1,551	1,998	3,064		1,723	433	1,587
2021	1,514	1,970	2,989		1,719	430	1,550
2022	1,455	1,927	2,875		1,712	425	1,491
2023	1,378	1,875	2,733		1,705	417	1,414
2024	1,335	1,844	2,651		1,700	412	1,370
TOTAL	35,193	42,464	69,407		33,894	8,818	35,905

NB: See previous note.

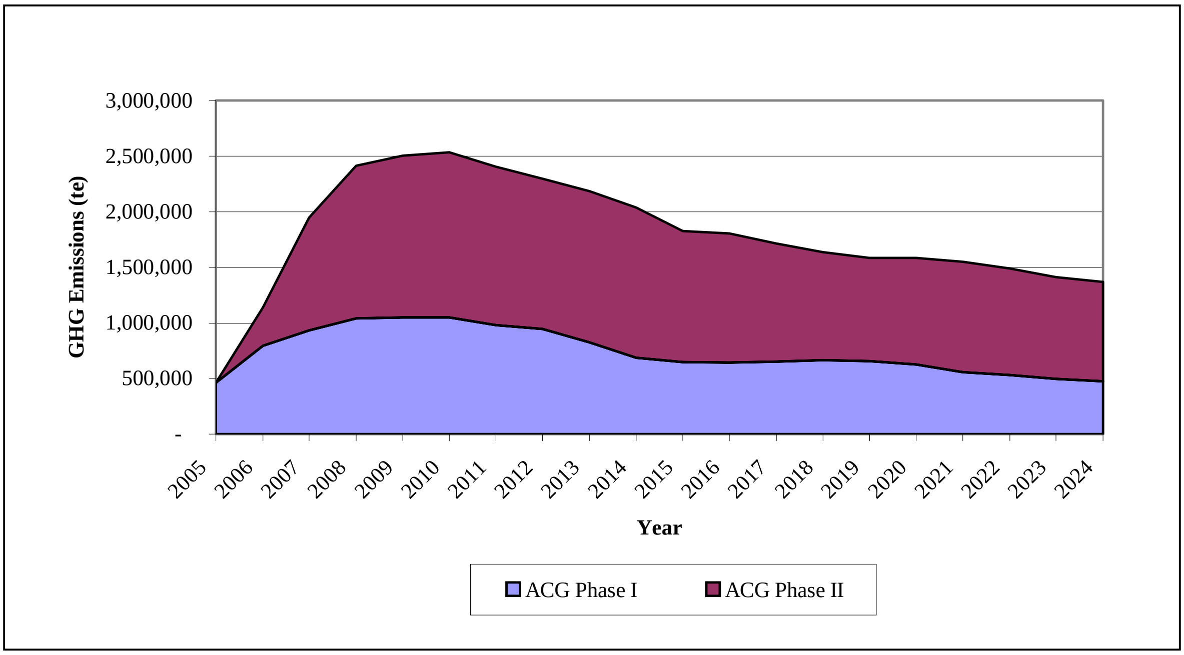


Figure 5.4 GHG Emissions from Combined ACG Phase 1 and Phase 2 Operations from 2005 to 2024 Excluding Construction, Installation, and Commissioning

Table 5.19: CO2 Emissions from Combined ACG Phase 1 and Phase 2 Operations by Area from 2005 to 2024 Excluding Construction, Installation, and Commissioning

Year	CO_2 Emissions (kte)					
	C&WP	East Azeri PDUQ	West Azeri PDUQ	Central Azeri PDUQ	Sangachal Terminal	Total
2005	113	-	-	178	157	448
2006	364	-	135	183	388	1,070
2007	690	130	218	191	682	1,910
2008	951	199	226	191	810	2,378
2009	1,024	206	227	200	810	2,467
2010	1,038	215	215	206	826	2,499
2011	1,038	208	208	203	714	2,371
2012	1,038	209	191	183	640	2,261
2013	1,038	211	190	142	570	2,150
2014	1,026	204	191	101	481	2,003
2015	950	191	184	90	375	1,790
2016	931	190	182	87	380	1,771
2017	897	181	162	87	351	1,678
2018	871	176	159	78	319	1,603
2019	849	174	157	72	301	1,553
2020	841	182	156	78	297	1,553
2021	834	186	154	72	270	1,516
2022	822	183	147	66	239	1,457
2023	794	178	146	66	196	1,380
2024	775	175	146	66	175	1,337
TOTAL	16,882	3,397	3,392	2,542	8,979	35,193

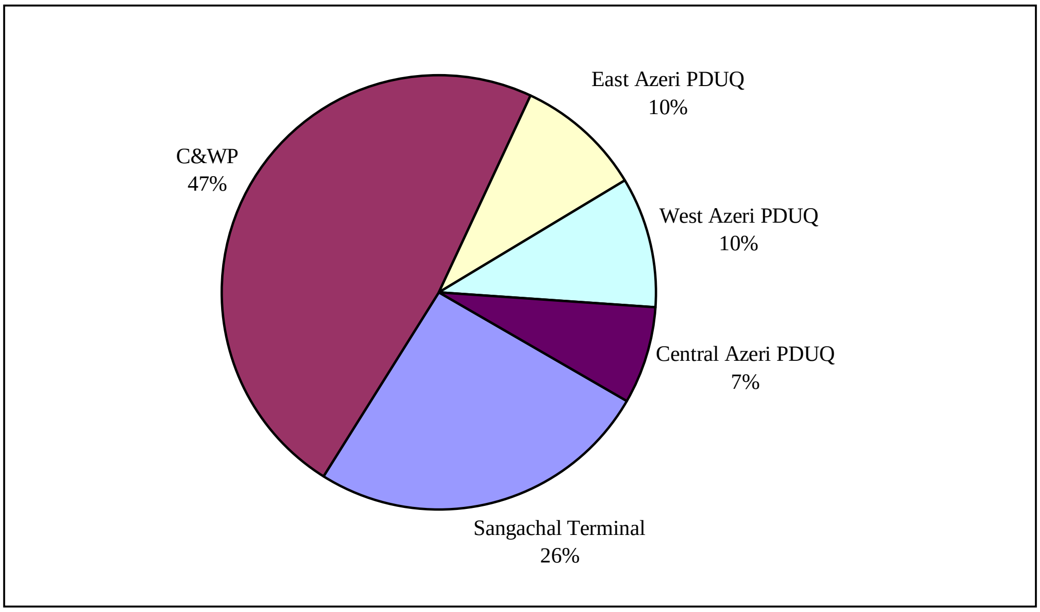


Figure 5.5: Breakdown of Combined Phase 1 and Phase 2 CO2 Emissions by Area - 2005 to 2024 Excluding Construction, Installation and Commissioning

Table 5.20: Atmospheric Emissions – Pre-drilling Activities

Operation	Pollutant Emissions					
	CO_2 (te)	CO (te)	NOx (te)	SOx (te)	CH_4 (te)	NMVOC (te)
Rig Transfer	460	2	8	2	1	1
Power Generation	28,512	196	726	41	2	1
Well Test Flaring	22,506	20	50	See notes	56	318
Vessel Travel	33,178	82	612	28	2	24
Helicopter Travel	758	2	2	2	-	-
TOTAL	**85,414**	**302**	**1,398**	**73**	**61**	**344**

Basis of Estimate

- Transfer & installation of the Dada Gorgud at each well drilling site will take 3 tugboats 4 days to complete.
- A total of 9 wells will be drilled from the Dada Gorgud at each location. Each will take 64 days to complete. The total duration of the drilling programme is therefore 576 days at each location.
- Typical diesel fuel consumption is as follows: i) Dada Gorgud: 9 te/day, ii) standby vessel: 3 te/day, iii) supply vessel: 6 te/day.
- Supply vessel trips: 7 return trips per week, each of 10 hours.
- Helicopter fuel consumption: 0.24 te/hr.
- Helicopter trips: 4 return trips per week, each of 1½ hours
- At each location there will be 3 well tests for a total period of 88 hours, resulting in 32 hours of flaring, with a maximum flow rate of less than 10,000 bbl per well.
- GOR = 1,100 scf/bbl.
- SOx data not available see note **Table 5.5**.

Table 5.21: Atmospheric Emissions – Offshore Platform Construction & Installation

Operation	Pollutant Emissions					
	CO_2 (te)	CO (te)	NOx (te)	SOx (te)	CH_4 (te)	NMVOC (te)
Power Generation	12,600	52	196	12	0	14
Buses, Trucks, etc	37,200	178	398	42	6	34
Cranes	8,000	48	286	348	14	84
Other Diesel Equipment	4,200	24	60	6	0	6
TOTAL	**62,000**	**302**	**940**	**408**	**20**	**128**

Basis of Estimate

The estimate has been developed from data presented in Figures 5.13 to 5.16 of the Phase 1 ESIA assuming that: a) the construction of the East and West Azeri PDUQs will result in twice the emissions resulting from the construction of Central Azeri PDUQ (given in Figures 5.13 & 5.14), and b) further Phase 2 work on the construction of the C&WP will result in an additional 50% of the Phase 1 emissions reported in Figures 5.15 & 5.16.

Table 5.22: Atmospheric Emissions – Pipeline Installation & Commissioning

Operation	Pollutant Emissions					
	CO_2 (te)	CO (te)	NOx (te)	SOx (te)	CH_4 (te)	NMVOC (te)
Installation	70,000	364	2690	364	12	110
Commissioning	20,000	108	796	0	4	32
TOTAL	**90,000**	**472**	**3486**	**364**	**16**	**142**

Basis of Estimate

- Vessel requirements: i) 1 lay-barge/saturation diving support vessel (210 POB) for 300 days, ii) 3 anchor handling vessels (15 POB each) for 300 days, iii) 4 pipe haul barges (14 POB each) for 300 days, iv) 2 tugs for 180 days, v) 1 air diving support vessel (26 POB) for periodic support, and vi) 1 survey vessel (15 POB) for 300 days.
- Typical diesel fuel consumption is as follows: i) lay-barge: 15 te/day, ii) anchor handling vessel: 6 te/day, iii) pipe haul barge: 15 te/day, iv) air diving support vessel: 6 te/day, and v) survey vessel: 6 te/day.

Table 5.23: Atmospheric Emissions – Sangachal Terminal Construction & Installation

Operation	Pollutant Emissions					
	CO_2 (kte)	CO (te)	NOx (te)	SOx (te)	CH_4 (te)	NMVOC (te)
Power Generation	7,000	33	136	5	2	6
Buses, Trucks, etc	38,000	206	444	49	10	58
Cranes	7,500	52	310	9	16	93
Other Diesel Equipment	5,500	39	157	3	3	13
TOTAL	**58,000**	**330**	**1047**	**66**	**31**	**170**

Basis of Estimate

The emissions resulting from the Phase 2 expansion of Sangachal Terminal are assumed to be identical to those for Phase1, which are presented in Figures 5.57 and 5.58 of the Phase 1 ESIA.

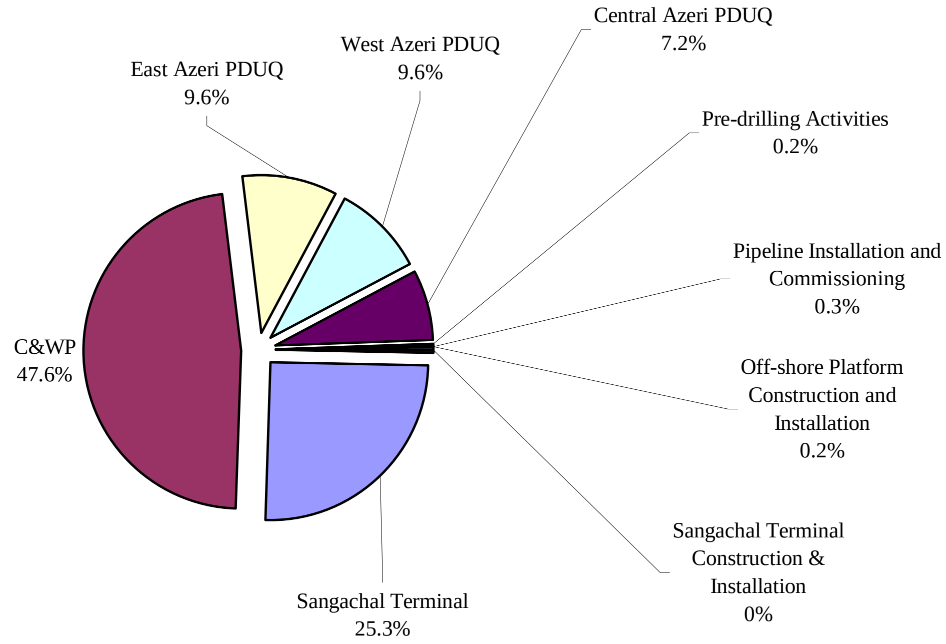


Figure 5.6: Breakdown of Combined Phase 1 and Phase 2 CO2 Emissions by Area - 2005 to 2024 Construction, Installation, Commissioning and Operations

5.4.2 Releases to the Marine Environment

The discharges to the marine environment resulting from the ACG Phase 2 project are set out in a series of tables and graphs below.

Table 5.24: List of Marine Discharge Inventories

Item	Inventory	Phase	Period/Comment
Table 5.25	Produced Water Discharges from East & West Azeri	Phase 2 Operations only excluding construction, installation, and commissioning.	2005 to 2024
Figure 5.7	Graph of Produced Water Discharges from East & West Azeri	Phase 2 Operations only excluding construction, installation, and commissioning.	2005 to 2024
Table 5.26	Seawater/Cooling Water Discharges to Sea at East and West Azeri, and the C&WP	Phase 2 Operations excluding construction, installation, and commissioning.	Design & maximum rates
Table 5.27	Black & Grey Water Discharges to Sea at East and West Azeri	Phase 2 Operations excluding construction, installation, and commissioning.	Design & maximum rates
Table 5.28	Pigging Waste Water Discharges to Sea at East and West Azeri	Phase 2 Operations excluding construction, installation, and commissioning.	Annual rates early and later field life, base case & alternative

Item	Inventory	Phase	Period/Comment
Table 5.29	Drill Cuttings & Muds – Top Hole & 26" Hole Section Discharges to Sea at East and West Azeri	Phase 2 Operations excluding construction, installation, and commissioning.	Total 74 wells Majority over a 7/8 year period
Table 5.30	Discharges to the Marine Environment	Phase 2 Pre-drilling Activities at East & West Azeri Platform Locations using *Dada Gorgud* semi-submersible rig.	Total 16 wells Over 1.5 years prior to platform installation
Table 5.31	Possible discharge to the Marine Environment	Phase 2 Drilling of 26" hole section if WBM is used	Contingency only
Table 5.32	Discharges to the Marine Environment	Phase 2 Off-shore Pipeline Installation & Commissioning.	
Table 5.33	Discharges to the Marine Environment	Phase 2 Sangachal Terminal Construction & Installation.	

Produced Water

As stated in the Project Description, in the event of a failure of the C&WP's water injection system, treated produced water (i.e. water meeting the project's oil-in-water specification) will be discharged to the Caspian via the Open Drains caisson on the East and West Azeri platforms.

The Phase 2 project has a design availability of 95%. Therefore, as a provisional estimate, it can be taken that 5% of the produced water handled on the platforms throughout the project life may be discharged to sea. On the basis of the current produced water profiles (**Figure 3.7**), the volumes of produced water likely to be discharged to the Caspian each year are summarised in **Table 5.25**. This discharge profile is illustrated graphically in **Figure 5.7**.

Table 5.25: Phase 2 Produced Water Discharges to Sea at East & West Azeri on the Basis of 95% Availability of Water Reinjection System

Year	Produced Water Discharge		Year	Produced Water Discharge	
	(bpd)	(mb/annum)		(bpd)	(mb/annum)
2005	0	0	2015	9,490	3,464
2006	0	0	2016	7,905	2,885
2007	0	0	2017	7,083	2,585
2008	0	0	2018	7,078	2,583
2009	843	308	2019	6,523	2,381
2010	4,273	1,559	2020	5,358	1,955
2011	5,090	1,858	2021	4,555	1,663
2012	6,445	2,352	2022	4,625	1,688
2013	8,578	3,131	2023	4,383	1,600
2014	11,448	4,178	2024	3,318	1,211

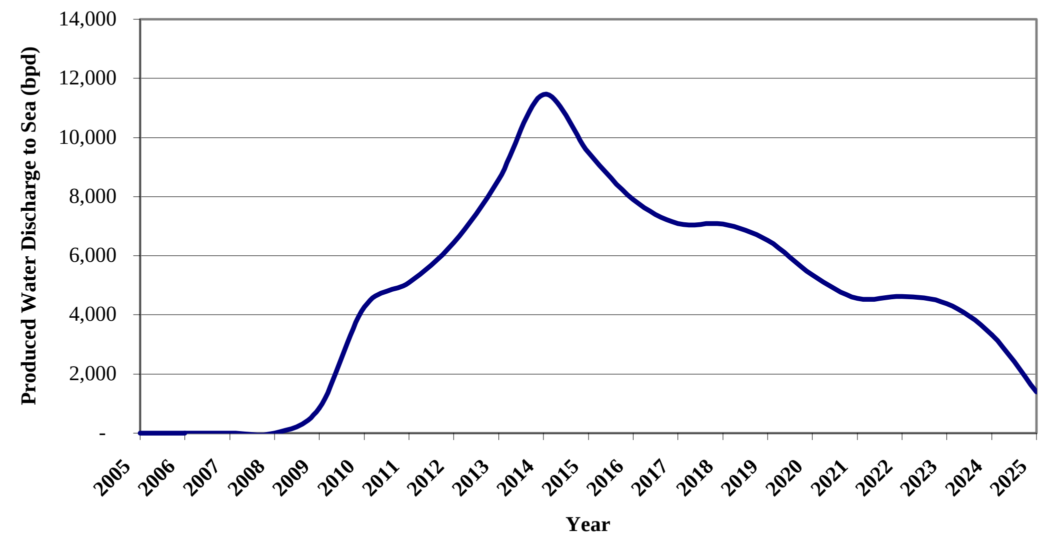


Figure 5.7: Produced Water Discharges to Sea on the Basis of 95% Availability of Water Reinjection System at East and West Azeri, and the C&WP

Seawater/Cooling Water

Table 5.26: Phase 2 Seawater/Cooling Water Discharges to Sea

Platform	Seawater/Cooling Water Discharge Rate (m^3/hr)		Notes
	Average	Maximum	
East Azeri PDUQ	1,700[2]	2,100	The returned seawater contains free chlorine at a bulk concentration of 10 ppb and copper at a concentration of 1 ppb. The seawater is returned at a temperature of approximately 25°C.
West Azeri PDUQ	1,700[2]	2,100	
C&WP[1]	5,230	10,500	

Notes.

1). The C&WP discharge rates apply to combined Phase 1/Phase 2 operations.

2). Assumes that all of the cooling water is returned to sea via the Seawater Discharge Caisson. In reality, only 660 m^3/hr is returned via the caisson with the remaining flow sent to the Cuttings Caisson or reinjected via the CRI system.

East & West Azeri Black & Grey Waters

Table 5.27: Phase 2 Black & Grey Water Discharges to Sea at East and West Azeri

Platform	**Black & Grey Water Discharge Rate (m^3/day)**		**Notes**
	Average	**Maximum**	
East Azeri PDUQ	58	96	Effluent generation rates based on 0.1 m^3 of black water and 0.22 m^3 of grey water per person per day. Total number of personnel: 180 on average with a peak of 300. Sewage treatment package has a maximum design black water treatment capacity of 56 m^3/day.
West Azeri PDUQ	58	96	

Pigging Waste Waters

Table 5.28 presents estimates of the volumes of waste water likely to be discharged to sea as a result of produced and reinjection water pipeline pigging operations. In the case of the produced water lines the transition date from 'early field life' to 'later field life' has yet to be confirmed. However, all produced water discharges will be compliant with the project's oil-in-water discharge standard. In the case of the reinjection water pipeline 'alternative', the only produced water discharges to sea will be those flows in excess of the produced water lines' design capacity.

Table 5.28: Phase 2 Pigging Waste Water Discharges to Sea at East and West Azeri

Pipeline	No.	Pigging Frequency	Pipeline Volume (m^3)	Scenario	Annual Pigging Waste Water Discharge (m^3)	Annual Pigging Waste Water Discharge (mbbls)	Discharge Point
14" Produced Water	2	Once per month	780	Early field life	18,720	118	East/West Azeri Open Drains Caisson
				Later field life	400[1]	2.5	C&WP Seawater Discharge Caisson
16" Reinjection Water	2	Once every 3 months	840	Base Case	Nil	Nil	Disposal via water reinjection system.
				Alternative	[HOLD]	[HOLD]	East/West Azeri Open Drains Caisson
18" Reinjection Water	1	Once every 3 months	530	Base Case	Nil	Nil	Disposal via water reinjection system.
				Alternative	[HOLD]	[HOLD]	East/West Azeri Open Drains Caisson

Notes
1). Assumes final 2% of pigging waters discharged to caisson.

Drill Cuttings & Muds – Top Hole & 26" Hole Section (Platform Drilling Only)

The amount of cuttings and seawater/WBM discharged from the platforms (East and West Azeri) is presented in **Table 5.29**. As already mentioned in **Chapter 3,** it is only from the 36" top hole and 26" sections that cuttings and seawater/WBM will be permitted for disposal to sea. The base case is for the 30" conductor to be driven using a hydraulic hammer. There will be no mud or cuttings discharge from this operation. If drilling is necessary as a result of operational difficulties seawater and cuttings will be discharged directly to the seafloor. All discharges from the 26" section will be via the cuttings caisson 97 m below the sea surface.

Table 5.29 below presents a range of volumes of discharge as the strategy for setting the surface conductor may vary with operational difficulties as mentioned above, hence the two totals bracketing the two upper and lower levels of discharge.

Table 5.29: Phase 2 Drill Cuttings & Muds – Top Hole & 26" Hole Section Discharges to Sea at East and West Azeri (Platform Drilling Only)

Hole Section	**Section Length**	**Cuttings Generation**	**Mud Generation**	**Total Cuttings & Mud**
(inches)	**(m)**	**(m^3)**	**(m^3)**	**(m^3)**
Top Hole (36)	150	Range 0-180	Range 0-359	Range 0-539
26	350	173	104	277
Total Discharge per Well [1]				**Range 277-816**
Total Number of Platform Wells for East Azeri				**42**
Total Number of Platform Wells for West Azeri				**32**
Total Discharge Range for East Azeri Platform Wells				**11,634-34,272**
Total Discharge Range for West Azeri Platform Wells				**8,864-26,112**

Note
1) Estimate based upon data presented in Table 5.12 of Phase 1 ESIA and KC-2DZZZZ-DR-CAL-0001.

Pre-drilling Activities

The anticipated cuttings and mud discharge during pre-drilling, carried out by *Dada Gorgud* at the East and West Azeri locations, is shown in **Table 5.30**. Cuttings and seawater from the top hole section will be discharged directly to the seafloor. Cuttings and seawater/WBM from the 26" section will be discharged via the *Dada Gorgud* cuttings caisson at 11 m below the sea surface.

Table 5.30: Discharges to the Marine Environment at East & West Azeri Locations – Pre-drilling Activities

Discharge	Discharge Estimate	Notes
Cuttings and WBMs from 36” top-hole and 26" hole sections.	8,160 m^3 at West Azeri	Estimate based on 10 wells at cuttings and mud generation rates given in **Table 5.29**. [1, 2]
Cuttings and WBMs from 36” top-hole and 26" hole sections.	4,896 m^3 at East Azeri	Estimate based on 6 wells at cuttings and mud generation rates given in **Table 5.29**. [1, 2]
Sea/cooling waters.	600 m^3/hr	*Dada Gorgud* cooling water flow rate. Anti-foulant chemicals are not added to the seawater.
Treated sanitary effluent and grey waters.	43 m^3 per platform location	Effluent generation rates: 0.1 m^3 of black water and 0.22 m^3 of grey water per person per day. Total number of personnel: 135 (120 on rig and 15 on supply vessel) Duration of pre-drill activities: 576 days per platform location.
Drainage water.	Variable	

Notes:
1) Pre-drilling 36” hole is carried out using a spud mud prior to running and cementing 30” casing, cuttings and mud are not returned to surface, but are discharged directly to the seabed.
2) The usage and therefore discharge of WBM for 26” hole sections is subject to operational variability. If WBM is, at the end of 26” section, in a re-usable condition it will be shipped ashore to be stored awaiting re-shipment and re-use. If the WBM is not re-usable it will be discharged. Hence, the above total is a maxima value for discharged cuttings and mud.

Discharge of Drilling Mud Components

The base case drilling fluid for both the top hole (if drilled) and 26” sections of the wells is seawater with added viscous sweeps. However, as a contingency a more complex WBM may be used for the 26” hole section where mud and cutting s will be discharged via the cuttings caisson. Possible chemical usage per well is indicated in **Table 5.31**.

Table 5.31 WBM and estimated chemical usage from each 26” hole section

Chemical	Composition	Function	Estimated use 26” (tonnes)	HOCNF Category[1]
Barite	Barium sulphate	Weighting agent	350	E
Bentonite	Clay	Viscosifer and removal of cuttings	50	E
KOH	Potassium hydroxide	Acidity control	0.15	D
KCl	Potassium chloride	Borehole stabiliser	3	E
Soda ash	Sodium carbonate	Chemical balance	0.08	E
Guar gum	Non-ionic polymer	Viscosifer and removal of cuttings	0.18	E
Polypac R Polysal	Poly anionic cellulose based polymer (PACP). Partilaay hydrolysed polyacrylamide	Fluid loss control and reduces risk of string sticking	3.3	D
XCD	Bioolymerr	Viscosifer and weighting agent – suspension and removal of cuttings	1.25	E
Glydrill	Alkyl glycol	Stabiliser to plug microfractures	33.5	E

Note
1) Harmonised Offshore Chemical Notification Format (HOCNF) scheme. HOCNF category E is the lowest category. Category E chemicals are of low aquatic toxicity, readily biodegradable and non-bioaccumulative.

Pipeline Installation & Commissioning

The current position regarding ultimate disposal of hydrotest water is under review and is subject to the outcome of a study. **Table 5.32** indicates the volumes of hydrotest water to be disposed in an acceptable manner.

Table 5.32: Discharges to the Marine Environment – Pipeline Installation & Commissioning

Discharge	Discharge Volume (bbls)	Notes
Hydrotest waters - 30" Oil line	500,000	• Feasibility study is ongoing to determine a disposal route for Phase 1 hydrotest water. If applicable Phase 2 will use the same route. If not, a new feasibility study will carried out. • Hydrotest waters contain oxygen scavenger, UV dye, biocide, and corrosion inhibitor. The concentrations of these chemicals at the time of discharge has yet to be confirmed.
Hydrotest waters – Produced Water lines	7,500	[HOLD]
Hydrotest waters – Reinjection Water lines	14,000	[HOLD]
Hydrotest waters – Gas line	19,000	[HOLD]
Hydrotest waters – Lift Gas line	1,500	[HOLD]

Sangachal Terminal Construction & Installation

The hydrotest water generated during the early testing of equipment within the Sangachal Terminal, shown in **Table 5.33**, is also subject to an ongoing feasibility study attempting to identify a suitable disposal option.

Table 5.33: Discharges to the Marine Environment – Sangachal Terminal Construction & Installation

Discharge	Discharge Estimate	Notes
Hydrotest waters – pipeline/vessel testing at terminal	800,000	• Feasibility study is ongoing to determine a disposal route for Phase 1 hydrotest water. If applicable, Phase 2 will use the same route. If not, a new feasibility study will be carried out. • Hydrotest waters contain biocide. The concentration of this chemical has yet to be confirmed.

Table 5.34: Estimated amounts of sanitary waste discharged to sea the transportation / installation / commissioning pipeline activities

Parameters		Installation
Grey water (m^3)	Per day:	70
	No days:	638
	Total:	44660
Black Water (m^3)	Per day:	32
	No days:	638
	Total:	20416

5.4.3 Releases to the Terrestrial Environment

The following tables are based upon work carried out during Phase 1, involving the identification and estimation of the solid and liquid waste streams. It is anticipated that Phase 2 will generate similar quantities and types of waste and there will be no significant difference in volumes or disposal routes.

Table 5.35: Estimated amounts of sanitary waste discharged during terminal construction operations

Parameters		Emissions
Grey water (m^3)	Per day:	132
	No of Days:	900
	Total:	118,800
Black Water (m^3)	Per day:	60
	No of Days:	900
	Total:	54,000

Table 5.36: Estimated annual amounts of sanitary waste discharged during terminal operations

Parameters		Emissions (per annum)
Grey water (m3)	Per day:	7
	Total:	2,730
Black Water (m3)	Per day:	3
	Total:	1,241

5.4.4 Solid & Liquid Wastes

Table 5.37: Estimated wastes during offshore platform construction and installation

Category/Waste type	**Annual Waste Generated**			
	<1 Tonne	**<10 Tonne**	**<100 Tonne**	**>100 Tonne**
Non-Hazardous Combustible Solid Waste				
Paper and cardboard			♦	
Wood, packing crates			♦	
Non-Hazardous Non Combustible Solid Waste				
Cable/electrical wire		♦		
Scrap metals				♦
Surplus construction material (concrete, aggregate)				♦
Insulation				♦
Plastic wrapping			♦	
Polystyrene chips				♦
Other metals (nails, solder)			♦	
Hazardous solid waste				
Empty drums				♦
Sand/shotblast materials				♦
Absorbents (spill clean-up)			♦	
Welding flux			♦	
Dessicants			♦	
Hazardous liquid waste				
Lubricating Oil			♦	
Oil	♦			
Paints	-	-	-	-
Solvents	-	-	-	-
Primers	-	-	-	-

Table 5.38: Estimated waste generation on the offshore facilities during operation

Category/Waste type	Annual Waste Generated (per annum)			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	♦			
Wood		♦		
Office dry waste, packaging			♦	
Non-Hazardous Non Combustible Solid Waste				
Electrical wire	♦			
Scrap metals		♦		
Wire rope, slings, netting	♦			
Hazardous solid waste				
Empty drums		♦		
Filters		♦		
Filtration solids	-	-	-	-
Clean out residues	-	-	-	-
Pig receiver residues	♦			
Activated carbon filter	♦			
Filter residues	♦			
Rags		♦		
Sand/shot blast materials			♦	
Batteries	♦			
Transformers		♦		
Capacitates				
Absorbents (spill clean-up)	♦			
Resins		♦		
Fire fighting agents		♦		
Clinical Waste	♦			
Hazardous liquid waste				
Lubricants	♦			
Diesel	-	-	-	-
Paints	♦			
Greases	-	-	-	-
Hydraulic Fluid	♦			
Oil				♦
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis	♦			
Drilling Chemicals			♦	
Rig wash		♦		

Table 5.39: Estimated waste generation from the Dada Gorgud during the drilling programme at East and West Azeri (1152 days)

Waste	Classification	Quantity
General waste	Non-hazardous combustible solid waste	252 tonnes
Waste oil	Hazardous liquid wastes	62 tonnes
Chemical sacks	Hazardous solid waste	114 tonnes
Empty drums (55 gal)	Hazardous solid waste	244
Empty drums (25 litre)	Hazardous solid waste	594
Scrap metal	Non-hazardous non combustible solid waste	70 tonnes
Fluorescent tubes	Hazardous solid waste	0.64 tonnes
Clinical waste	Hazardous solid waste	228 kg
Oily/paint solids	Hazardous liquid wastes	40 tonnes
Paint thinner	Hazardous liquid wastes	3.2 tonnes

Table 5.40: Estimated waste types and volumes for a 6 month pipeline installation programme offshore

Category/Waste type	Annual Waste Generated (per annum)			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	♦			
Wood		♦		
Food Waste		♦		
Non-Hazardous Non Combustible Solid Waste				
Electrical wire	♦			
Scrap metals		♦		
Scrap electrical materials	♦			
Hazardous solid waste				
Empty drums		♦		
Filters		♦		
Rags		♦		
Sand/shotblast materials		♦		
Absorbents (spill clean-up)	♦			
Clinical Waste	♦			
Hazardous liquid waste				
Oil				♦
Paints	♦			
Thinners	♦			

Table 5.41: Estimated waste types and volume (tonnes) terminal operations only

Category/Waste type	Annual Waste Generated			
	<1 Tonne	<10 Tonne	<100 Tonne	>100 Tonne
Non-Hazardous Combustible Solid Waste				
Paper and cardboard	♦			
Wood		♦		
Non-Hazardous Non Combustible Solid Waste				
Inert (e.g. building rubble)		♦		
Scrap metal		♦		
Wire rope, slings, netting	♦			
Electrical wire	♦			
Hazardous solid waste				
Sand/shotblast materials			♦	
Absorbents (spill clean-up)	♦			
Batteries	♦			
Transformers		♦		
Capacitors	♦			
Clinical waste	♦			
Radioactive	♦			
Empty drums (metal and plastic)		♦		
Filters		♦		
Rags		♦		
Resins		♦		
Hazardous liquid waste				
Greases		♦		
Hydraulic fluid			♦	
Oil				♦
Lubricants			♦	
Diesel		♦		
Paints	♦			
Thinners	♦			
Coatings	♦			
Solvents	♦			
Acids	♦			
Alkalis	♦			
Fire fighting agents		♦		

6. ENVIRONMENTAL DESCRIPTION AND SENSITIVITIES

This chapter defines and describes the environment within which the ACG Phase 2 Project will take place, and identifies the key environmental sensitivities against which the impacts of the project will be assessed.

6.1 Introduction

The chapter covers the onshore environment in the vicinity of the Sangachal Terminal, the nearshore environment through which the pipeline will be laid and the offshore environment in which the drilling and hydrocarbon extraction occur. The three zones are defined, for the purposes of this assessment, below;

- Onshore (mainly focused on the area surrounding the Sangachal Terminal down to the Caspian, but also includes coastlines which could be impacted by an offshore or nearshore oil spill);
- Nearshore (water depth less than 10m, description primarily of Sangachal Bay); and,
- Offshore (open water, depth greater than 10m).

(See **Figures 1.2** and **8.1**)

These areas are described in more detail in **Sections 6.3, 6.4** and **6.5** respectively. Some more general features of the physical environment are included in **Section 6.2**.

For the purposes of this description, the 10m water depth contour has been selected as the definition between the nearshore and offshore zones. However, it should be considered as a guide only, as there is a gradation from nearshore to offshore with regard to the natural processes rather than a precisely definable threshold.

Section 6.6 provides a summary of the environmental sensitivities.

A general overview of the Caspian Sea is shown in **Figure 6.1** presenting place names and features mentioned in the text.

Figure 6.1: The Caspian Sea

6.1.1 Data Sources

The ACG Phase 2 ESIA covers activities in many locations common to the ACG Phase 1 ESIA (URS, 2002). Within the baseline description chapter of the Phase 1 ESIA there are detailed descriptions of all the environments in which AIOC activities will take place. This current document refers frequently to the details held in the earlier ESIA, and in many cases the sections below provide only a summary of the previously presented information.

A series of environmental surveys and data reviews have been carried out in and around the ACG contract area, pipeline route, nearshore environment at Sangachal Bay and onshore environment in the vicinity of the Sangachal Terminal. These have been drawn upon as the main information sources for the description of the environment provided below. **Table 6.1** lists the documents reviewed.

Table 6.1: Field and Monitoring Surveys Providing Input to this Chapter

Date	Title of Survey
Marine Surveys	
1992	Pilot Environmental Survey, Chirag oilfield
1995	Environmental baseline study: Review of the existing scientific literature applicable to AIOC contract area
1995	AIOC Offshore Environmental Baseline Survey 1995, September and December
1996	Pipeline landfall survey: sediments and macrobenthos
1996	AIOC Contract Area Long Term Monitoring Stations, 1996
1996	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey 1996
1996	Sangachal coastal environmental survey, 1996
1997	AIOC Appraisal Well 1 Pre and Post Appraisal Drilling Seabed Environmental Survey 1997
1997	AIOC Appraisal Well GCA No. 3 and Appraisal Well GCA No. 4, Post Appraisal Drilling Seabed Environmental Surveys, 1997
1998	AIOC Chirag 1 mid drilling environmental survey, 1998
1998	AIOC Phase 1 environmental description, 1998 (draft)
1998	Phase 1 Platform 1a and 1b environmental baseline surveys
1999	Review of AIOC environmental monitoring, 1999
1999	Chevron Absheron Exploration Drilling EIA
1999–2001	Gunashli field fisheries surveys
2000	Chirag 1 post Saraline survey, 2000
2000	GCA 5 and 6 post well survey, 2000
2000	Chirag - Sangachal sub-sea pipeline survey, 2000
2000	Sangachal coastal environmental survey, 2000
2001	ACG Phase 1 ESIA Surveys
2001	SD1 (and pipeline) survey
2001	GCA7 environmental survey
2000-2001	Sangachal fisheries monitoring programme
2002	ACG Phase 2 environmental survey (preliminary data only)
Terrestrial Surveys	
1996	EOP Sangachal Terminal survey
2001	Phase 1 Terrestrial Survey
2002	Phase 2 Terrestrial Survey

6.2 Physical Environment - General

6.2.1 Geology and Geomorphology

The dominant geological structures of the Caspian region were formed during the period of tectonic movement that resulted in the formation of the Caucasus Mountains and the associated basin and plateau structures that form the Caspian and adjacent onshore regions. Numerous erosional alterations to the landscape have occurred since the original structures were formed. Ensuing periods of tectonic compression (mainly during the Late Pliocene period) resulted in the production of a number of folded structures within the region, forming a number of anticlines (upward thrusting folds).

The offshore geology of the Caspian is composed of a block structure with numerous rises and depressions separated by deep basement faults. The faulting present within the crust forms complex intersecting systems. Deep faults and extensive shallow faults are present, orientated in a NW-SE direction.

The offshore geomorphology varies across the Contract Area from ridges and scarp slopes to slump areas, debris flows, mud volcanoes and buried volcano structures.

Subsea landslides and slumping cause disturbance of the offshore environment, and can be induced by earthquakes and mud volcano activity. Displaced sediments travel into the deeper water areas found in parts of the south Caspian Basin. Mud volcano eruptions can initiate sediment movements on even the most gentle slopes, and underwater turbidity currents can transport these muds over large distances.

A typical stratigraphic column for the ACG area (**Figure 6.2**) shows sedimentary strata, which are mainly rich in claystones with varying characteristics. The claystones are interlayered with siltstone and sandstone beds, and contain high proportions of quartz. Lower in the sequence, units are encountered with potential as oil reservoirs, and in areas the claystones become progressively siltier and sandier with increasing depth before the sandstone develops.

In order to create this pattern the depositional environment will have progressed from a low energy environment (for example deep water remote from coastal areas or weaker currents) in which fine grained materials are deposited (claystones) to periods of higher energy (stronger ocean currents, shorter distance to shore or high energy storm events) resulting in deposition of slightly larger particles (the siltstone and sandstone interlayers). Where units with high hydrocarbon contents are encountered, a depositional environment is indicated in which organic material was deposited, which suggests a terrestrial environment in which plant remains built up prior to re-immersion and continued marine or alluvial deposition. The fine to medium grained nature of the sandy deposits suggests that the rate of deposition was generally slow, with possible periods of faster deposition where coarser grained sediments are encountered.

In Azerbaijan as a whole over 95% of discovered hydrocarbons are found within the Productive Series rocks from the Upper Miocene - Late Pliocene period. In the case of the ACG fields, approximately 56% of the oil is found in the Pereriv formation with the remainder being found in the Balakhany.

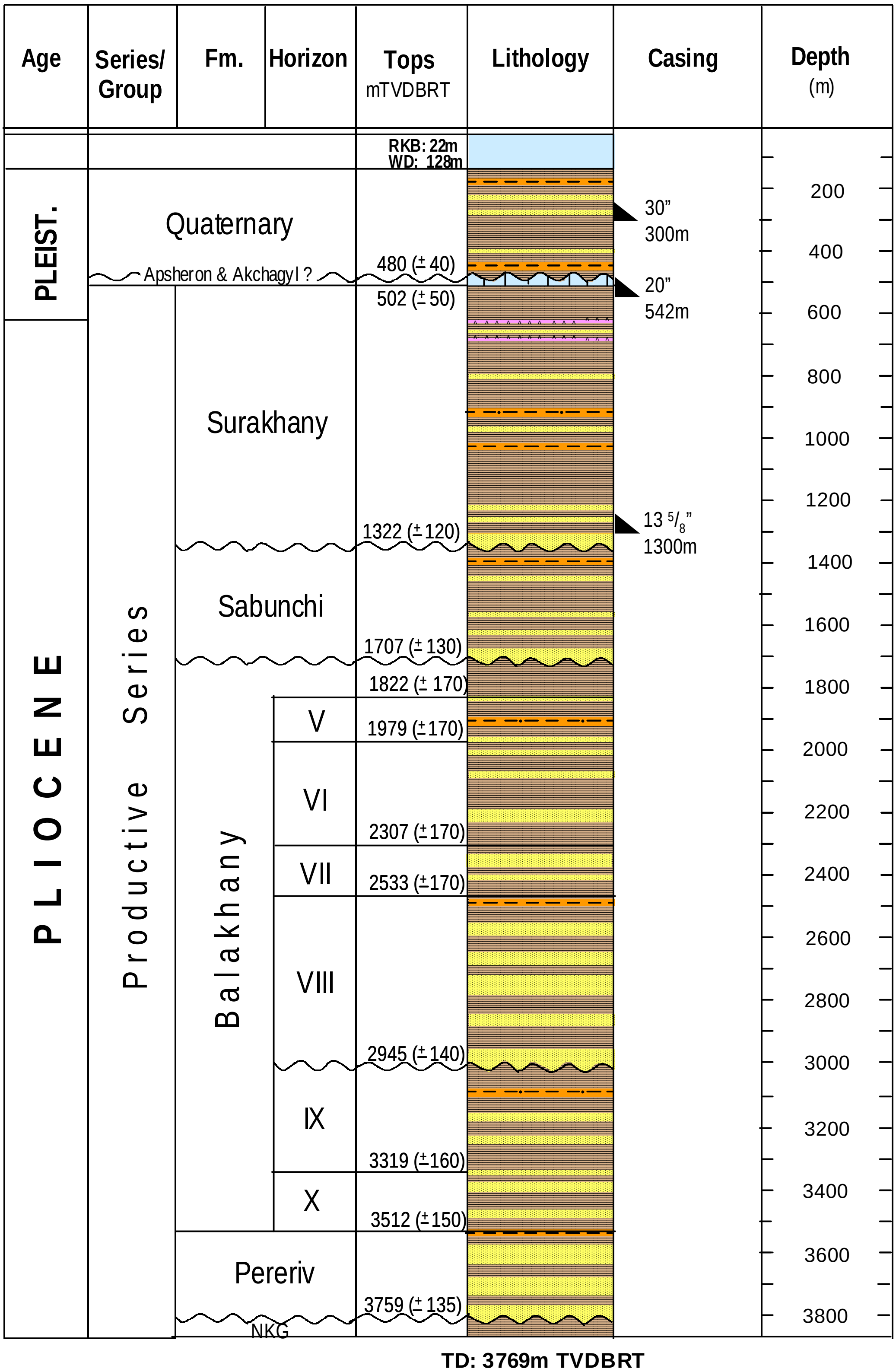


Figure 6.2: A typical stratigraphic column for the ACG area

Seismicity and tectonics

The earth's surface is divided into seven major and twelve smaller plates, and the continents are carried passively upon these plates. The plates move relative to each other in three distinct ways tensional (apart), transverse (alongside) or convergent (together), over geological time scales, depending upon the form of movement between two adjacent plates, the planet's features will be created or destroyed.

The Caspian region, which is part of the Eurasian continental plate, has a convergent plate boundary with the Arabian and Indian continental plates. This has occurred for hundreds of millions of years leading to the destruction of an ocean (Tethys), which lay, between Eurasia to the north with Africa and India forming its southern shores. The mountain chains of the Alps, Caucasus and the Karakorum/Himalayas are composed of upthrusted rocks formed in and around this ancient ocean; this process of mountain forming is termed orogeny.

The Southern Caspian area is defined by the Scythian microplate, as part of the Russian plate, the Turanian, Iranian and small Caucasian plates, as well as, the South Caspian microplate. Current neotectonic (more recent) processes are leading to convergent movements of these plates of 1.8 cm/year in the Caspian (Karabanov, Institute of Geology, *pers comm*.). Convergent plate movements are generally associated with relatively high levels of seismic activity and accompanied by earthquakes and volcanism.

Azerbaijan is known for its seismic activity, particularly in the Greater and Lesser Caucasus Mountains. Five earthquakes with a magnitude greater than 6.0 on the Richter scale have occurred since 1842 with the most recent, measuring 6.5, on 25th November 2000 with an epicentre 30km east-north east of Baku. More detailed information on the seismicity and tectonics of the area can be found in the ACG Phase 1 ESIA (URS, 2002).

6.2.2 Coastal Morphology and Sea Level Rise

The coastal morphology of Azerbaijan has been significantly altered by changes in the Caspian water levels over the last 20 years (see **Figure 6.3**). These changes are a feature of the Caspian and its level has fluctuated significantly over time and is currently between 27 and 28 m below Mean Sea Level (MSL). The reasons for the changes in sea level are not fully understood, a number of theories have been put forward to explain the individual events, including the view that the changes are a natural cyclical phenomenon. The recent trend of water level rise has shown some signs of reversing. In 1996, the sea level rise slowed and since then levels have returned to 27 m below MSL (Mamedov, 1999).

Within the coastal study area (**Figure 6.4**) the Absheron Peninsula has the most varied morphology. The north eastern coast is dominated by rocks, with inundated sandy beaches, which give way to lagoon areas and reed grasses towards Shakdilli spit. Rounding the Peninsula, the southern coastline is well developed with many small towns and nearshore oil installations. The coastline is dominated by rocky limestone headlands, punctuated with sandy bays and lagoons.

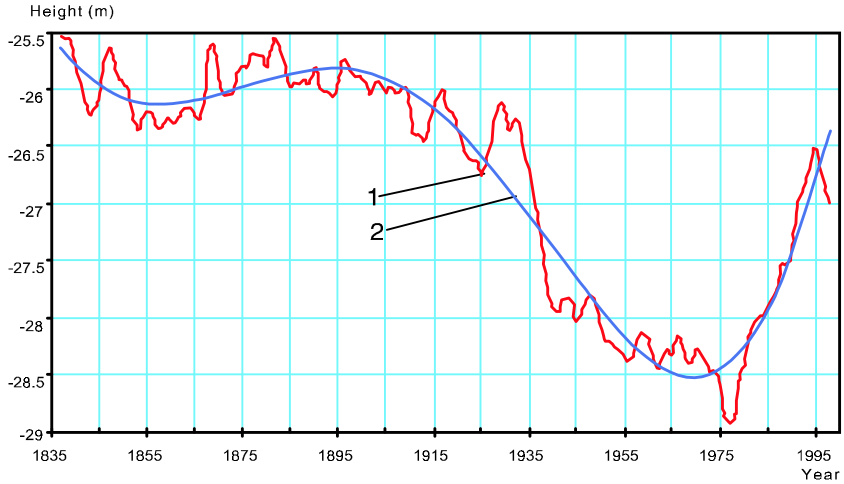


Figure 6.3: Caspian water level height for the period 1835-1998 (based on data from the Baku tide gauge) (1 = Actual water level line. 2 = General trend line)

South from the Absheron Peninsula, the region of Shikova has a sandy beach and lagoon area, which gives way to a long sandy beach towards the region of Primorsk and then to a gently sloping headland bounded by wetlands north of Sangachal. Between Sangachal and the Kura Delta the coastline is characterised by promontories with Sandy Bays between, the main promontories being Alyat Cape, Pirsagat Cape and Bandovan Cape. South of Bandovan Cape, a sand beach extends along the Shirvan reserve towards the Kura delta, which is composed of low lying mud flats, with reed grasses, lagoons and isolated sand islands.

South of the Kura, the coastline is low lying eroded clay interspersed with exposed bedrock that gives way to the vast expanse of the Kyzyl-Agach wetland. The outer coast of the Large Kyzyl-Agach Bay is sandy with lagoons behind, while the inner coast is densely reeded. Small Kyzyl-Agach bay is separated from the main water body by a causeway and road system.

South of Kyzyl-Agach, the coastline consists of steep sandy beaches with man-made rock defences in the vicinity of Lenkoran; further south towards Iran, the coastline becomes more rocky and exposed.

The coastline of Northern Iran is generally uniform with a sequence of sand beaches, dunes, spits and bars, bordered by a series of low-lying brackish and freshwater lagoons. Along most of its length the shore is backed by a line of sand dunes, approximately 10 – 20 m high, and up to 600 m wide.

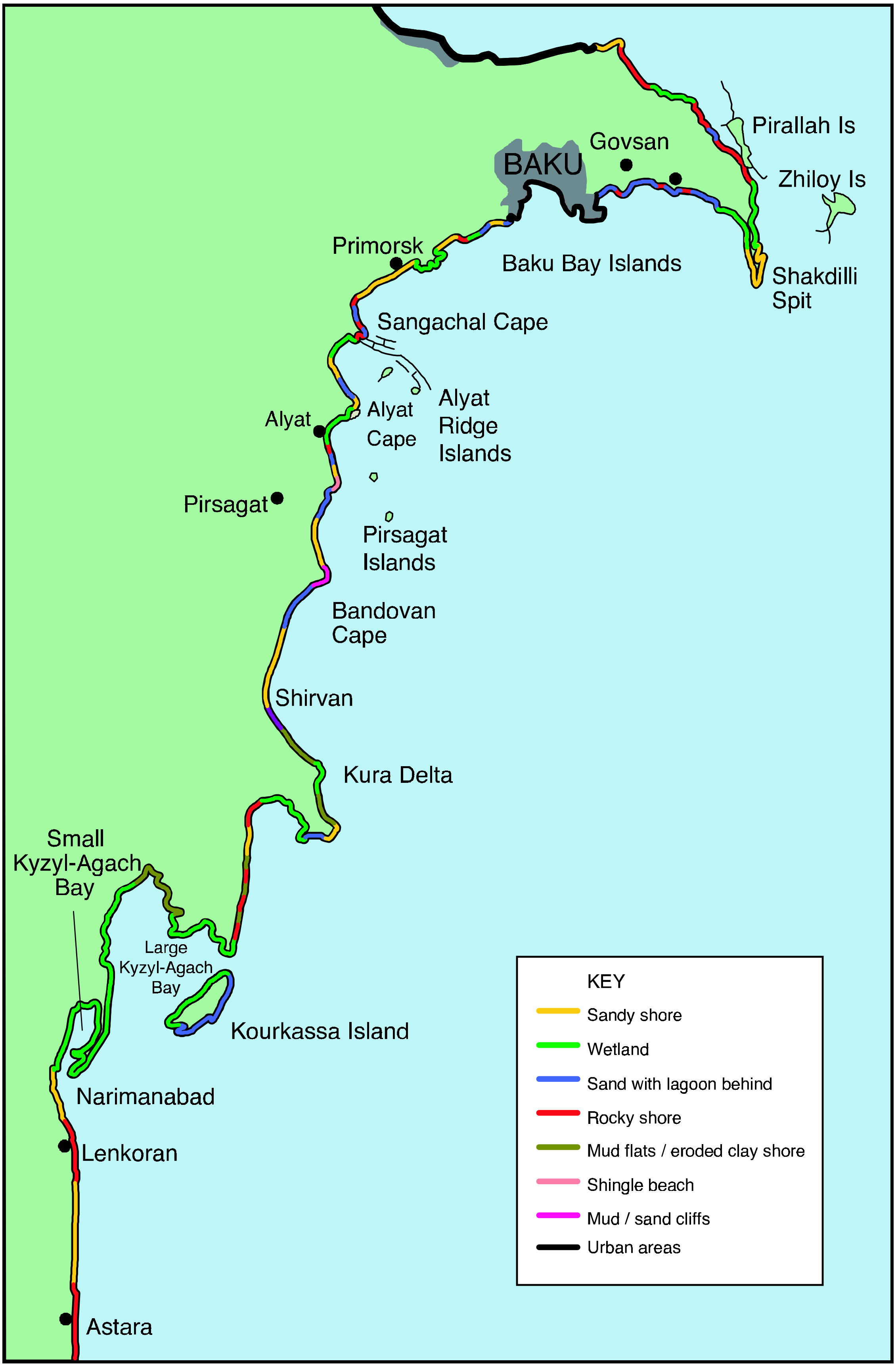


Figure 6.4: The coastal morphology of Azerbaijan from Buzovna to Astara (after AIOC, 1997a)

6.2.3 Atmospheric Conditions

Temperature

Nearshore and onshore

The weather station at Alyat, approximately 30km south of Sangachal, represents the closest operational data source. The climate at Alyat is classified as being warm, semi-arid steppe, with an annual mean air temperature of 14.4°C. July, with an average air temperature of 26.4°C is the warmest month, while January, with an average of 0°C is the coldest. Temperature extremes of 41°C and –16°C have also been historically recorded in these months respectively.

Offshore

Air temperatures show considerable seasonal variation in the Caspian area. According to Kosarev and Yablonskaya (1994), average air temperatures above the Caspian Sea itself typically peak at 25.5°C during the summer, and may drop to 0°C for some periods in the winter.

Precipitation

Nearshore and onshore

The Sangachal area is one of the driest in Azerbaijan, mean annual precipitation being less than 150 mm, the majority of which falls between September and April. The driest months are July and August. Snowfall in the area on average occurs for 10 days per annum.

Offshore

It is expected that rainfall in the ACG Contract Area would be similar to the data listed in **Table 6.2.** The Absheron Peninsula experiences relatively dry summers and winters with rainfall increasing in the spring and autumn months. **Table 6.2** provides rainfall data from the Absheron Peninsula for 1999 and 2000 on a monthly basis.

Table 6.2: Absheron Peninsula 1999 and 2000 rainfall data (mm) (FAO, 2001)

Year	J	F	M	A	M	J	J	A	S	O	N	D	Total
1999	14	7	46	34	52	26	41	53	60	41	61	5	440
2000	46	20	34	18	45	20	2	15	45	64	44	33	386

Wind

Nearshore and onshore

The wind regime of Sangachal Bay is on the whole consistent with that for the Absheron peninsula, although it is recognised that there is also a local thermally driven wind system. The effects of the local system are most noticeable offshore in the bay, resulting in a slight (1 to 2 $m.s^{-1}$) offshore wind during the early hours of the morning, which then drops and becomes a stronger onshore wind as the land heats up. This thermal influence coupled with the meteorological dynamics of the region can result in strong winds occurring in the region with little forewarning.

Figure 6.5 shows a wind rose compiled from data collected over the period between January 1999 and October 2001 at Baku airport. Of all available auditable datasets this data was judged to be the most representative of the conditions at Sangachal and was used in connection with the Air Emissions Modelling presented in **Chapter 10**.

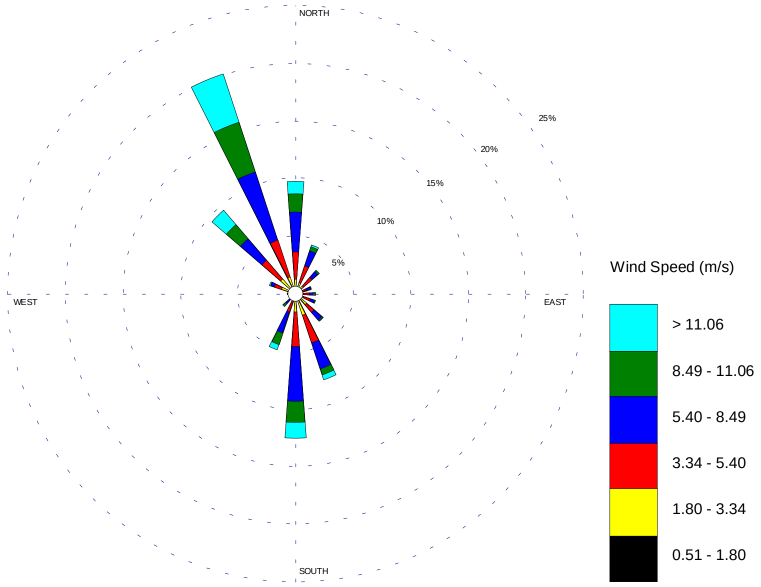


Figure 6.5: Annual wind rose for the Sangachal area (data from Baku airport)

Offshore

Wind conditions have been calculated from isobar maps over a 9 year period between 1980 and 1989. The wind roses provided in **Figure 6.6** summarise that data, which has also been used in the oil spill modelling.

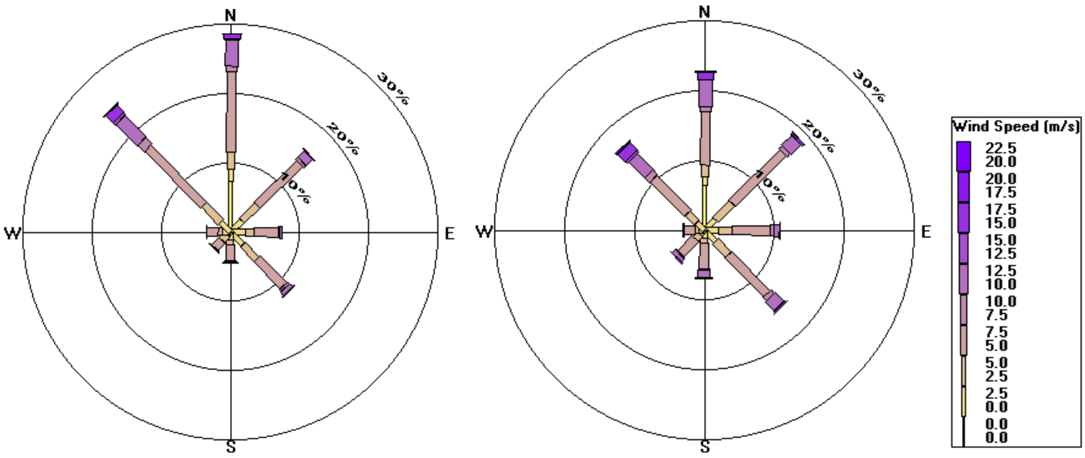


Figure 6.6: Summer and Winter wind roses for the ACG area (data from BMT, 1997)

Air Quality

AIOC have carried out a number of studies in order to assess the baseline air quality in the vicinity of the Sangachal Terminal. AIOC monitored baseline air quality in 1997 prior to the start of EOP, and in 2000, when EOP was in operation (AIOC Air Quality Survey 2000, R.W. Finney). Ambient levels of NO_2, SO_2 hydrocarbons and particulates were monitored and reported. Diffusion tubes were deployed and analysed during the surveys, and were set up at pre-determined locations. These give average concentrations over the exposure time; hence these results are used for background annual average concentrations.

In the 2000 survey, sampling was undertaken at Sangachal Terminal for 6 periods of approximately 14 days for hydrocarbons and 2 periods of approximately 28 days for SO_2 and NO_2 in spring and autumn. Sample locations were defined in the vicinity of the Sangachal Terminal (16 locations ranging from fence lines to Sangachal Town).

Meteorological data was provided by an automatic solar-powered weather station, located at the Sangachal terminal site.

Average concentrations were derived by laboratory analysis of sample tubes at UTG Ltd., Sunbury and Caspian Environmental Laboratory.

NO_2/SO_2

At all locations around the Sangachal Terminal, NO_2 was consistently within the Air Quality Standard of 21 ppb. Details of Air Quality Standards are shown in **Chapter 10, Table 10.1**. Individual SO_2 concentrations were mainly within the 19 ppb Air Quality Standard.

The data indicates that the current EOP operations at Sangachal are having no significant negative impact on the level of NO_2 and SO_2 in the air. Ambient air concentrations of NO_2 and SO_2 are similar to those reported before start-up of the operation in 1997.

For both NO_2 and SO_2, there was little to suggest a significant seasonal fluctuation.

The baseline ambient air quality data has been reviewed in connection with Air Dispersion Modelling (see **Chapter 10**) and is presented in a summarised form in **Table 6.3**. In estimating the background level appropriate for assessing the impact of short term predicted concentrations the procedure has been followed from the UK Technical Guidance on local air quality management (TG4), ‘Pollution specific guidance’. The report recommends that twice the annual mean be used as a background concentration for consideration of short term mean concentrations. Therefore the annual mean taken from the diffusion tube results from 1997 and 2000 was doubled for the background hourly mean. It should be noted that the data used to calculate the annual mean, although the best available, is not actually based on full annual measurements.

Table 6.3: Ambient concentrations of NO_2 and SO_2

Background concentrations	Nitrogen Dioxide		Sulphur Dioxide	
	Hourly $\mu g.m^{-3}$	Annual $\mu g.m^{-3}$	Hourly $\mu g.m^{-3}$	Annual $\mu g.m^{-3}$
Terminal	6	3	56	28
Sangachal Town	8	4	12	6
Pipeline Landfall	4	2	12	6

Hydrocarbons

Benzene values around Sangachal Terminal ranged from <0.3 ppb to 1.0 ppb, with the highest values consistently occurring at the location on the South fence (0.6 to 1.0 ppb). All values remained lower than the current 5ppb UK Air Quality Standard.

Concentrations of other aromatic hydrocarbons remained low throughout the monitoring period and were comparable with values reported in 1997.

Total hydrocarbons C_5-C_{10} was in the range 6 to 54 ppb around Sangachal Terminal and average values were very similar to background values reported in 1997.

Particulates

Particulates were surveyed over 6 x 24 hour periods at a location close to the main site entry security gate at Sangachal Terminal. It was observed that particulate matter <10µm (PM_{10}) concentrations were high in the area where construction activities were occurring. This is an issue that will be covered in further monitoring studies.

Conclusion

As a general conclusion to the status of the air quality of the area around the Sangachal Terminal, the 2000 Air Quality Survey showed that ambient air concentrations of NO_2 and SO_2 are similar to those reported before start-up of the operation in 1997 indicating that there has been no deterioration in air quality as a result of AIOC activities.

6.2.4 Noise

Onshore

Noise in the vicinity of the Terminal was measured during a baseline survey carried out over a period of 3 days in November 2001 (includes contribution from existing works at the site). The community and commercial receptors most likely to be impacted by noise from terminal operations are people inhabiting nearby buildings. These include the Umid Settlement, the Herdsman's Farmstead and the Roadside Café/Garage. The locations of these sites are shown in **Figure 6.7**.

Table 6.4 provides the noise level summaries for these sites, also including a site near Sangachal village, immediately south east of the Terminal site.

Table 6.4: Measured noise levels at receptors from the Baseline Noise Survey

Location	Noise Level, dB (A)			
	L_{eq}		L_{90}	
	Day Time	Night time	Day Time	Night time
Roadside Café (Commercial)	59-67	54	46-52	45
Umid Settlement (Community)	48	45	41-45	40
Umbaki (near Sangachal) (Community)	43-48	42	38-41	38
Herder settlement (Community)	40-48	40	33-41	33

Note: A night time measurement at the herder settlement was not possible. Levels shown for nighttime were actually taken in the early morning.

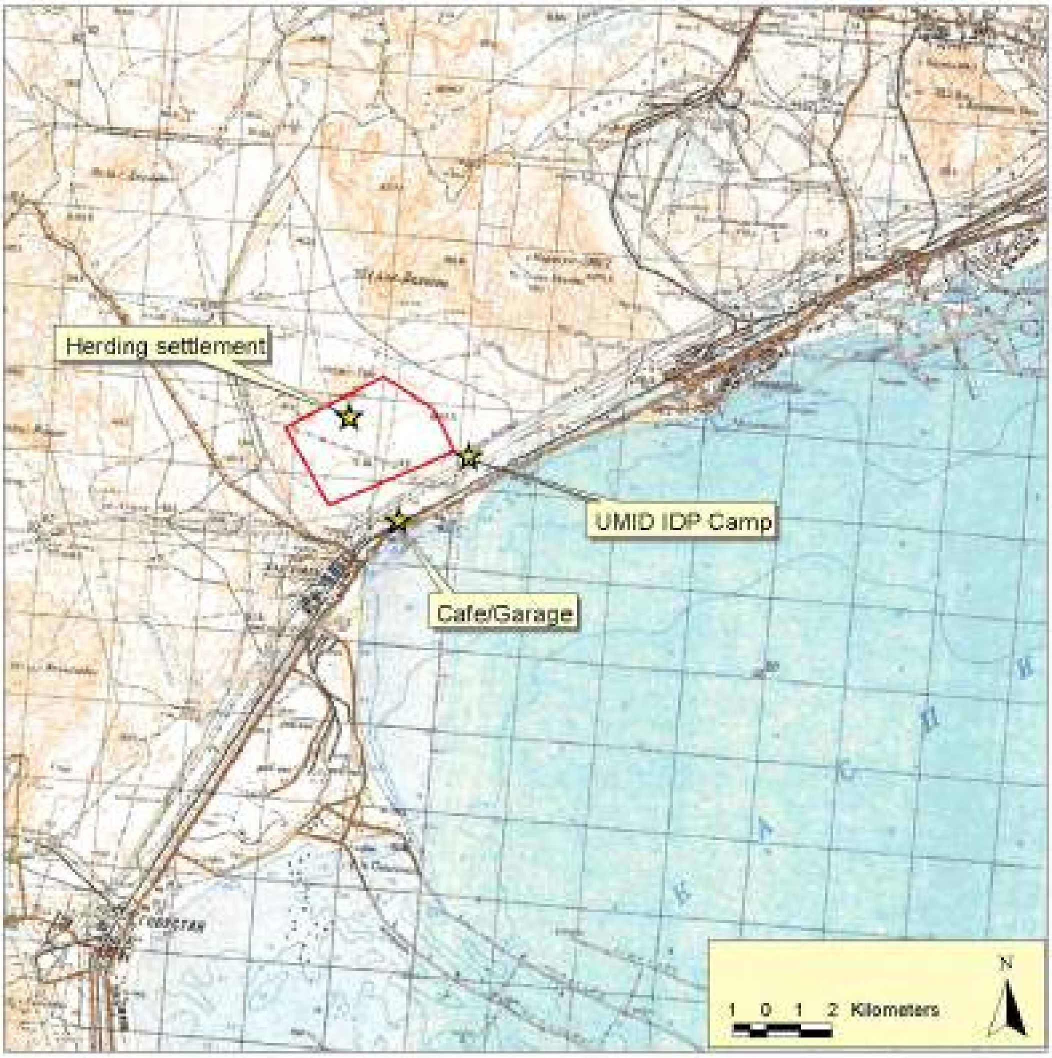


Figure 6.7: The location of the Sangachal Terminal and noise monitoring points

The L_{eq} measurements (accepted index for noise in terms of measuring ambient levels over a given time period) for both daytime and nighttime at Roadside Café, a commercial property, were below the World Bank guideline value of 70 dB (A). The daytime L_{eq} measurements were below 55 dB (A) and nighttime L_{eq} measurements were equal or less than 45 dB (A) at three other residential receptors. Thus, the measured existing noise levels at the community receptors are in compliance with the World Bank Guidelines.

Offshore

There have been no subsea noise measurements taken in the vicinity of the existing ACG offshore facilities, however, data from other parts of the world have been reviewed, and it is expected that the underwater noise level generated by operational activity of the existing production platform is low. This is due to the relatively small surface area in contact with the water, and the location of noise and vibration generating machinery on decks well above water level.

6.2.5 Marine Pollution Sources

In general terms the greatest volumes of pollutants enter the Caspian via rivers, especially the Volga, Ural, Terek, and Kura. It has been estimated that during the period 1986-1990, the annual input of oil and oil products was 100,000 tonnes (Kosarev and Yablonskaya, 1994). About 90% of river discharges enter the north Caspian. Pollution enters the western coastal areas of the south Caspian from domestic and industrial sources along the coast and also via the rivers, in particular the Kura River. The most polluted waters are off the coast of Sumgait, on the north side of the Absheron Peninsula, and Baku Bay. The main sources of pollution are the oil refineries, oil production plants, the Baku sewerage system and the Sumgait industrial complex. Recent economic decline has reduced industrial activity resulting in about 25% reduction in discharges.

Azerbaijan has been taking measures to reduce environmental pollution. During the last decade, 59 water protection measures have been implemented and about 170 wastewater treatment facilities have been constructed. As a result of these measures, the projected capacity of the treatment facilities of the Republic has increased by a factor of 4 from 1.28 to 4.46 million. m^3 day^{-1}. Unfortunately, these measures did not take into account the increase in the amount of sewage. Today, Azerbaijan discharges approximately 300 million tonnes of highly contaminated and 300 million tonnes of normally treated sewage. As a result, these waters bring 4,000 tonnes of oil products, 28,000 tonnes of suspended solids, 550,000 tonnes of solid residue, 74,000 tonnes of sulphates, 150,000 tonnes of chlorine, 300,000 tonnes of surfactants, 5 tonnes of phenols and other hazardous substances into the Caspian (UNDP, 1997).

The Kura River is a major source of contaminant discharge to the south Caspian. In the period 1970-1992, there was an intensive development of mining, metallurgical, chemical and processing industries, as well as energy production and agricultural irrigation. This, together with a rapid increase of water consumption and sewage discharges to the river basin resulted in a drastic decrease in the water quality of the Kura River and its large tributaries (Mamedov, 1999). More than 74% of the Kura River's water balance has its source outside of Azerbaijan and its overall ecological status is dependent to a significant extent on the conditions in neighbouring countries (UNDP, 1997).

More localised information on water and sediment quality can be found in **Sections 6.4** and **6.5**.

6.3 Terrestrial and Coastline Environment

6.3.1 Physical Environment

Topography and landscape of the Sangachal area

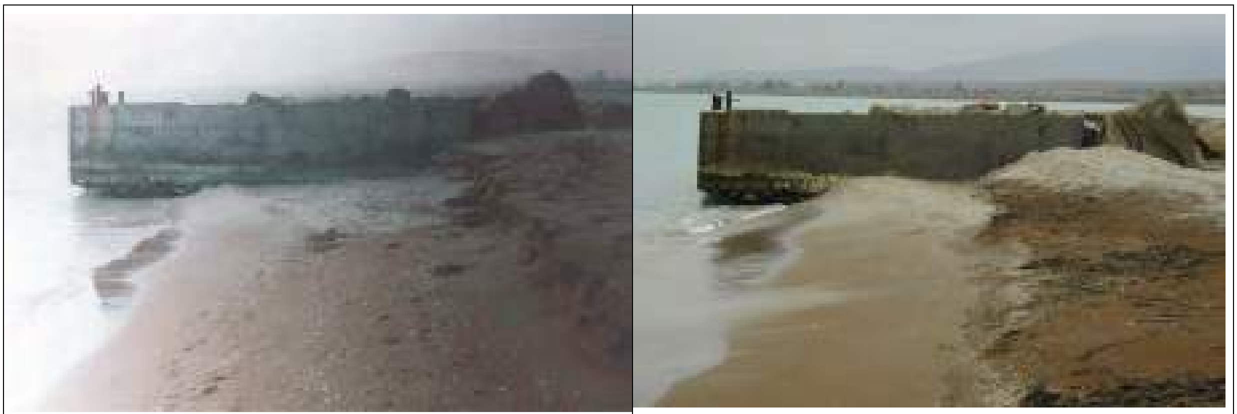
The Sangachal region, including the terminal site, is located close to the centre of a flat, low-lying basin that occupies an area of around 32 km^2 along the margin of the Caspian Sea. Within the basin area the land surface is typically 12 to 14 m below the world ocean datum (taken to be the Baltic Sea in Former Soviet Union (FSU) countries) and is therefore, approximately 10 to 12 m above the local sea level. The land rises sharply to the north of the basin to form a range of steeply sloped hills with a maximum elevation of 300 to 400 m above the world ocean datum. Ground surface elevations rise more gradually from the Sangachal terminal to the north west. Ground surface topography in the vicinity of Sangachal terminal is fairly uniform with gentle undulations of less than a metre spread over a large area. A railway and road run parallel with the coastline generally less than 100 m inland. From the road, the terrain slopes moderately down to a beach front approximately 10 m lower.

In addition to the rail and road infrastructure, the area is also crossed by a number of underground and above ground pipelines (oil, water and gas), and contains a number of poorly abandoned exploration wells.

The coastline of Sangachal Bay is formed from sedimentary deposits and debris of reeds and seagrass. The seabed slopes evenly and gradually to the open sea and is comprised of poorly sorted mixtures of silt, clay, sand and shell gravel. There are also isolated patches of very soft cohesive grey clays and areas of carbonate concretions.

Coastal erosion/accretion

The sediment dynamics of Sangachal Bay were the subject of a study in 2001, with particular attention paid to changes in the coastal configuration associated with the rock groyne jetty and concrete sewerage outfall structure on the Sangachal Bay coastline. The jetty and sewerage outfall structure appeared to have resulted in sediment accreting on the eastern side of the jetty, while to the west the beach was being eroded. The period over which this study was undertaken was relatively short. However, a photo taken in April 2002 (**Figure 6.8**) shows the same situation to be present. It is anticipated that the changes to the sedimentary regime as a result of the presence of the jetty will not reach equilibrium for a number of years.



January/February 2001	April 2002

Figure 6.8: Photos of the shoreline adjacent to the jetty – eastern side

Sea level change has a significant impact on the coastal environment. Longer-term changes have been discussed in **Section 6.2.2**. Short-term sea level changes within Sangachal Bay can occur during storm surge conditions, and these can range from +70 cm to –60 cm.

Soils

Surface soils in the region of the Sangachal Terminal have been formed in semi-arid conditions with accompanying 150 mm of winter precipitation and high summer temperatures. These conditions lead to a high rate of disintegration of organic matter. Consequently, soils have a low humus content, short soil profile and low agricultural productivity. The soils are typically fine-grained clayey silts or silty clays with a low porosity and high salt content.

During 2001 soil samples were taken from across the Terminal site and in the area between the shoreline and the Terminal. The soils were analysed for total petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAHs), metals, total organic carbon (TOC) and particle size analysis.

While some areas of the site showed higher metal concentrations in the soil than others, all metal concentrations were within the range considered to be “protective of human health and the environment” (URS, 2002). None of the soil sample results for TPH and PAH exceeded the significance screening criteria applied for the study.

Particle size analysis conducted on surface soil samples indicated that sites located at or near the coastline comprised well-sorted fine to medium sands with a high carbonate, but low organic content, while the samples from the inland area generally comprised fine to medium silts with low organic and low carbonate content.

The study concluded that the soils in the vicinity of the site have been slightly impacted in localised areas as a result of past activities and most probably, earlier oil exploration and production activities. Identified contamination was not however, significant and is not considered to have resulted from AIOC activities at the EOP Sangachal terminal.

The full survey results are presented in the ACG Phase 1 ESIA (URS, 2002).

Hydrogeology

Aquifers

In the vicinity of the Sangachal region there are no reported aquifers used to provide potable drinking water.

Groundwater

There have been two intrusive investigations into the presence of groundwater at the Terminal site, one in 1996 (Fugro, 1996) and one in 2001 (URS, 2001). In 2001, from a total of six boreholes, only one showed a slight indication of moisture after a few days. This suggests low permeability with slow ingress of water. It was concluded that there is no significant groundwater within 20 m of the surface beneath the site.

Ephemeral watercourses

There are a number of ephemeral watercourses (wadis) within the vicinity of the terminal site, mostly to the west of the site. For the majority of the year these incised channels are dry, as transmission losses (through bed leakage and evaporation) are normally substantial. However a number of them did contain a small amount of water during the site visit in March 2002.

The largest wadi in the vicinity of the terminal area is that associated with the Djeyrankechmes River. This watercourse, which is often dry, exhibits poor bank stability and is liable to flash flooding during periods of heavy rain. During periods of flow it has a high sediment load. Water resources here are the scarcest in Azerbaijan, and the Djeyrankechmes basin delivers an average water yield of just 1.0 $l.s^{-1}km^{-2}$, decreasing to zero near the coast.

In addition to the above, there is a large man-made drainage ditch around the perimeter of the terminal site.

6.3.2 Habitats

Introduction

The focus of this section is a summary of the results of a botany survey carried out in the vicinity of the terminal site during March 2002. The results obtained are intended to complement those from the Phase 1 ESIA (URS, 2002) survey carried out in May/June 2001. The 2002 survey was timed to enable the easier recording of ephemeral /ephemeroid species which flower before May/June. Comparisons between the two surveys are made where appropriate. An earlier site survey was carried out in connection with the ESIA for the Early Oil Project (DNV, 1996). However, the area studied during this survey is now part of the FFD landtake.

In order to gain a fuller understanding of the ecological processes and seasonal and annual variability of the area, it is necessary to have a more extensive data set taken over a number of years using a standard methodology. This strategy will be a component of AIOC's long term monitoring plan for the area (see **Chapter 10**). The description in this section of the Phase 2 ESIA must therefore be seen as a contribution to a knowledge database that, as part of long term monitoring strategy will enable a full interpretation of the dynamics of the terrestrial environment in the vicinity of the Terminal to be achieved.

Flora - Higher plants

The study area was traversed on foot along predetermined transects based on those followed during the Phase 1 fieldwork (these transects are numbered and shown in **Figure 6.17**, the names of the zones are provided to allow comparison with the Phase 1 transects). All visible species present were identified, recorded (see **Technical Appendix A** [separate volume] for survey sheets) and used to compile a species list. Habitat types were identified, where possible, through observation of the changes in dominant perennial species as the transect routes were traversed. The extent of the habitats was mapped within an area of radius 4.5km from the "no development area" (**Figure 6.7**). In addition, quadrat plots of 2m^2 were selected within which to record higher plant species representative of the habitat type sampled. The Internationally recognised Domin. Scale of cover-abundance (*sensu* Dahl & Hadac, 1941) was used (**Table 6.5**) to produce an index of vegetation cover. Quadrat sampling undertaken as part of the Phase 1 ESIA botany survey was repeated, where possible, in addition to 15 new plots.

Table 6.5: Domin. scale of cover-abundance

Domin scale	Cover abundance	Domin scale	Cover abundance
+	One individual, reduced vigour	6	26-33%
1	Rare	7	34-50%
2	Sparse	8	51-75%
3	<4%, frequent	9	76-90%
4	5-10%	10	91-100%
5	11-25%		

The results of the botany survey are discussed below, completed fieldwork proformas are presented in **Technical Appendix A** and a summary of the findings are presented in **Figure 6.9**. The location of the transects described below are shown in **Figure 6.17.**

Transect 1 – The coastal zone

As identified in the Phase 1 botany survey, the coastal zone can be split into semi-linear habitats types; sandy beaches, coastal reed beds, littoral ecotones, coastal-terrestrial ecotones and rocky shores, as illustrated in **Figure 6.10**. Additionally within the south eastern area a discrete salt marsh area dominated by the sea-blite species *Salicornia europea* **(Figure 6.10c**) occurs where the coastal terrain remains flat and is susceptible to tidal (or wind driven) inundation.

The sandy beach habitat type was found primarily along the south eastern area of coastline identified in the Phase 1 report. A sparse cover of bindweed, *Convolvulus persicus* dominated this habitat during the March 2002 survey. Sea rosemary *Argusia sibirica*, which was dominant in the June 2001 survey, was not found extensively as its vegetative growth phase is thought to start in May.

A3 figure

Figure 6.9: Indicative Terrestrial Habitats in the Sangachal Area

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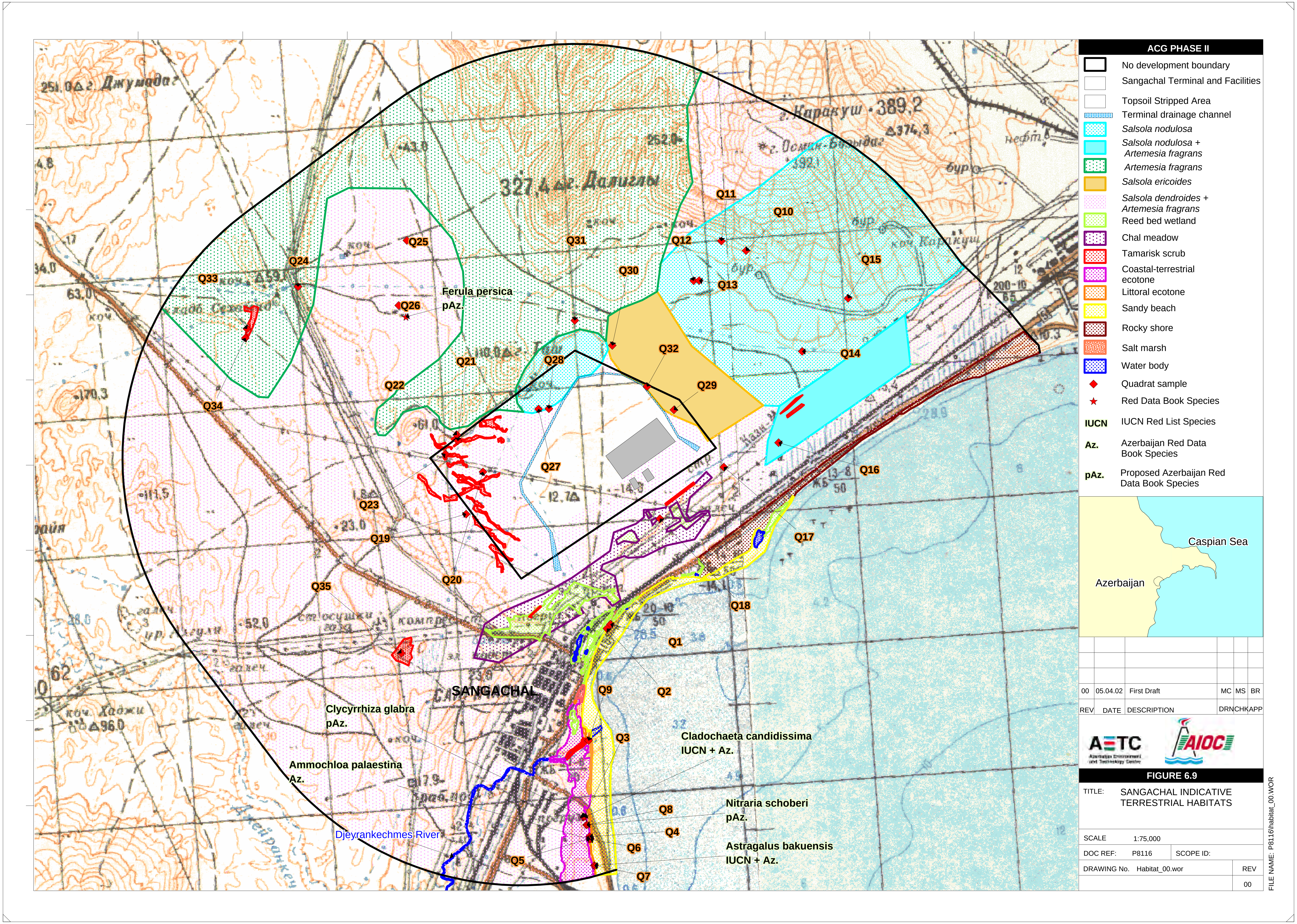

ACG PHASE II
No development boundary
Sangachal Terminal and Facilities
Topsoil Stripped Area
Terminal drainage channel
Salsola nodulosa
Salsola nodulosa + Artemesia fragrans
Artemesia fragrans
Salsola ericoides
Salsola dendroides + Artemesia fragrans
Reed bed wetland
Chal meadow
Tamarisk scrub
Coastal-terrestrial ecotone
Littoral ecotone
Sandy beach
Rocky shore
Salt marsh
Water body
Quadrat sample
Red Data Book Species
IUCN IUCN Red List Species
Az. Azerbaijan Red Data Book Species
pAz. Proposed Azerbaijan Red Data Book Species
Caspian Sea
Azerbaijan
SANGACHAL
Djeyrankechmes River
Ferula persica pAz.
Clycyrrhiza glabra pAz.
Ammochloa palaestina Az.
Cladochaeta candidissima IUCN + Az.
Nitraria schoberi pAz.
Astragalus bakuensis IUCN + Az.
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12 Q13 Q14 Q15 Q16 Q17 Q18 Q19 Q20 Q21 Q22 Q23 Q24 Q25 Q26 Q27 Q28 Q29 Q30 Q31 Q32 Q33 Q34 Q35
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FIGURE 6.9
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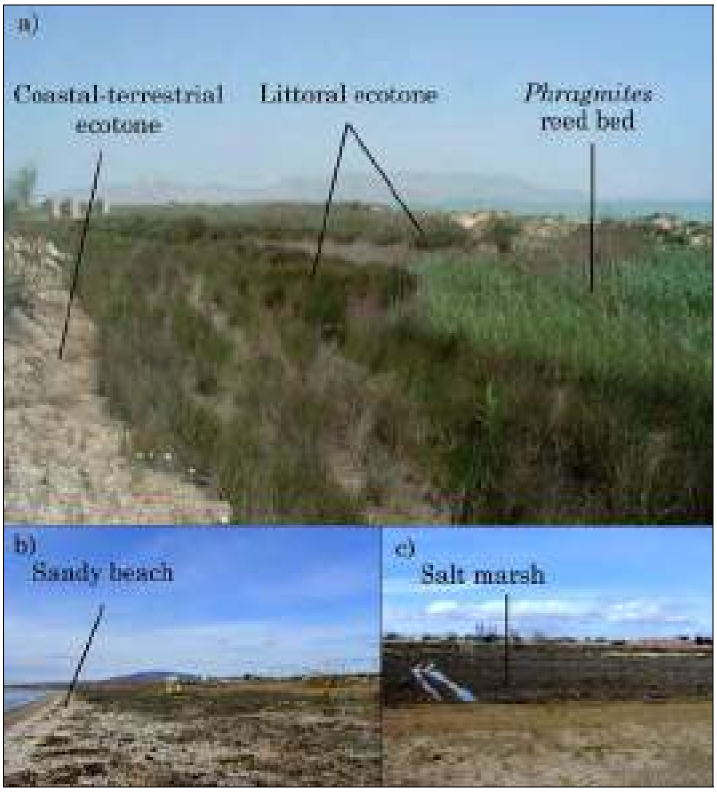


Figure 6.10: Coastal zone habitat types

Reed beds dominated by *Phragmites australis* and associated *Juncus acutus* were found throughout the south east section of the coastal transect. This habitat was generally associated with sandy clay soils, occupying seasonal wetland areas in topographic depressions and alongside ephemeral channels and areas where broken water pipes provided the necessary levels of moisture. Littoral ecotones dominated by *J. acutus*, tamarisk and sparse *Phragmites* cover, as illustrated in **Figure 6.10a**, were often associated with the aforementioned reed bed habitats and represented a transition from coastal wetland to drier coastal and terrestrial habitat types.

The coastal-terrestrial ecotone type (**Figure 6.9**) was found extensively in the area adjacent to the Baku-Tbilisi highway and the Djeyrankechmes River which discharges to sea in the south east section of the coastline. This community was more complex than surrounding habitat types, being made up of a mixture of low growing, shrubby species of saltwort (*Salsola dendroides*), glasswort (*Salicornia europea* and *Halocnemum strobilaceum*), camelthorn (*Alhagi psuedalhagi*) and various grass and ephemeral flowering species. Where the coastal-littoral zone ran adjacent to the Djeyrankechmes River swathes of tamarisk thicket lined the banks in a buffer between wetland and coastal terrestrial vegetation. In addition to the Red Data book species (*Calligonum bakuensis* and *Astragalus bacuensis*) previously recorded in this habitat type, four further Azerbaijan Red Data Book species; *Ammochloa palaestina*, *Cladochaeta candidissima*, *Glycyrrisa glabra* and *Nitraria schoberi* were also recorded and are discussed in **Table 6.6**.

Extensive stretches of rocky shoreline habitat type were confined to the north east section of the coast. The vegetation of the rocky coast was found in both surveys to have a sparse cover (<4%) of vegetation similar to that of the coastal-terrestrial ecotone habitat type.

Transect 2 – Northern foothills

Transect 2 traversed an area of rocky foothills, to the north east of the Sangachal Terminal, that gave way to areas of relict mud volcano flows.

The foothills (**Figure 6.11b.**) were dominated by a sparse cover of the perennial saltwort species *Salsola nodulosa*, which was associated with a patchy but widespread cover of flowering ephemeral species including *Anthemis candidissima*, *Calendula persica*, *Medicago minima*. Barren elevated areas of sparse *Salsola nodulosa* associated with occasional *Suaeda microphylla* characterised the mudflow area that was incised throughout by dry ephemeral channels populated by spring ephemeral flowering plants (*Veronica arvensis, Tragopogon graminifolius, Torularia contortuplicata and Nonea lutea)* and grasses (*Cynodon dactylon*, *Anisantha rubens* and *Aegilops biuncialis)*. See **Figure 6.11a**.

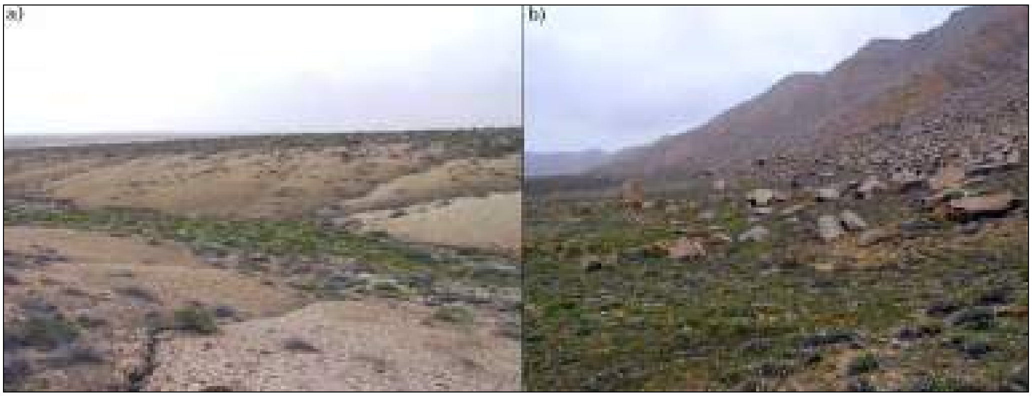


Figure 6.11: Areas of the Northern Foothills a) relict mud flows, b) rocky foothills.

Transect 3 –Central south plains

The Central South Plains transect bisected *Salsola nodulosa-Artemesia fragrans*, *S. dendroides-A. fragrans* desert, chal meadow and reed bed wetlands dominated by *Phragmites australis* or *Typha latifola* stands located on saline fine mud and clay soils.

S. nodulosa-A. fragrans areas were complexed with patchy areas of flowering, low-growing herbaceous species, including *C. persica*, *C. falcatus*, *Veronica denudata* and *Allium rubellum*, and the grasses *Poa bulbosa* and *C. dactylon*, whilst areas to the south and south west of the terminal site were dominated by *S. dendroides* and *A. fragrans*. To the south this dominance was complexed with the occasional occurrence of *Alhagi psuedalhagi* and in both areas intermittent patches of low herbaceous cover including the ubiquitous species of *C. persica* and *P. bulbosa* were present.

Chal meadow vegetation bordered areas of reed bed wetland recharged by freshwater streams and pools fed by a leaking water main to the north east of the terminal access road. The chal meadow vegetation was made up of grass species *P. bulbosa* and *A. rubens* and flowering species of *C. persica* and *Carduus arabicus*, along with occasional stands of *J. acutus*. Reed bed areas throughout the transect were dominated by *P. australis* (**Figure 6.12**), however stands of *T. latifolia* were recorded in topographic depressions found at the foot of the embankments of the Sangachal Terminal access road.

Figure 6.12: *Phragmites australis* stands to the south and west of Sangachal Terminal

Transect 4 and 5 – Western and far northern plains and the western hills

The Western and Far Northern Plains constitute relatively homogenous saline clay soil terrain dominated by *S dendroides-A. fragrans* to the south and the far north of the Western Hills and *A. fragrans* desert throughout and to the immediate north of the Western Hills. To the south, strips of tamarisk associated with a ground cover of grasses and flowering ephemeral species were recorded in troughs and at the foot of topographic peaks.

Areas dominated by *S. dendroides-A. fragrans* and *A. fragrans* desert were interspersed with patchy areas of low growing herbaceous plants and grass along with the occasional presence of *Suaeda microphylla* and *A. pseudalhagi*. Ephemeral species recorded throughout the transect included *inter alia C. persica*, *Lycopsis arvensis*, *Xanthium spinosum*, *Carduus albidus*, *N. lutea* and *Silybum marianum* along with the grass species *P. bulbosa*, *Eremopyrum triticeum*, *E. orientale* and *Trigonella coerulescens*, whilst *Avena eriantha* and *Bromus japonica* were recorded to the north. The Azerbaijan Red Data Book Species *Ferula persica* was recorded in the Northern extent of the Transect 4, see **Table 6.6.**

Swathes of tamarisk *Tamarix meyeri* to the south (**Figure 6.13**) were associated with a more abundant cover (relative to the surrounding desert area) of low growing herbaceous species including *Taraxacum praticola*, *C. persica*, *Vicia cinerea* and grasses *L. arvensis*, *Hordeum leporinum*, *P. bulbosa* and *C. dactylon*.

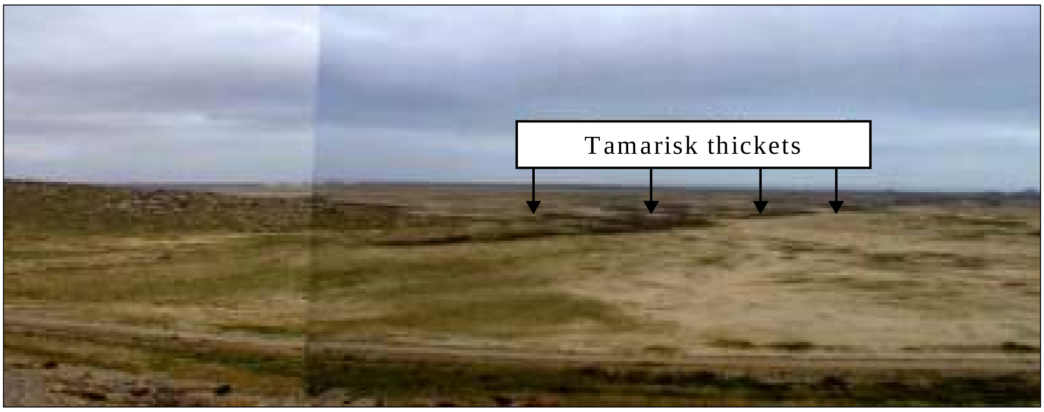


Figure 6.13: *S. dendroides-A. fragrans* desert and Tamarisk thickets, looking south from the Western Hills

Transect 6 – Central north plains

The Central North Plain immediately to the north and west of the Sangachal Terminal (**Figure 6.14**) was found to be a flat expanse of desiccated and cracked fine clay soil with very little vegetation cover. Areas of disturbed ground with no vegetation cover extended from topsoil dumps at the northern extent of the Terminal site. Individuals of *Salsola nodulosa* and *Suaeda microphylla* along with tufts of stunted *P.bulbosa* and *Medicago minima* were recorded as the transect progressed northward to the east of the Western Hills, however the maximum cover encountered was considered to be sparse until the foothills to the north were reached.

Figure 6.14: Sangachal terminal and the Central North Plains, looking south from the eastern extent of the Western Hills

Transect 7 – North-western plains

Transect 7 traversed an area of tamarisk scrub (**Figure 6.15**) in the far north west of the survey area. The scrub was dominated by *T. meyeri* and a continuous ground cover of grasses; including *inter alia Colpodium humile*, *P. bulbosa* and *Eremopyrum triticeum*, and the ubiquitous ephemeriod *C. Persica.*

Figure 6.15: Tamarisk scrub

Transect 8 – Western plains

Transect 8 crossed areas of *S. dendroides-A. fragrans* on the higher hills and an area of tamarisk thicket and camelthorn in a lowland depression (**Figure 6.16**) previously thought to be an artificial lake.

Figure 6.16: Tamarisk and camelthorn in lowland depression

Azeri Red Book / IUCN Red List plant species encountered

The two botanical surveys have, in combination, encountered a total of eight protected (including two proposed) Azerbaijan red list plant species, four of which are also included in the IUCN red list **Table 6.6**. It should also be noted that there may be other species in the survey area that were not present above ground level during the time when either of the surveys took place.

Table 6.6: Azeri Red Book / IUCN Red List plant species encountered

Family	Genus species	Biotope	Type of Evidence[1]	ARB[2]	IUCN Red List[3]	Phase 1 Survey	Phase 2 Survey
Fabaceae	*Astragalus bakuensis*	Slightly inland (coastal/semi-desert)	Plant	Y	I	Recorded in coastal zone and the central southern plain.	Recorded in the western and far northern plains.
Polygonaceae	*Calligonum bakuensis*	Slightly inland (coastal/semi-desert)	Plant	Y	I	Dead individuals recorded in coastal zone.	Not recorded
Iridaceae	*Iris acutiloba*	Semi-desert	Seeds	Y	En	Seeds recorded in central plains	Not recorded
Apiaceae	*Ferula persica*	*S. dendroides-A. fragrans* desert	Plant	Y	-	Not recorded	Individuals recorded within Transect 4
Poaceae	*Ammochloa palaestina*	Slightly inland (coastal/ semi-desert)	Plant	Y	-	Not recorded	Individuals recorded in Transect 1
Asteracae	*Cladochaeta candidissima*	Slightly inland (coastal/ semi-desert)	Plant	Y	I	Not recorded	Individuals recorded in Transect 1
Fabaceae	*Glycyrrisa glabra*	Slightly inland (coastal/ semi-desert)	Plant	pY	-	Not recorded	Individuals recorded in Transect 1
Nitrariaceae	*Nitraria schoberii*	Slightly inland (coastal/ semi-desert)	Plant	pY	-	Not recorded	Individuals recorded in Transect 1

1). Whole plant, seeds, etc.
2). Azerbaijan Red Book: Y – listed; pY – proposed for inclusion
3). 1997 International Union for the Conservation of Nature Red List of Threatened Plants categories: I = Indeterminate; R = Rare; En = Endangered; En/Ex = Endangered/Extinct

6.3.3 Fauna

The following pages summarise the results of a fauna survey carried out during March 2002. The Phase 1 ESIA (URS, 2002) included the results of a fauna survey carried out in May/June 2001. The 2002 survey was intended to complement the 2001 survey, and was timed to enable the easier recording of some species (especially vocalising amphibians), and during a period of flux for bird populations.

Mammals, reptiles and amphibians

Fieldwork Observations

During the fauna survey, the study area was traversed on foot along predetermined transects based on those followed during the Phase 1 fieldwork. All direct sightings of mammals and herpetofauna (reptiles and amphibian) species were recorded in terms of the species, time and place of observation and photographs were taken where possible. Indirect evidence of species presence, e.g. burrows, nests, tracks, scat, food remains, vocalisation, etc, were recorded by place encountered and type.

The results of the fauna survey are discussed below, completed fieldwork proformas are presented in **Technical Appendix A** and a summary of the findings are presented in **Figure 6.17** and **Table 6.7**.

Transect 1 – The coastal zone

Table 6.7 indicates that the coastal sector supports a relatively high biodiversity of species. This is predominantly due to the concentration of different biotopes within a relatively small area. Sandy beaches, rocky coastlines, wetlands and semi-desert are all found within the coastal sector, providing different habitat types, and accordingly, of the 23 species recorded during the fieldwork period, 15 of these were recorded within the coastal zone. In addition the climatic conditions, with higher temperatures experienced on the first day of the fieldwork within the costal zone, may also have had an influence.

A domestic drainage channel with *Phragmites* stands located to the south-east of the terminal site was an area of particularly high diversity, with sightings of marsh frog *Rana ridibunda* and European grass snake *Natrix natrix* (**Figure 6.18**), and tracks of fox *Vulpes vulpes* and wolf *Canis lupus* all recorded in this area.

ACG PHASE II

No development boundary

Sangachal Terminal and Facilities

Terminal drainage channel

Red Data Book Species Sightings

Transect

Transect Start/End

IUCN IUCN Red List Species

Az. Azerbaijan Red Data Book Species

pAz. Proposed Azerbaijan Red Data Book Species

Bird

Reptile

Amphibian

REV	DATE	DESCRIPTION	DRN	CHK	APP
00	05.04.02	First Draft	MC	MS	BR

AIOC

AETC Azerbaijan Environment and Technology Centre

FIGURE 6.17

TITLE: SANGACHAL SURVEY TRANSECTS AND FAUNA RED DATA BOOK SIGHTINGS

SCALE 1:75,000

DOC REF: P8116 SCOPE ID:

DRAWING No. Red_data_fauna.wor REV 00

FILE NAME:P8116\Red_data_fauna.WOR

Table 6.7: Recorded Herpetofauna and Mammal Species

Genus / Species	English Name	Transect Number Within Survey Area Where Species Observed								Evidence
		1	2	3	4	5	6	7	8	
Reptiles										
Agama caucasia	Caucasian agama (lizard)	X								Sighting
Coluber spp.	Whipsnake				X					Skin
Eramias arguta	Eramius species (lizard)		X							Sighting
Eramias velox	Racerunner species (lizard)	X	X							Sighting
Mauremys caspica	Caspian marsh turtle			X (dead)						Sighting
Natrix natrix	European grass snake	X								Sighting
Ophisops elegans	Snake-eyed lizard	X								Sighting
Testudo graeca *	Spur thighed tortoise			X (dead)	X (two alive, one dead)					Sighting
Viper libetina	Levantine viper							X		Skin
Amphibians										
Bufo viridis	Green toad		X	X						Sighting – adults and tadpoles
Hyla arborea #	Tree frog			X						Sighting
Rana ridibunda	Marsh frog	X		X	X	X				Sighting – adults and tadpoles
Mammals										
Allactaga elater	Small five toed jerboa	X	X	X	X	X		X	X	Burrows
Arvicola amphibious	Vole *spp.*	X								Burrow, faeces, tracks
Canis aureus	Golden jackal	X								Tracks
Canis lupus	Wolf	X	X	X		X				Tracks, den
Lepus europeus	Brown hare	X	X	X	X	X				Sighting, tracks, faeces, signs
Meles meles	Badger			X						Hole
Meriones erythrourus	Red tailed sanderling	X			X	X		X		Burrows
Meriones lybicus	Libyan jird	X							X	Burrows
Microtus socialis	Gunther's vole	X	X	X	X			X	X	Burrows, tracks, faeces
Rattus rattus	Black rat	X								Burrows, tracks
Vulpes vulpes	Fox	X	X	X						Sighting, tracks

* Azerbaijan Red Data Book
# IUCN Red List of Threatened Species

Figure 6.18: European grass snake *Natrix natrix*

The findings of the Phase 2 survey are in agreement with those of the Phase 1 survey, which also found high biodiversity within the coastal sector.

In addition to the above, tracks of larger mammals such as wolf, fox and hare were recorded at the eastern end of the transect. This is in agreement with the Phase 1 fieldwork, which also recorded large mammals in this area. In contrast, however, large numbers of Caucasian agama *Agama caucasia* and Dahl's whipsnake, *Coluber najadum*, were sighted during the Phase 1 fieldwork reflecting the higher temperatures during the May/June 2001 survey.

Transect 2 – Northern foothills

The majority of mammal and herptile sightings were confined to the eastern end of transect 2 where the rocky foothills gave way to areas of relict mud flow. Within this area a green toad (*Bufo viridis*) (**Figure 6.19**) and two lizard species were recorded (*Eremias arguta* (**Figure 6.20**) and *E.velox*). *Eremias arguta* is a rare species and has been proposed for inclusion in the Azerbaijan Red Data Book.

Figure 6.19: *Bufo viridis*

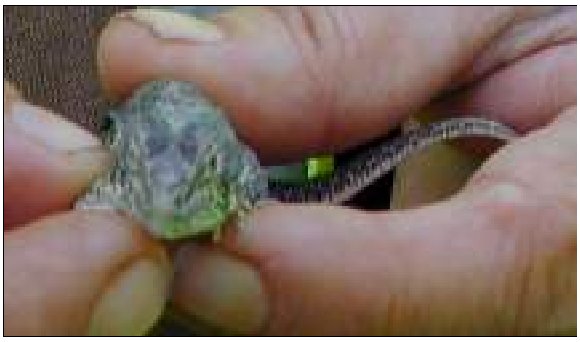


Figure 6.20: *Eremias arguta*

Transect 3 –Central south plains

The highest diversity of amphibian species was recorded along this transect, with tadpoles of marsh frog *Rana ridibunda* and *B. viridis* and juvenile *B. viridis* and European tree frog *Hyla arborea* sighted. These species were concentrated within three main areas, namely, within a freshwater stream fed by a leaking water main to the east of the terminal site, in *Typha* stands around the terminal access road and in *Phragmites* stands to the south-west of the terminal site. *H. arborea* is listed in the 2000 IUCN Red List of Threatened Animals.

Larger mammal observations (fox, hare and wolf) were concentrated around the south western end of the transect, in clearings between the *Phragmites* stands. In addition, what was thought to be a badger hole was recorded to the east of the terminal access road.

The findings of the Phase 2 survey are in general agreement with the survey results of the Phase 1 fieldwork, which also found pockets of higher biodiversity in the central plains where leaky water mains had given rise to marshy vegetation.

Transect 4 – Western and far northern plains

The western and far northern plains constitute relatively homogenous clay/saline soil terrain and support a low diversity of animals. Water is in short supply in these areas; therefore the majority of mammal observations were limited to small rodents (see **Table 6.7**).

Pockets of higher biodiversity were generally observed in areas where water was more plentiful, such as in natural depressions and excavated areas, giving rise to swathes of tamarisk. Two spur-thighed tortoise *Testudo graeca* (**Figure 6.21**) were sighted in areas such as this, one in a tamarisk stand to the west of the terminal site and one in a military dug-out to the north of the West Hills, see **Figure 6.17**. The spur-thighed tortoise is listed in the 1989 Red Data Book of the Azerbaijan Republic and in the 2000 IUCN Red List of Threatened Animals where it is classed as “vulnerable”.

These findings agree with those of the Phase 1 survey, which found higher biodiversity in topographically varied sections of the western plains.

Figure 6.21: Spur thighed tortoise *Testudo graeca*

Transect 5 – Western hills

The rocky slopes at the feet of the western hills support a relatively diverse mammal community and high number of individuals relative to the amount of area they comprise. This is attributable to the habitat edge they form between the flat semi-desert and rocky slopes. Four sightings of hare were recorded and a wolf den (**Figure 6.22**) with many entrances was found at the top of the most westerly hill (GPS 40.20226^{0}N

049.44598^{0}E). Juveniles of the marsh frog *R. ridibunda* were sighted in a wadi area between the hills.

Although numerous reptiles were recorded in this area during the Phase 1 baseline survey in May/June 2001, none were observed during the Phase 2 survey due to the low March temperatures.

Figure 6.22: Entrance to wolf *Canis lupus* den in West Hills

Transect 6 – Central north plains

The central plains to the north of the terminal site were the least diverse in terms of animal community. The lack of water and vegetation in this area and the fact that the area had been impacted by the dumping of topsoil piles resulted in no mammal or herptile observations within this area.

Transect 7 – North-western plains

The transect in this area cut through an area of tamarisk thickets with a high density of rodent burrows. No larger mammal species were recorded in this area (see **Table 6.7**).

No direct sightings of reptiles were made, however, a skin from the Levantine viper (*Viper libetina*) was recorded caught in tamarisk thicket close to a burrow.

The Phase 1 survey recorded a higher diversity of species in this area, with marsh frog and a number of reptile species observed. The lack of reptiles recorded in the Phase 2 survey was probably due to the low March temperatures.

Transect 8 – Western plains

A transect was walked between the *Salsola* plains on the higher hills and an area of tamarisk thicket in a lowland area, which was previously an artificial lake. No herptile observations were made, however a number of rodent burrows were identified within the lowland thicket area (see **Table 6.7**).

Summary

It should be noted that only low numbers of lizards were observed during the first two days of the Phase 2 fieldwork. The small numbers recorded and the failure to observe these species during the remainder of the fieldwork was due to the climatic conditions prevalent at the time, namely cloudy skies and low temperatures.

In contrast to the above, however, more species of amphibians were sighted during the

Phase 2 survey work, with three frog/toad species recorded namely *R. ridibunda*, *B. viridis* and *H. arborea*. In general the mating season is April-May for these species, however, sightings of tadpoles in a number of water bodies throughout the survey area shows that spawning had already taken place.

During the Phase 1 bat survey three species were recorded, the horseshoe, the Asian barbastelle and Kuhl's bat. No bat survey work was carried out during the Phase 2 survey as bats are less active in March than May/June, and therefore less likely to have been recorded.

During the Phase 2 survey there was evidence to suggest that the small rodents *Allactaga elater*, *Meriones erythrourus* and *Microtus socialis* were common throughout the study area based on the number of burrows sighted. However, no direct sightings were made, as rodent trapping was not carried out.

Rare Species Azeri Red Data Book / IUCN Red List Species Encountered

A summary of red data book species recorded during the Phase 1 and Phase 2 field surveys is provided in **Table 6.8**.

Table 6.8: Azeri Red Book / IUCN Red List Mammal and Herpetofauna Species Encountered During the Phase 1 and Phase 2 Fieldwork.

Genus species	Designation	Phase 1 Survey	Phase 2 Survey
Testudo graeca Spur-thighed tortoise	Azerbaijan Red Data Book. 2000 IUCN Red List.	Recorded in coastal zone and the central southern plain.	Recorded in the western and far northern plains.
Phoca caspica Caspian seal	2000 IUCN Red List.	Dead individuals recorded in coastal zone.	Not recorded
Hyla arborea Tree frog	2000 IUCN Red List.	Not recorded.	Recorded in vicinity of terminal access road
Eremias arguta Lizard species	Proposed for inclusion in Azerbaijan Red Data Book.	Not recorded.	Recorded in northern foothills.

Birds

Fieldwork Observations

During the ornithology survey, the study area was traversed on foot along the same predetermined transects used for the mammals and herpetofaunal surveys. All bird species heard or seen were recorded, along with their position, and a telescope was used to aid identification.

Due to the seasonal timing of the Phase 2 survey (end of March) the bird populations in the area were in a state of flux (see **Figure 6.23**). The wintering period was drawing to a close, migratory birds were passing over the area flying northwards, and resident and migratory populations were beginning their breeding seasons.

The results of the ornithology survey are discussed below, completed fieldwork proformas are presented in **Technical Appendix A** and a summary of the findings are presented in **Table 6.9.**

Table 6.9: Recorded Bird Species

Genus / Species	English Name	Migrating (M) Resident (R) Breeding (B) Overwintering (O)	Transect Number Within Survey Area Where Observed								Evidence
			1	2	3	4	5	6	7	8	
Acrocephalus arundinaceus	Great reed warbler	M, B	X		X						Visual, telescopic, auditory.
A. schoenobaenus	Sedge warbler	M, B	X		X						
A. scirpaceus	Reed warbler	M, B	X		X						
Alektoris chukar	Chukar	R		X			X				
Anas platyrhynchos	Mallard	O, M	X								
Anser anser	Greylag goose	M				X					
Athene noctua	Little owl	R		X							
Buteo rufinus	Long-legged buzzard	O, M		X	X						
Calandrella cinerea	Short-toed lark	R				X					
Carduelis carduelis	Goldfinch	R				X					
Charadrius alexandrinus	Kentish plover	M	X	X	X						
Ch. dubius	Little ringed plover	M	X	X	X						
Circus aeruginosus	Marsh harrier	R	X		X					X	
Columba livia	Rock dove	R				X			X		
Corvus cornix	Hooded crow	R			X				X		
Corvus fruigilegus	Rook	R	X								
Delichon urbica	House martin	M, B								X	
Falco naumanni #	Lesser kestrel	M				X					
Falco tinnunculus	Kestrel	R	X	X	X		X				
Fringilla coelebs	Chaffinch	O, M							X		
Fulica atra	Coot	O, M	X								
Galerida cristata	Crested lark	R	X	X		X	X		X	X	
Hippolais rama	Skye’s warbler	M, B			X						
Hirundo rustica	Barn swallow	M								X	
Larus argentatus	Herring gull	R	X		X						
Larus melanocephalus	Mediterranean gull	M	X								
Larus ridibundus	Black-headed gull	O, M	X								

Genus / Species	English Name	Migrating (M) Resident (R) Breeding (B) Overwintering (O)	Transect Number Within Survey Area Where Species Observed								Evidence
			1	2	3	4	5	6	7	8	
Limosa limosa	Godwit	O, M			X						
Melanocorypha calandra	Calandra lark	R				X	X		X		
Motacilla alba	Pied wagtail	R	X		X				X		
Oenanthe finschii	Finsch's wheatear	R	X	X		X	X				
Oenanthe isabellina	Isabelline wheatear	R		X							
Oenanthe oenanthe	Northern wheat ear	O, M				X					
Oenanthe pleshanka	Pied wheatear	O, M	X	X		X	X				Visual, telescopic, auditory.
Passer domesticus	House sparrow	R	X		X				X		
Pastor roseus	Rose coloured starling	M				X					
Pelecanus crispus *#	Dalmatian pelican	M		X							
Phalocrocorax carbo	Great cormorant	O, M	X								
Pica pica	Magpie	R			X						
Podiceps cristatus	Great crested grebe	O, M	X								
Podiceps nigricollis	Black necked grebe	O, M	X								
Pyrrhocorax pyrrhocorax	Chough	R		X		X		X			
Rallus aquaticus	European water rail	O, M, B			X						
Tachybaptus ruficollis	Little grebe	O, M, B	X								
Tadorna tadorna	Shelduck	O, M	X								
Tringa totanus	Red shank	O, M	X		X						
Troglodytes troglodytes	Wren	O, M, B								X	
Turdus merula	Black bird	O, M, B				X			X	X	
Sitta neumayer	Rock nuthatch	R		X			X				
Sturnus vulgaris	European starling	M, B	X		X	X	X				
Upupa epops	Hoopoe	M, B	X						X		

* Azerbaijan Red Data Book
\# IUCN Red List of Threatened Species

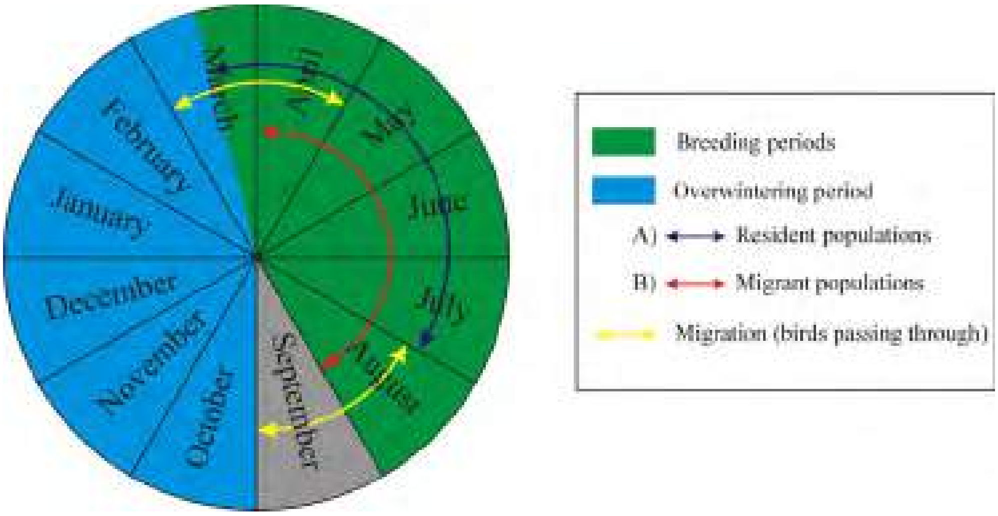


Figure 6.23: Key periods for birds in the Sangachal area

<u>Transect 1 – The coastal zone</u>

Sangachal Bay is known to have a high abundance for waterfowl during migratory periods and relatively large numbers of bird species were observed over the open water during the fieldwork period. In particular grebes (e.g. *Podiceps nigricollis, P. cristatus* and *Tachybaptus ruficollis*) and gulls (*Larus argentatus, L. melanocephalus* and *L. ridibundus*) were seen on the water surface and several great cormorants (*Phalacrocorax carbo*) on the offshore fishing platforms.

In addition, several bird species were seen in the coastal sector, particularly in wetland and lagoon areas where stands of *Phragmites* and other reeds had colonised. Plovers, warblers, wagtails and larks were recorded in an area of coastal lagoon and associated reed stands south east of the terminal site (GPS 40.19052^{0}N 049.51285^{0}E). There was also evidence to suggest that shelduck *Tadorna tadorna* and little ringed plover *Charadrius dubius* were nesting in this area. The Phase 1 survey recorded a breeding colony of common terns *Sterna hirundo* and little terns *Sterna albifrons* in this area during the May/June period 2001.

<u>Transect 2 – Northern foothills</u>

The northern foothills provides a suitable habitat for a number of birds of prey including little owl *Athene noctua*, long-legged buzzard *B. rufinus,* and kestrel *F. tinnunculus*. These species often nest on rocky crags and take advantage of the air currents created by hilly areas to reach suitable thermals. In addition, large numbers of chukar *Alectoris chuckar,* large numbers of the chough *Pyrrhocorax pyrrhocorax* and several passerine species including larks, plovers, wagtails, and wheatears were observed.

Ten Dalmatian pelicans *Pelecanus crispus* were seen migrating northwards over the area. *P. crispus* is listed in the 1989 Red Data Book of the Azerbaijan Republic and in the 2000 IUCN Red List of Threatened Animals.

<u>Transect 3 –Central south plains</u>

Concentrations of birds were generally seen around isolated wetland areas within the central southern plain. The majority of these areas were formed by leaking water mains with the water collecting in depressions. Stands of *Phragmites* and *Typha* also provided excellent bird habitats in these areas.

Sightings included a number of birds of prey such as long-legged buzzard *Buteo rufinus*, marsh harrier *Circus aeruginosus* and kestrel *Falco tinnunculus*, several warbler and plover species, a number of corvids including hooded crow *Corvus cornix* and magpie *Pica pica* and water birds such as water rail *Rallus aquaticus* and red shank *Tringa totanus*.

The Phase 1 survey in 2001 recorded the presence of a migrant species Syke's booted warbler breeding in the wet tamarisk scrub to the south of the access road during the May/June period. This observation was noteworthy as it constituted the first confirmed breeding season presence of the species in Azerbaijan. A pair of booted warblers were also sighted during the Phase 2 surveys towards the south western end of this transect.

Transect 4 – Western and far northern plains

At the southern end of the transect, bird sightings were relatively low in number and generally confined to areas of tamarisk thicket in lowland depressions. The majority of birds recorded were passerine species such as larks *Galerida cristata* and *Melanocoypha calandra*, wheatears such as *Oenanthe pleshanka* and *O. oenanthe* and finches such as *Carduelis carduelis*.

Towards the northern end of the transect, bird sightings were much more numerous and included large flocks of European starling *Sturnus vulgaris* and calandra lark *Melanocorypha calandra* and a number of migratory species such as greylag goose *Anser anser* and lesser kestrel *Falco naumanni.* Lesser kestrel is listed in the IUCN red list of threatened species.

The Phase 1 survey recorded the Azerbaijan Red Data Book species black-bellied sandgrouse *Pterocles orientalis* on the western plains; however, this species was not sighted during the Phase 2 survey.

Transect 5 – Western hills

The isolated trio of hills lying to the north west of the terminal site are lower than the western hills but possess a similar rocky topography. Only low cliff faces are present and these are largely inadequate for nesting birds of prey, with the exception of kestrels *Falco tinnunculus*. The majority of birds recorded in the area were passerines such as larks and wheatears. In addition a number of chukar *Alectoris chukar* were sighted.

Transect 6 – Central north plains

The central plains to the north of the terminal site were the least diverse in terms of bird species present. This can be explained by the lack of water and vegetation in this area and the presence of topsoil piles from the Terminal land clearance. A single bird sighting of chough *Pyrrhocorax pyrrhocorax* was made.

Transect 7 – North-western plains

The transect in this area cut through an area of tamarisk thickets where large numbers of calandra lark *M. calandra* were recorded. In addition a number of species associated with human developments were recorded, including the house sparrow *Passer domesticus*, the rock dove *Columba livia* and the black bird *Turdus merula*. The presence of these species can be attributed to a herder settlement in the area.

Transect 8 – Western plains

A transect was walked between the salsola plains on the higher hills and an area of tamarisk thicket in a lowland area. Bird sightings were restricted to the tamarisk stands where a number of species associated with human developments and not generally observed in natural desert habitats were recorded. These included the blackbird *Turdus merula* and the summer visitors barn swallow *Hirunda rustica* and house martin

Delichon urbica. The presence of these species can be attributed to the village settlement close by.

Summary

The most common birds, which were ubiquitous to the *Artemisia fragans* desert and *Salsola nodulosa* desert of the area, included the crested lark *Galerida cristata*, calandra lark *Melanocorypha calandra* and a number of wheatear species *Oenanthe spp.*

Several birds of prey species were recorded in the rocky hilly areas including long-legged buzzard *Buteo rufinus*, kestrel *Falco tinnunculus*, lesser kestrel *Falco naumanni* and the marsh harrier *Circus aeruginosus*. Opportunistic scavenger species were also relatively common and included hooded crow *Corvus cornix*, rook *Corvus fruigilegus* and choughs *Pyrrhocorax pyrrhocorax*.

A number of species observed were considered to be associated with human settlements including the house sparrow *P. domesticus*, the rock dove *C. livia*, black bird *T. merula* and the summer visitors barn swallow *Hirunda rustica* and house martin *Delichon urbica*.

Large numbers of bird species pass through the Sangachal terminal area in spring and autumn as the Azerbaijan coast lies on a major flyway for waterfowl, raptors and other birds migrating between breeding grounds that extend to the Arctic and wintering areas in south Asia and Africa. Several species of passage migrants were recorded, most notable of which were Dalmatian pelican *Pelecanus crispus*, greylag goose *Anser anser* and lesser kestrel *Falco naumanni*.

The wetland areas close to the coast may have a high abundance of migrating wildfowl and passerines such as ducks, waders, warblers and plovers and the coastal waters supported large numbers of grebes (*Podiceps nigricollis, P. cristatus* and *Tachybaptus ruficollis*) gulls (*Larus argentatus, L. melanocephalus* and *L. ridibundus*) and great cormorants (*Phalacrocorax carbo*).

Rare Species Azeri Red Data Book / IUCN Red List Species Encountered

A summary of red data book species recorded during the Phase 1 and Phase 2 field surveys is provided in **Table 6.10**.

Table 6.10: Azeri Red Book / IUCN Red List Bird Species Encountered During the Phase 1 and Phase 2 Fieldwork.

Genus species	Designation	Phase 1 Survey	Phase 2 Survey
Pterocles orientalis Black-bellied sandgrouse	Azerbaijan Red Data Book. 2000 IUCN Red List.	Recorded in western plains.	Not recorded.
Pelecanus crispus Dalmatian pelican	Azerbaijan Red Data Book. 2000 IUCN Red List.	Not recorded.	Recorded migrating north over northern foothills.
Falco naumanni Lesser kestrel	2000 IUCN Red List. Proposed for inclusion in Azerbaijan Red Data Book.	Recorded in central plains.	Recorded in far northern plains.
Buteo rufinus Long-legged buzzard	Proposed for inclusion in Azerbaijan Red Data Book.	Recorded in foothills of northern hills and in western plains.	Recorded in foothills of northern hills and in central southern plains.

6.4 Nearshore Environment

For the purpose of this assessment the focus of the nearshore environment description is Sangachal Bay, through which the export pipeline will be constructed. Other coastal areas over a longer length of coastline, which may be impacted by a large oil spill, are described in **Section 6.6** (sensitivities).

6.4.1 Physical Environment

Bathymetry

Sangachal Bay is a shallow bay, which slopes gently from the shore and reaches a depth of 10 m approximately 3 km offshore. **Figure 6.24** shows bathymetry obtained from a survey carried out in 2001.

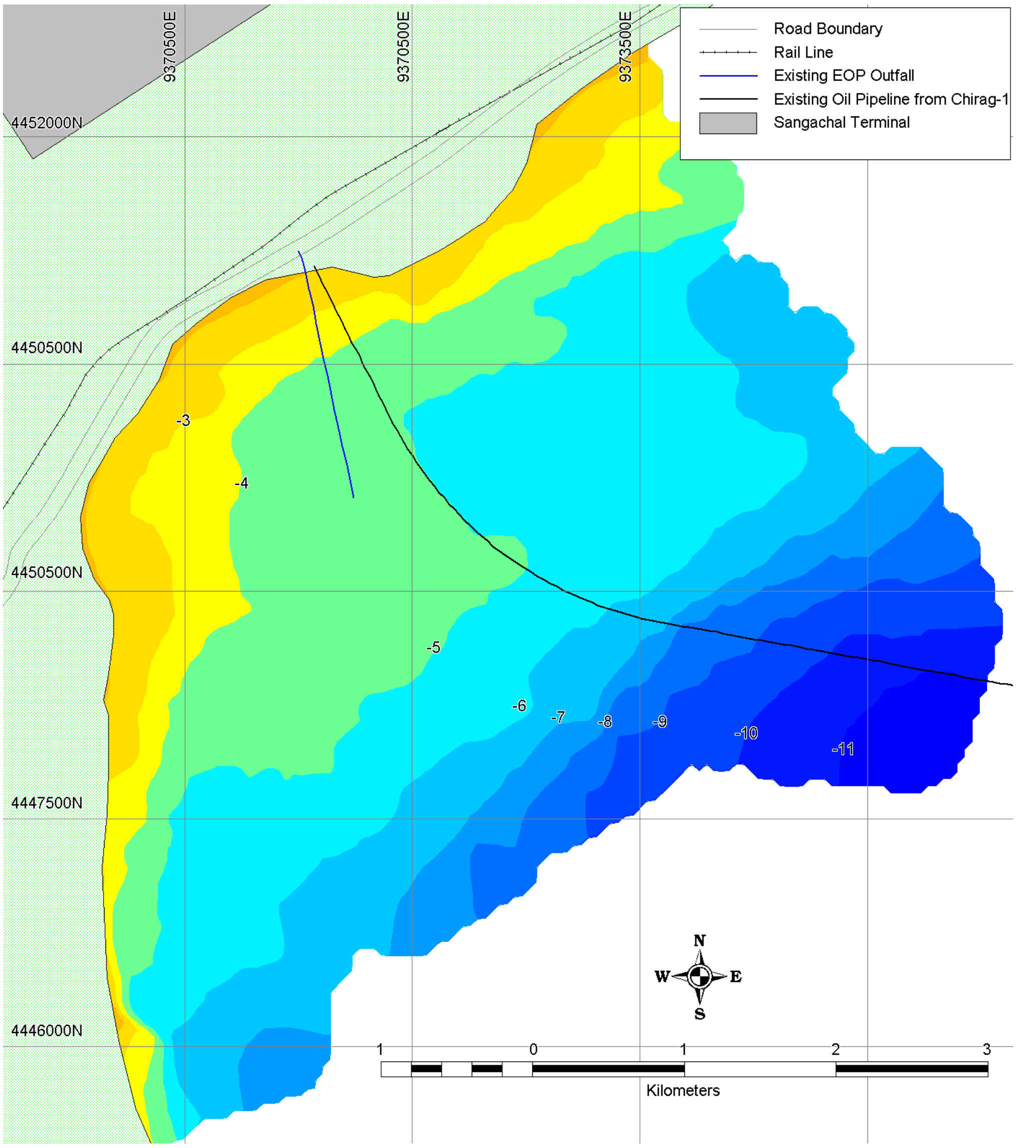


Figure 6.24: Bathymetry of Sangachal Bay (depths in metres) (from URS, 2002)

Currents

The Caspian Sea is effectively non-tidal, and water currents are mainly wind generated. Measurements of currents in the Bay were recorded from 13 October 1999 to 15 December 1999 and 28 January 2000 to 11 May 2000 (URS, 2001). The minimum current speed was 0.0 cm s^{-1} and the maximum, approximately 42.5 cm s^{-1}. The mean current speed was approximately 7.9 cm s^{-1}.

Current direction was evenly distributed between flowing in a south westerly direction and a north easterly direction; that is, down coast and up coast respectively (**Figure 6.25**). The higher current speeds were generally associated with the south westerly currents.

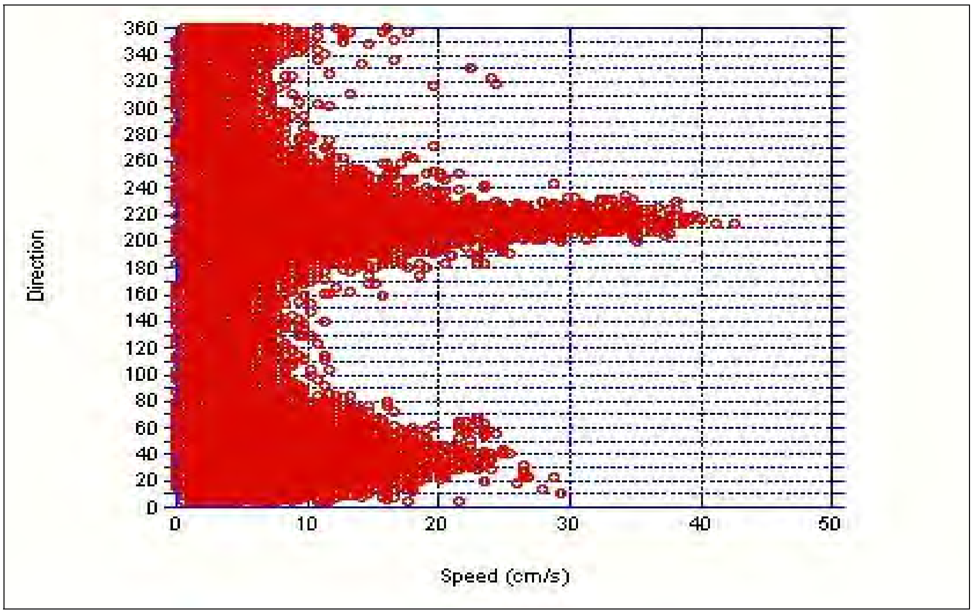


Figure 6.25: Distribution of current speeds per direction

For the Phase 1 ESIA, an investigation into surface currents in Sangachal Bay, using surface drifters, were carried out under two contrasting wind conditions in June 2001 (URS, 2002). During the first day, winds were light and from the south east and with wave heights of approximately 20 cm. On the second day, two days later, winds were strong from the north east and little or no wave action was observed.

During the light wind period, a complex nearshore circulation pattern was observed. The direction of drift was unexpected in that drifters released in the northern part of the Bay moved northwards and those released in the southern part of the Bay, southwards (**Figure 6.26** (**left**)). Drifter speeds varied from 1 to 6 cms^{-1}. Two drifters left in the wave break area north east of the jetty showed a slow residual current to the north east, concluded to be most likely associated with wave action.

During the strong wind period, southerly current speeds varied from 17 to 22 cm s^{-1} were operating (**Figure 6.26 (right**)). However, a large sediment plume approximately 100 to 200 m offshore was observed to be moving in a northerly direction.

Figure 6.26 shows inferred current directions in relation to wind directions from the June 2001 survey (URS, 2002).

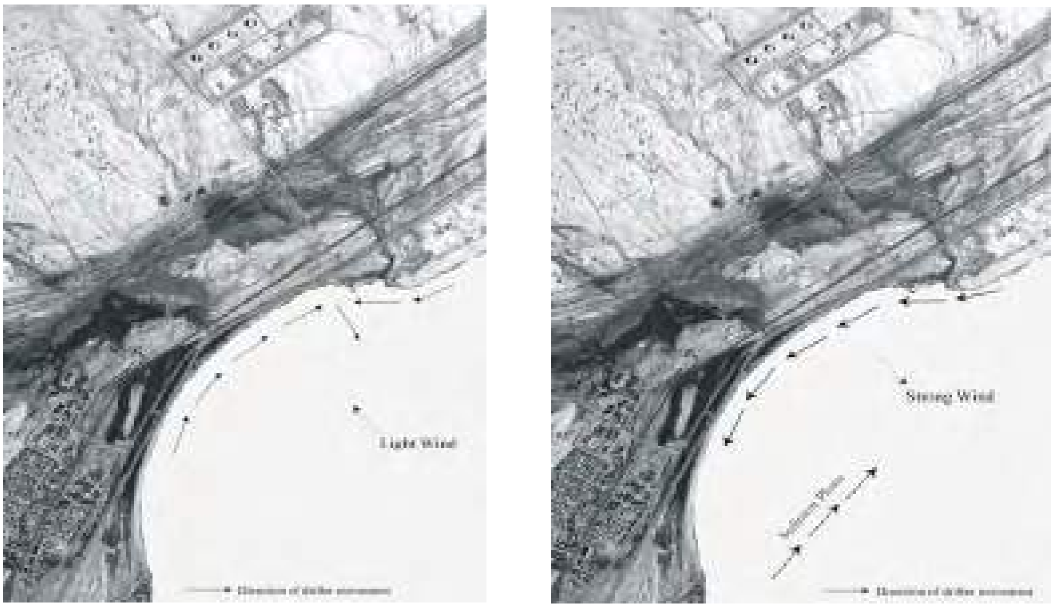


Figure 6.26: Inferred current directions: light south east winds (left), strong north east winds (right) (from URS, 2002).

It was concluded from these investigations that a complex nearshore current regime exists in Sangachal Bay. Currents have been observed to be moving in opposite directions over distances of a few kilometres. Currents are primarily wind driven but are also influenced and generated by waves. Shoreline configuration (i.e. shape and make-up) contributes to the behaviour of currents in the very nearshore zone and is itself shaped by the currents.

Sea Temperature and Salinity

Between July 2000 and July 2001, a nearshore fisheries study in Sangachal Bay (ERT 2001) recorded nearshore water temperatures of between 9 and 33°C. During the same time period the salinity varied between 9.8 and 12.0 ‰, (**Table 6.11**).

Table 6.11: Temperature and salinity ranges measured during the nearshore fisheries study (ERT, 2001)

Survey	Temperature (°C)	Salinity (‰)
July 2000	26.8-32.6	9.8-11.9
October 2000	15.1-17.1	10.1-11.4
March 2001	9.4-10.9	10.6-10.9
June 2001	24.6-28.9	12.0

These results indicate the greater natural variability in conditions in the shallow nearshore environment compared to offshore areas (see **Section 6.5**).

6.4.2 Water Column

Water Quality

The following sections provide a summary of the water column data for the nearshore environment of Sangachal Bay derived from 3 surveys covering a period of 4 years (1996 to 2000) (ACG Database, 2002).

Hydrocarbons

The initial surveys of the contract area and Sangachal Bay determined hydrocarbon concentration using the UVF (Ultra-violet fluoroscopy) detection methodology, which has since been superseded by the more sophisticated, and accurate, gas chromatography-mass spectrometry (GC-MS) technique. Consequently direct comparisons of these data are not appropriate. **Table 6.12** summarises recent total hydrocarbon and poly-aromatic hydrocarbon (PAH) concentrations, including those from the pipeline route to a depth of 25m. The maximum permitted concentrations (MPC) for total hydrocarbon (from CEP, 2001) is also given. The data presented here are considered to represent background levels and are not indicative of locally elevated amounts, however, it is accepted that the MPC has on occasion been exceeded at all of the three, shallow water Chirag pipeline route stations (ERT, 2000). The concentrations are generally comparable with data from offshore (see **Section 6.5**).

Metals

In the nearshore water column, the trace metals analysed in these surveys (barium, copper, cadmium and mercury) were all at concentrations below their limit of detection.

Nutrients and other parameters

Ammonia, nitrate and phosphate concentrations were only sampled during the Sangachal 2000 survey. Concentrations were found to be below or approaching the detection limits for all parameters. BOD was also only recorded during the Sangachal 2000 survey. Concentrations ranged from 0-10.8 mg l^{-1}. These data and also those for suspended solids and surfactants represent typical background concentrations (**Table 6.12).**

Table 6.12: Selected water quality parameters for nearshore sample stations

Parameter	MPC threshold (µg. l^{-1})	Nearshore		Chirag Pipeline (nearshore to 25 m)
		Sangachal	Sangachal	
Year		**1996**	**2000**	**2000**
Total Hydrocarbons (µg. l^{-1})	50	-	3.5-9.1	56-75
Total Hydrocarbons (µg. l^{-1}) (UVF)	50	13-21	-	-
PAH (µg. l^{-1})	-	-	6.85-14.55	0.006-0.027
Total Suspended solids (mg.l^{-1})	-	-	-	0-53
Surfactants (mg.l^{-1})	-	-	<0.10-0.155	0.17-0.52
BOD (mg.l^{-1})	-	-	0-10.775	-
Ammonia (mg.l^{-1})	-	-	n/d	-
Nitrate (mg.l^{-1})	-	-	<2.0-4.15	-
Phosphate (mg.l^{-1})	-	-	<0.15-0.41	-

Phytoplankton

The data summarised here is taken from the reports listed in **Table 6.1** and have been derived from a total of eighteen samples from three surveys carried out in 1995 and 2000. As with water quality parameters described above, these represent a small dataset from which it is possible to provide a qualitative snapshot of the phytoplankton communities that were present at the time of sampling. Further, given that all sampling occurred between September and December there is limited seasonal data. Consequently, the following paragraphs are limited to providing an indicative list of the principal species present and the relative contributions of each taxonomic grouping.

In the nearshore environment, diatoms and dinoflagellates were the most abundant groups with samples typically being composed of approximately equal quantities of each (**Table 6.14**). Blue-green algae were found in relatively low abundance except during the Sangachal pipeline survey 2000, where blue-green algae were equal in abundance to dinoflagellates.

The principal species recorded have been:

Diatoms:

- *Pseudosolenia (Rhizosolenia) calcar-avis;*
- *Acnanthes longipes;*
- *Thalassionema nitzschioides;*
- *Chaetoceros wighamii;* and
- *Nitzschia spp.*

Dinoflagellates:

- *Prorocentrum cordatum;*
- other *Prorocentrum spp;*

Blue-greens:

- *Oscillatoria spp*; and
- *Phormidium thermophilum.*

Chlorophytes:

- *Ankistrodesmus convolvulus.*

Insufficient data for nearshore locations is available to firmly quantify natural seasonality in plankton abundance and species composition. The water column of the nearshore environment is likely to be sufficiently mixed to preclude any spatial patterns in abundance and species distribution.

Zooplankton

The comments with respect to the limitations of the available data for phytoplankton apply equally to that for the zooplankton. The nearshore zooplankton community consists primarily of copepods and cladocerans The characteristic species are as follows:

Copepods:

- *Acartia tonsa;*
- *Calanipeda aqua dulcis;*
- *Eurytemora spp.;* and
- *Limnocalanus grimaldi.*

Cladocera:

- *Pleopis polyphemoides;* and
- *Evadne anonyx.*

Numerical abundance and biomass are highly variable within surveys, but insufficient data are available to comment on seasonal trends in either the zooplankton as a whole or its component groups. The dominant presence of the ctenophore *Mnemiopsis leidyi*, both in respect of abundance and biomass, is evident in the two most recent surveys.

Numerical dominance by *Acartia* in the copepod fauna has been noted previously as a characteristic of nearshore waters (Woodward Clyde 1996, referring to results published in the 1930's and 1940's). A number of these species have been introduced into the Caspian Sea, including the numerically dominant copepods *Acartia tonsa, Calinipeda aqua dulcis* and *Limnocalanus grimaldi*. However, the introduced species causing greatest concern with respect to its apparent impact on the plankton fauna in the Caspian, including endemic species such as the *Eurytemora spp.* and all of the cladocerans is the zooplanktivorous *Mnemiopsis leidyi* as mentioned above. Not initially recorded in earlier surveys, it appears to have become established in the South Caspian basin subsequent to the EOP survey being carried out in 1995. Its presence in the Caspian Sea was first detected in 1999 (CEP, 2001). The relative numerical abundances of these groups and the split between endemic and introduced (non-endemic) species is summarised from the Sangachal Bay 2000 survey (ERT, 2001) in **Table 6.13**. This table clearly shows the degree of numerical dominance of non-endemic species over the endemic ones.

Table 6.13: The relative numerical abundances of zooplankton groups (and endemic/non-endemic categories) from samples collected in Sangachal Bay, October 2000 (ERT, 2001)

Taxonomic group	**Station**					
	5	**7**	**11**	**20**	**26**	**27**
Cladocera	1.0%	3%	2%	11%	42%	1%
Copepoda (excluding nauplii)	9%	26%	27%	18%	58%	22%
Ctenophora	90%	71%	71%	71%	0%	77%
Endemic	1%	4%	5%	11%	42%	1%
Non-endemic	99%	96%	95%	89%	58%	99%

Table 6.14: Phytoplankton data from previously executed studies

Surveys	Date	number of stations	sample depth	Blue greens	Diatoms	Dinoflagellates	Others
				cells.l^{-1}			
Nearshore							
EOP nearshore	Sep-95	2	surface	0	2599-3627	0-5625	0-1222
	Dec-95	2	surface	0	8296-9101	910-1176	4761-8920
Sangachal Bay	Oct-00	6	surface	0-6400	23640-32280	21200-60400	0
		6	bottom	0-12000	22000-4120	19200-32400	0
Pipeline	Nov-00	1	surface	3800	98800	36400	0
		1	bottom (10m)	34600	79080	12800	0
Offshore							
EOP	Sep-95	32	surface (max. 10m)	0-8970	564-9107	434-7129	0-1137
	Sep-95	12	bottom	0-1353	0-2858	0-286	0-47
	Dec-95	10	surface (max. 10m)	0	1989-34141	1499-6350	1197-57227
	Dec-95	5	75/124	0	304-3250	0-203	0-1164
Pipeline	Nov-00	5	surface (max 10m)	3360-52000	29960-48280	3840-26520	0-120
Chirag 1 post drill	Nov-00	5	surface	0-11720	23440-42000	7440-12120	0-280
GCA 7	Aug-01	3	surface	881600-1723200	65200-159400	19000-46000	0-400
			midwater	24600-45200	86000-219000	600-1600	0
			bottom	15000-54200	81400-93600	0-1200	0
ACG environmental baseline	July-01	3	surface	7200-54800	22000-37200	13400-31200	0-1200
			midwater (45-50m)		12800-24400	10400-21200	0
ACG phase 2	Feb-02	2	surface	16800-18200	106000-131000	5600-5800	0
			Midwater (60-75m)	8000-33000	87600-105600	2200-3800	0
			Bottom (120-150m)	6600-7600	35800-52400	400-600	0

Table 6.15: Zooplankton data from the Phase 2 platform locations and previous surveys.

Surveys	Date	number of stations	sample depth	Cladocerans		Copepods		Ctenophores	
				abundance (number.l^{-1}) and biomass ($mg.m^{-3}$)					
				abundance	biomass	abundance	biomass	abundance	biomass
Nearshore									
EOP	Dec-95	1		0 - 1.0	-	0	0	0	0
Sangachal Bay	Oct-00	6	Surface	27 - 146	0.53 – 6.3	187 - 718	5.3 – 25.9	0 - 1277	30.5 - 268.2
		6	Bottom	0 - 225	0 – 6.6	143 - 424	1.6 – 32.7	0 - 1115	0 – 234.2
Pipeline	Nov-00	2		9-10	0.2	26-38	0.4 – 3.8	0-12	0 – 38.4
Offshore									
EOP	Dec-95	1	Bottom	0	0	0	0	0	0
	Dec-95	4		0 - 0.6	-	0		0	0
Pipeline	Nov-00	6		0 - 15	0 – 0.63	08 - 52	0.3 – 1.8	eggs	-
Chirag 1 post drill	Nov-00	5	Surface	0 - 13	0 – 0.21	22 - 36	1.0 – 2.4	0 - 43	0 - 1920
GCA 7	Aug-2001	3		20 - 84	0.3 – 1.8	64 - 233	15.7 – 49.8	0	0
ACG Ph 1 baseline	July-2001	3		22-120	0.7 – 2.9	1903 - 2680	97.9 – 157.5	2-130	2.4 – 2.5
ACG phase 2	Feb-02	2	Surface	0	0	170-231	3.5 – 6.5	eggs	-
		2	Middle	0	0	344-453	4.2 – 7.8	eggs	-
		2	Bottom	0	0	296-327	1.5 – 1.6	eggs	-

6.4.3 Fish and Fisheries

Preliminary seasonal data on resident fish populations were acquired in 2000-2001 (CEL, 2001). Seventeen species were recorded in catches from the shallow water of Sangachal Bay, with the numerically dominant species being:

- Vobla (*Rutilus rutilus kurensis*);
- Goby (*Neogobius fluviatilis pallasi*);
- Sandsmelt (*Atherina mochon caspia*); and
- Mullet (*Liza spp.*).

Other species present in the majority of seasons included:

- Pipefish (*Syngnathus nigrolineatus*);
- Goby (*Neogobius melanostomus*);
- Vimba (*Vimba vimba caspia*); and
- Kutum (*Rutilus frisii kutum*).

In addition to the resident fish, migratory species will inevitably be present from time to time in the nearshore environment as they move to and from their overwintering and summer spawning grounds. **Table 6.25** provides summary data for these species.

From the data collected, it was tentatively concluded (ERT, 2001) that weak seasonal trends in overall abundance were apparent, with most species at minimum abundance in the March 2001 survey. Seasonal variation was greatest in those species which grow to a larger size and which range more widely as adults (e.g. roach, mullet and herring species). It was thought that these fish used Sangachal primarily as a nursery area. Physiological and body burden analyses of a sample of the most numerically abundant resident species (goby, *Neogobius spp.* and roach, *Rutilis spp.*) were carried out. The study concluded that the fish populations of Sangachal Bay were healthy and that the data offered a reliable baseline for future monitoring work.

6.4.4 Aquaculture

Sturgeon hatcheries were established by the State Fisheries Concern (Azerbalyg) in order to release juveniles into the Caspian for stock replenishment. The existing hatcheries are centred on the Kura River and the Kura River Delta.

In 1998, the World Bank allocated grants for the design and construction of a new sturgeon hatchery near Khilli village (Neftchala district). It is anticipated that this will increase the existing capacity of Azerbaijan’s sturgeon farms from 6 million juvenile sturgeon per year to 15 million.

6.4.5 Nearshore Birds

The coastal zone of the Caspian is one of international ornithological importance. It regularly supports both internationally and nationally significant numbers of migrating and overwintering birds, as well as species afforded protection status both within Azerbaijan and Europe.

At present, survey data are inadequate to rank individual sectors of the open coast in terms of their relative ornithological importance (Andrews, 1997). Migrating and wintering birds tend to move widely along the open coast and factors which determine their distribution include water depth, food location and abundance, inter-specific competition for food, roost location, weather conditions and disturbance by human activity or natural predators. However, several sites located in the coastal region are of particular significance (see **Figure 6.4**), including;

- Shakdilli Spit and associated islands (Absheron Peninsula);
- the Pirsagat Islands;
- the Kura Delta (Azerbaijan);
- Kyzyl-Agach Bay (Azerbaijan); and,
- Bandar Kiashar Lagoon and mouth of the Sefid Rud river (Iran).

These areas are discussed in more detail below:

Absheron Peninsula

The majority of the species found in the Absheron Peninsula (41 %) use the area during the migration period, 34 % are resident species, whilst the remaining 25 % are use the area for overwintering purposes. Bird species residing in the Absheron Peninsula can be categorised according to their feeding habits;

- Birds feeding on fish – grebe, cormorant, gull, tern, egret;
- Birds feeding on plants or invertebrates – grebe (partially), swan, goose, duck, coot, stint; and,
- Predators that feed on birds or relatively large fish – white tailed eagle, harrier.

The main breeding season is from late March through April when bird numbers will be highest.

Pirsagat Islands

The Pirsagat Islands hold important seabird colonies. Data collected prior to 1991 indicated that herring gull, slender-billed gull, Mediterranean gull, great black-headed gull, gull-billed tern, sandwich tern, common tern and little tern all breed on Pelicanniy, Baburiy and Baklanniy Islands (AIOC, 1996a).

Kura Delta

The Kura Delta is an important ornithological region as it may, on occasion, support large numbers of waders during the spring migration period. A number of ‘vulnerable’ shorebirds have been recorded in this area such as broad-billed sandpiper, dunlin and bittern. Some ‘Endangered’ species such as the black-winged pratincole and the spoonbill have also been recorded here (Tucker and Heath, 1994).

Kyzyl-Agach State Nature Reserve

Kyzyl-Agach State Nature Reserve was established in 1929 for the protection and reproduction of wintering and migratory waterfowl, wader and steppe birds. The total area of the reserve is 99,000 hectares. It has been estimated that there are 248 bird species within the reserve including a number of red data book species and species of European or International importance (UNDP, 1997).

Under the 1971 Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention), an area can be designated as an internationally important ‘Ramsar site’ if it regularly supports 20000 waterfowl, or 1% of the flyway population of a species or subspecies (Ramsar Convention, as revised). Kyzyl-Agach was designated as a Ramsar site in 1976; however, Azerbaijan only became a signatory to this convention in 2000.

According to the Ramsar Convention Bureau (1990) the coastal fringes and shallow bays of Kyzyl-Agach are wintering grounds for some 300,000-400,000 waterfowl and during the spring period, 20,000-24,000 pairs of nesting birds breed there.

The sea level rise of the Caspian has resulted in the formation of vast shallow gulfs and rich feeding grounds, which has resulted in an increase in the number of wintering and migratory waterfowl using the site (UNDP, 1997).

Bandar Kiashar Lagoon and Mouth of Sefid Rud

Bandar Kiashar Lagoon lies immediately east of the mouth of the Sefid Rud River, in the south west Caspian region and consists of a shallow sea bay (formerly brackish lagoon), associated freshwater marshes and the nearby riverine marshes at the mouth of the Sefid Rud. In 1975, 500 ha of the wetlands were designated as a Ramsar site but otherwise the site is unprotected.

The area is an important staging and wintering area for a wide variety of migratory wildfowl, notably grebes, pygmy cormorant, ducks, shorebirds, gulls and terns, and for marsh harrier and merlin.

The number of wintering waterfowl has decreased considerably since the 1970s due to increased disturbance from fishing activities.

Table 6.16 provides a list of the species present in the nearshore and offshore environment, which are also on either the Azerbaijan or IUCN Red List.

Table 6.16: Bird species potentially present in the nearshore and offshore environments and their conservation designation

Common name	Scientific name	Nearshore/offshore	Conservation designation
Ducks, geese and swans			
Marbled teal	*Marmaronetta angustirostris*	Nearshore	Azerbaijan red list
White-headed duck	*Oxyura leucocephala*	Nearshore	IUCN red list
Red-breasted goose	*Branta ruficollis*	Nearshore	Azerbaijan red list
Lesser white-fronted goose	*Anser erythropus*	Nearshore	IUCN red list
Mute swan	*Cygnus olor*	Nearshore	Azerbaijan red list
Bewick swan	*Cygnus columbianus bewicki*	Nearshore	Azerbaijan red list
Raptors			
Osprey	*Pandion haliaetus*	Nearshore/ offshore	Azerbaijan red list
White-tailed eagle	*Haliaetus albicilla*	Nearshore/ offshore	Azerbaijan red list
Cormorants and pelicans			
Pygmy cormorant	*Phalacrocorax pygmeus*	Nearshore	IUCN red list
Dalmatian pelican	*Pelecanus crispus*	Nearshore	Azerbaijan red list, IUCN red list
White pelican	*Pelecanus onocrotalus*	Nearshore	Azerbaijan red list

Protection priority for species groups of birds is shown in **Chapter 8**, **Table 8.17.**

6.4.6 Benthic Environment

Sediments

Sampling of Sangachal Bay sediments has determined that they consist predominantly of a poorly sorted mixture of silt, clay, sand and shell gravel. Occasional patches of soft cohesive grey clay and muddy patches also occur within the bay. Sediments in the shallows within 200 to 300 m of the shoreline tend to be less muddy and are often rippled as a result of wave action. At a distance from the shore of 2 to 3km, sediments are coarser, and overlain to varying extents (20 to 99 % cover) by a 2 to 4 cm layer of hard carbonate concretion having the appearance of a flat 'pavement' (**Figure 6.27**).

However, the sediment regime is somewhat dynamic given the shallow water and consequent exposure to wind generated currents and surges, which can be of sufficient strength to resuspend fine particles of sediment. This has been evidenced by changes in sediment character between surveys carried out in the bay in 1996 and 2000 (see **Figure 6.28**). In the 2000 survey, there was a central band of fine sediment with coarser material nearshore and to the south. In 1996, there was a more consistent gradation of increasing particle size with increasing distance offshore.

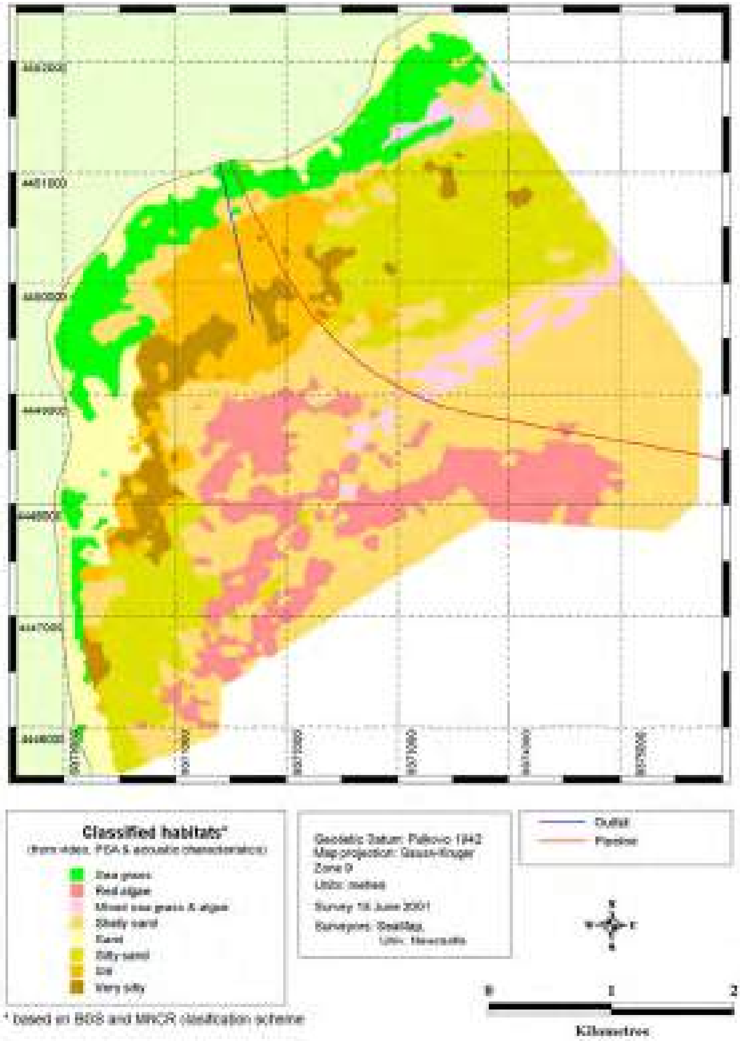


Figure 6.27: Sediment classification and distribution of seagrass beds in Sangachal Bay, 2001

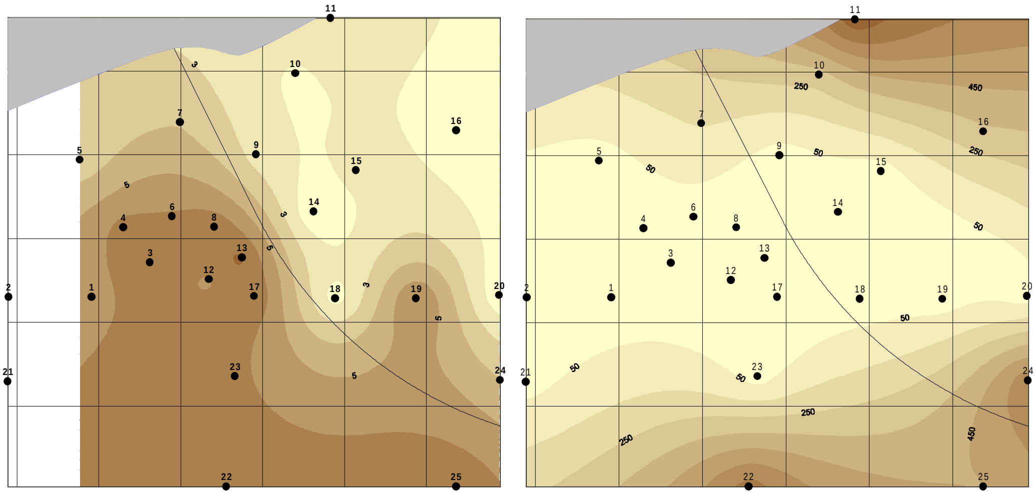


Figure 6.28: Comparison of mean sediment particle diameter between the 1996 (left) and 2000 (right) Sangachal surveys (from ERT, 2001). Particle diameter marked on contours.

Seabed Chemistry

The heterogeneous nature of the physical sediment characteristics is also reflected in the chemical composition of the sediments. The metals data outlined below have been derived from two surveys that have employed different analytical methods (inductively-coupled plasma, ICP in 1996 and atomic absorption spectroscopy, AAS in 2000). This difference severely restricts the opportunity to make a detailed comparison between datasets.

Metals

Higher concentrations of the analysed metals such as copper, iron and zinc in both the 1996 and 2000 surveys were associated with fine grained sediments present in the central part of the survey area with high levels of silt/clay and organic content.

Bearing in mind the different analytical methods employed for the two datasets it can tentatively be noted that, with the exception of lead, the range and average values of trace metal concentrations between the 1996 and 2000 survey show little difference (**Table 6.17**). Concentrations of lead in the 2000 survey had increased in comparison to 1996 at nearly all stations. Mean continental crust concentrations are included for comparison (Wedepohl, 1995) and using these criteria there is some indication of elevated levels for some metals.

Table 6.17: Selected trace metal concentrations (µg.g-1) in Sangachal Bay sediments (summarised from 1996 and 2000 surveys)

1996	**Chromium**	**Copper**	**Iron**	**Mercury**	**Lead**	**Zinc**	**Cadmium**
Max	-	90.3	57200	<0.05	31.6	131	1.25
Min	-	5.1	7710	<0.05	6.5	15	0.12
2000							
Max	84.80	59.3	41789	0.06	63.77	106	<2.5
Min	17.84	10.8	7738	0.01	14.1	17	<2.5
Mean Conc. in Continental Crust*	126	25	43200	0.04	14.8	106	0.1

* from Wedepohl (1995)

Hydrocarbons

Data from both the 1996 and 2000 surveys (combined in **Figure 6.29**) showed, in general, that the highest total hydrocarbons concentrations were present in sediments with the highest proportion of organic material and silt/clay fraction. A comparison of the sediment hydrocarbon concentrations between the two years is provided in **Table 6.18**.

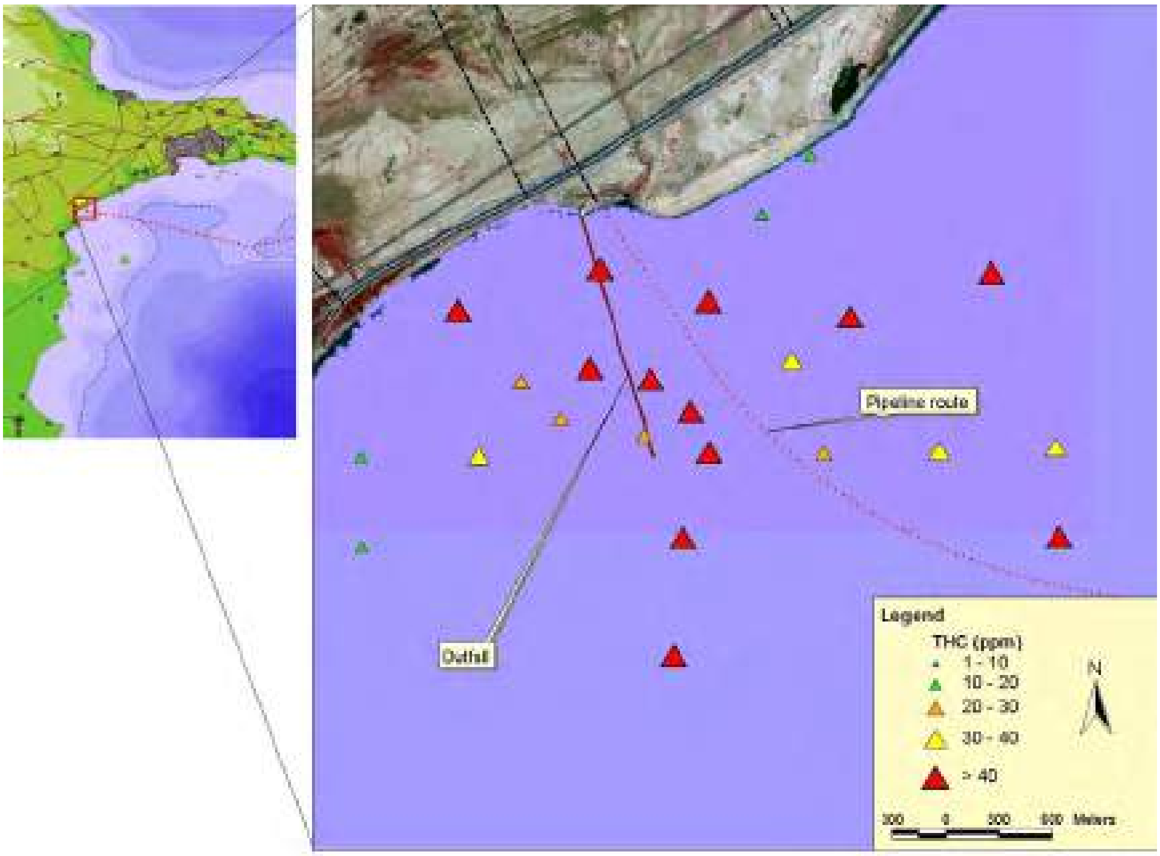


Figure 6.29: Total hydrocarbon concentrations in nearshore sediments

Table 6.18: Comparison of sediment hydrocarbon concentrations (µg.g-1)

Parameter	1996	2000
Min	10	11.9
Max	280	120.2
Mean	121.6	48.9

Benthic flora

The distribution of seagrass (*Zostera noltii*) has been mapped in Sangachal Bay (**Figure 6.27**). Dense beds of seagrass were present close to the shoreline in water depths of less than 4 m. A narrow band of seagrass was also found in deeper water (6-7m) nearly 2 km from the shoreline, in an area of gravel.

The majority of sea grass growth takes place in the spring and summer, and established patches can enlarge at 0.5 m per year (C. Maggs *pers comm*.). Seagrasses form continuous mats, of varying size, which extend marginally by growth of stolons. During periods of low light intensity in the autumn the leaves are shed (Brown, 1990). They are also removed by grazing or wave action during the winter. *Z. noltii* overwinters as a rhizome and shoot fragments, which enables recruitment and re-growth in the spring (Marta *et al*., 1996).

The harder substrata supported assemblages of filamentous red algae (*Ceramium, Osmundea, Polysiphonia, Callithamnion* and *Laurencia*). **Figure 6.27** indicates the distribution of these algae in Sangachal Bay.

The life history strategy of ephemeral species found in the nearshore environment (*Callithamnion spp*., *Ceramium* cf. *tenuicorne, Polysiphonia denudata* and *Acrochaetium spp*.) are based on the opportunistic colonisation of suitable substrata where and when available. The perennial species (including *Osmundea caspica* and *Polysiphonia stricta*) grow from a winter dormant base during spring. This base, like the rhizomes of *Z. noltii* acts as an energy store; this allows the plant to survive sub-optimum conditions for a lengthy period of time, perhaps several months. These growth rates and life history strategies are of relevance when assessing the impacts of construction activities in Sangachal Bay (see **Chapter 8**).

Macrobenthic fauna

The macrobenthic faunal community of the nearshore environment, typified by that sampled in Sangachal Bay (1996 and 2000) is characterised by the presence of the following species:

Polychaetes:

- *Nereis diversicolor;*
- *Hypania invalid;* and
- *Hypaniola kowalewskii.*

Oligochaetes:

- *Isochaetidaes michaelseni;*
- *Tubificidarum spp;* and
- *Tubificidae spp.*

Molluscs:

- *Abra ovat;,*
- *Cerastoderma rhomboids;* and
- *Mytilaster linearis.*

Apart from being characterised by these taxa, community assemblages from each station varied in composition in terms of the diversity, overall abundance and relative abundance of each of these characterising species. These features have been summarised in **Table 6.19.** Generally, the bulk of the data summarised in this table demonstrate a good deal of overlap between the two surveys with the exception of numerical abundance which was higher in 1996 and the absence of the polychaetes *H. invalida* and *H. kowalewskii* in the 1996 samples. Such variation is likely to be largely attributable to natural variation, and changes in sediment conditions described above.

Table 6.19: Summary data for a range of community assemblage aspects including the relative abundance for the characterising species from 1996 and 2000 surveys.

Parameter	**1996**		**2000**	
Diversity	1.65 – 2.63		0.74 – 2.93	
Taxa per station	8 – 16		4 – 21	
Individuals per station (0.5 m^2)	404 – 15,476		22 – 3,127	
	% Stations present	**Individuals per station (0.5 m^2)**	**% Stations present**	**Individuals per station (0.5 m^2)**
N.diversicolor	100%	22 - 553	68%	0 – 280
H.invalida	0	-	52%	0 – 200
H.kowalewskii	0	-	48%	0 – 120
I.michaelseni	0		68%	0 – 2,202
Tubificidarum spp.	17%	0 – 245	44%	0 – 175
Tubificidae spp.	100%	1 – 321	96%	0 – 175
Abra ovata	91%	0 - 977	96%	0 - 2472
C.rhomboides	100%	10 - 129	80%	0 – 368
M. linearis	83%	0 – 2,616	44%	0 – 2,222

Also noteworthy is the relative lack of crustaceans, particularly amphipods, and only very localised presence of gastropod molluscs. In general the total number of species present in the nearshore environment would appear to be lower than that observed offshore (excluding the deep water mud locations).

The 1996 survey report included an assessment of the correlation between selected species and physical parameters. The following correlations were identified;

- Positive correlation with gravel content: Bivalve molluscs, total number of individuals;
- Negative correlation with gravel content: the cumacean, *Shizorhynchus euderolloides;* and,
- Positive correlation with sediment heterogeneity: total number of taxa.

6.5 Offshore Environment

6.5.1 Physical Environment

Bathymetry

The ACG contract area tends to slope from a depth of about 100 m to approximately 400 m toward its south western limit. The seabed topography throughout the area is very irregular, especially in the vicinity of the mud volcano vents present in the shallower parts (see **Figure 8.1**).

Residual currents

The late spring river flows, particularly from the Volga, create a southwards flow down the west coast of the Middle Caspian (Kosarev & Yablonskaya, 1994). This may also drive counter currents up the east coast and set up a residual circulation in the South Caspian. However, wind driven circulation is the principal feature in the Caspian (URS, 2002). **Figure 6.30** shows the pattern of residual currents in the Caspian.

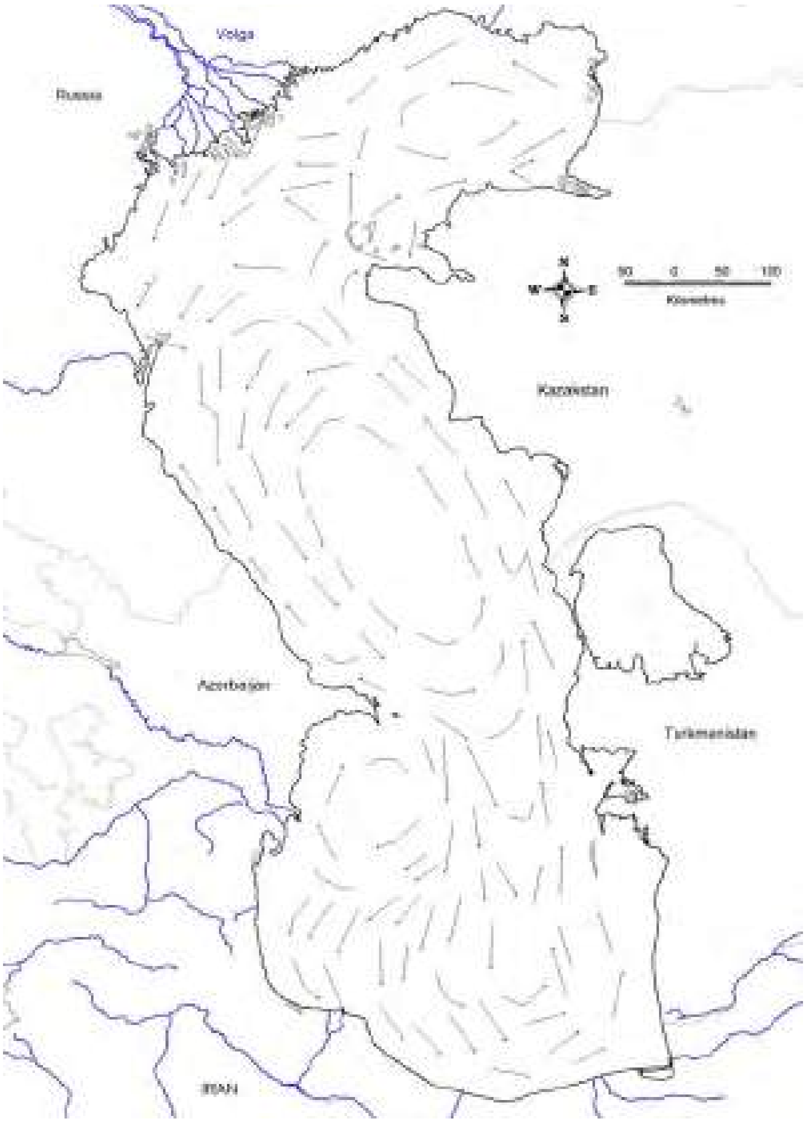


Figure 6.30: Residual current pattern in the Caspian Sea (Woodward Clyde, 1995)

Wind driven and subsurface currents

Current patterns in the Caspian generally correspond to the main wind directions, with the strongest and most stable currents generally occurring in the upper water layers. Thus, with winds from the north, a southern surface current generally prevails. Similarly with south easterly winds, the resulting surface currents are usually in a north west direction. These currents are also greatly influenced by the configuration of coastlines, bathymetry and bottom relief.

Measurements of water currents made in the Contract Area from October to December 1996 (cited in the Phase 1 ESIA, URS 2002) indicated that most of the time currents were weak (90 % of the time below 0.2 ms^{-1}). Maximum currents detected were 0.65 m s^{-1}, at a depth of 50 m. Maximum surface currents were 0.4 m s^{-1} and mean surface currents around 0.1 m s^{-1}. Near seabed current speed and direction data collected along the Chirag pipeline corridor from October 1999 to May 2000 has been summarised and presented in **Figure 6.31**. Highest current speeds were measured at 1.26 m s^{-1}.

Storm surges are a common event causing temporary rises in sea level. These events are associated with persistent strong winds causing water to push up against the coastline. From the wave height data in the following section (**Table 6.20**) it is possible to infer, on the basis of the frequency of wave heights in excess of 3 m, that the months of July and August (months 7 and 8) are the stormiest. Conversely the windiest months overall, on the basis of the frequency of waves in excess of 2 m in height, are October to February, with a peak period consisting of December and January. However, it should be noted, however that the data in **Table 6.21**, indicates that storm events occur all year round.

Wind direction and strength for summer are shown in **Figure 6.5** and **Figure 6.6.**

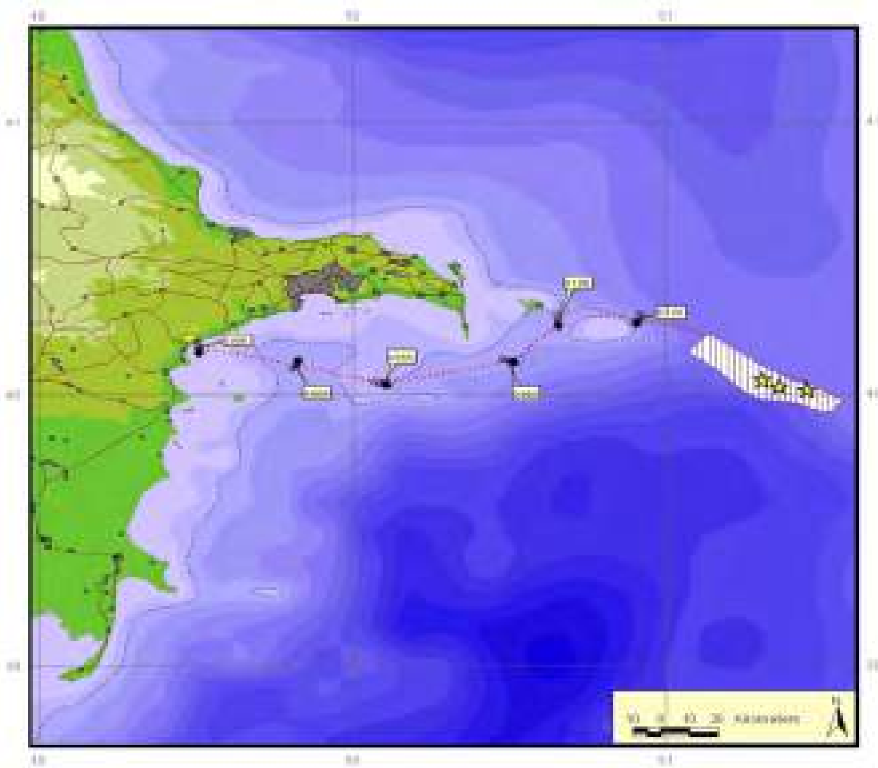


Figure 6.31: Mean current vectors showing mean speed (m s-1) and direction along the existing pipeline route during the period October 1999 to May 2000

Waves

The surface wave regime generally follows the prevailing wind patterns. The area of greatest wave development extends from the western portion of the Middle Caspian basin down and across the central section of the Absheron Ridge. Maximum expected waves are around 10 m in height with a 10 second period. The directionality and seasonality in wave fields is shown in **Table 6.20** and **Table 6.21.**

Table 6.20: Directionality of waves at Bulla Island (Israilov, 1977)

Wave	Direction of motion							
	N	NE	E	SE	S	SW	W	NW
Wave heights (m)	1.2	0.6	0.4	0.4	0.4	0.6	-	0.9
Wave periods (s)	2.8	2.1	1.5	2.3	1.4	1.7	1.0	1.5

Table 6.21: Seasonality in wave heights at Oil Rocks (Tambovtseva, 1975)

Wave height (m)	Days/ month												Days /year
	1	2	3	4	5	6	7	8	9	10	11	12	
0.1 - 1.0	1	5	11	14	18	14	10	11	9	8	7	5	119
1.1 - 2.0	16	16	10	10	8	10	9	10	11	14	13	16	143
2.1 - 3.0	5	4	5	3	3	4	6	5	6	6	6	6	59
3.1 - 4.0	2	2	3	2	1	2	5	3	2	1	3	2	28
4.1 - 5.0	2	1	1	1	0	0	1	2	1	0	1	1	11
5.1 - 6.0	0	0	1	0	1	0	0	0	1	1	0	1	5

The theoretical 100 year wave height data gives a maximum measured wave height of 16.7 m. A 1996 storm modelling study carried out on behalf of AIOC confirmed this (AOIC EIA for the Appraisal drilling, 1996).

Sea Temperature

During the winter the surface water temperature in the ACG Contract Area falls to 5 - 6 °C, and may freeze in exceptional circumstances, however this phenomenon has not been observed recently. Water temperature reaches its maximum during July and August when values of 25 to 26 °C are common in the Contract Area. Temperatures in deeper water in the South Caspian remain at about 6 °C all year round. In extreme winters dense cold water is believed to flow from the North to the South Caspian basins, under warmer and less dense surface waters.

During the late spring and summer months a stratified water column develops, with a thermocline at water depths of between 20 and 60 m. The depth of the thermocline increases during the summer and autumn months as surface water temperatures and wind-driven turbulence increase. During the winter the thermocline breaks down.

Salinity

The average salinity of the South Caspian Sea is approximately 12.9 ‰. The lowest salinity (<5‰) is found in the shallow North Caspian. For offshore areas of the Middle and South Caspian seasonal and spatial differences in salinity are less than 1 ‰, ranging between 12.5 and 13.4‰. Near the river deltas on the western coast of the South Caspian, salinities may reduce to 12 ‰ and in shallow bays on the eastern coast values can reach 14 ‰ due to increased evaporation.

Sea Water Chemistry

The Caspian contains waters of oceanic origin, which have been diluted and changed by river outflows. This process has led to a lessening of the relative contents of chlorides in the general salt mass and a relative increase in carbonates, sulphates and calcium compounds (see **Table 6.22**).

Offshore areas of the Caspian, including the Contract Area, are characterised by high oxygenation of the surface waters in the winter months and saturation levels in the spring due to increased water mixing during the winter and phytoplankton activity in the spring. During summer months the water column becomes stratified and this results in a reduction in oxygen levels below the thermocline.

Table 6.22: Average ion composition of the World Ocean and the Caspian

Ions	World Ocean (Lyman and Fleming, 1940)		Caspian Sea (Blinov, 1962)	
	$g\ kg^{-1}$	% equ.	$g\ kg^{-1}$	% equ.
Na+	10.6	38.7	3.2	31.6
K+	0.4	0.8	0.1	0.6
Ca2+	0.4	1.7	0.3	3.8
Mg2+	1.3	8.8	0.7	14.0
Cl-	19.0	45.1	5.4	34.7
Br-	0.1	0.1	0.01	0
SO_4^{2-}	2.6	4.6	3.1	14.6
CO_3^{2-}	0.1	0.2	0.1	0.7
Total	**34.5**	**100**	**12.9**	**100**
Source: Kosarev and Yablonskaya (1994)				

6.5.2 Water Column

Water Quality

Available data allows an approximate indication of the general trends and an order of magnitude of concentrations of the parameters tested. Quantitative assessments of temporal and spatial changes in water quality is however not possible.

Hydrocarbons

The maximum permitted concentration (MPC) for total hydrocarbons is given in **Table 6.23** and indicates that on occasion, concentration of this parameter in the water column has exceeded this threshold. There are no apparent spatial or temporal trends in the data, though the data is insufficient to present a clear representation of the environmental load. The presence of high concentrations of suspended solids can, in part, explain some of the high concentration values reported, for example in the GCA5 and Chirag 1, 2000 surveys as hydrocarbons have a tendency to preferentially adsorb to particulates. It should also be noted, however, that values in excess of the MPC threshold of 50 $\mu g.l^{1}$ have been exceeded in the absence of high suspended solids concentrations, for example in the GCA7, 2001 survey. As the MPC threshold relates to dissolved hydrocarbons, then high values need to firstly be assessed with reference to the suspended solid concentration of the sample and whether the sample was filtered prior to analysis. The significance of this distinction, between dissolved and adsorbed, components is relates to the bioavailability of the hydrocarbon compounds. When in solution, bioavailability is appreciably greater than for adsorbed components.

Metals

For all of the surveys containing water column metals data, barium, copper and mercury were always at concentrations below the detection limits of the analytical equipment. Cadmium was found to be present in the concentration range of <0.05-0.37 $\mu g.l^{-1}$. The maximum permitted concentration (MPC) for these elements is included in the table (**Table 6.23**) and indicates that measured concentrations are typically lower than this threshold. Data for other metals (not presented here) show that concentrations, with the exception on occasion of iron, copper and nickel (CEP, 2001) are not considered to be elevated, or do not exceed the MPC levels.

Nutrients and other parameters

Other than surfactants and suspended solids, there is limited data from the various surveys. BOD was also only recorded during the GCA7, 2001 survey. Concentrations ranged from 0.04 –1.0 mg l^{-1}, which was considerably lower than the data from Sangachal Bay. The available data for ammonia, nitrate, phosphate and surfactants are considered to represent typical background concentrations, when compared to data from other surveys in the South Caspian Basin (ERT, unpublished) (**Table 6.23**).

As commented above with respect to hydrocarbons, suspended solid concentrations have been noted to have an important role in fate of contaminants. Adsorption is not only a key aspect of the behaviour of hydrocarbons in the water column but also other parameters including metals and BOD. Suspended solids levels have the potential to make marked differences to the fate of discharged contaminants, which may adsorb to particulates and settle out of the water column rather than remain in solution.

Table 6.23: Selected water quality parameters from offshore sample stations.

Parameter	**MPC threshold (µg. l^{-1})**	**Chirag 1992**	**EOP 1995**	**Chirag 1 2000**	**Chirag Pipeline 2000**	**Chirag post drill 2000**	**GCA5 2000**	**Phase 1 2001**	**GCA 7 2001**
Total Hydrocarbons (ug.l^{-1})	50	-	-	18-61	23.3-74.8	1.2-14.3	19-81	5-42	21-78.4
Total Hydrocarbons (ug.l^{-1}) (UVF)	50	0.6-1.1	-	<0.1-6.0	-	-	-	-	-
PAH (ug.l^{-1})	-	-	-	0.001-0.014	0.001-0.027	1.2-14.3	n/a	0.006-0.014	0.003-0.015
					-	-	-	-	-
Ba (ug. l^{-1})	2000	n/d	n/d	-	-	-	-	n/d	n/d
Cu (ug. l^{-1})	5	n/d	-	-	n/d	n/d	-	n/d	n/d
Cd (ug. l^{-1})	10	n/d	-	-	n/d	n/d	-	0.13-0.37	n/d
Hg (ug. l^{-1})	0.1		n/d	-	n/d	0.01	-	n/d	n/d
Total Suspended solids (mg.l^{-1})	-	-	-	8-69	-	8.1-68.7	12-120	15-46	n/d-0.36
Surfactants (mg.l^{-1})	-	-	-	0.25-0.46	0.17-0.50	0.22-0.46	0.19-0.48	0.27-0.46	0.33-0.41
BOD (mg.l^{-1})	-	-	-	-	-	-	-	n/d	0.04-0.95
COD (mg.l^{-1})	-	-	-	-	-	-	-	n/d	131-188
Ammonia (mg.l^{-1})	-	-	-	-	-	n/d	-	n/d	n/d
Nitrate (mg.l^{-1})	-	-	n/d	-	-	<0.5-3.51	-	n/d	<0.5-0.86
Phosphate (mg.l^{-1})	-	-		<0.03	-	n/d	-	n/d	<0.005-106.25

Phytoplankton

The data summarised here are taken from the reports listed in **Table 6.1** and have been derived from a total of 77 samples from six surveys carried out between 1995 and 2002. As with water quality parameters described above, these represent a small dataset from which provides a qualitative snapshot of the phytoplankton communities that were present at the time of sampling. Further, given that the bulk of sampling occurred between September and December there is limited seasonal data. Consequently, the following paragraphs are limited to providing an indicative list of the principal species present and the relative contributions of each taxonomic grouping. Biomass data have been reported, for example ACG environmental baseline 2001 (ERT, 2001), but this has been determined indirectly and has not been included in this discussion, as it does not greatly assist the environmental description.

The abundance and number of taxa of both diatoms and dinoflagellates in offshore samples were slightly reduced when compared to inshore samples. Conversely, blue-greens were generally more abundant. Limited though the data is, it appears that phytoplankton populations, across all groups, are highest in summer (July/August). Though surface samples tended to support the largest populations in comparison with midwater and near bottom samples, this is by no means clearly defined. This is probably a reflection of wind induced vertical mixing in the upper part of the water column. Such water movements would be associated with subsurface currents, which as noted in **Section 6.5.1**, occur throughout the year.

Blue green algae showed the greatest variation in seasonality with respect to abundance. Highest abundances, particularly of diatoms, were recorded in August (GCA 7, ERT, 2001). Such patterns in abundance and seasonal variation as can be inferred from these data, follow the general view that phytoplankton populations are low through the winter months (blue-green algae in December 1995) then increase rapidly in the spring in conjunction with increased temperature and light (all groups February 2002). The spring bloom is transient, as nutrients become utilised and herbivorous zooplankton populations rise. Toward the end of summer a second, smaller bloom is often apparent, particularly with respect to dinoflagellates (dinoflagellates in August 2001 compared with July 2001).

With respect to species composition, the characteristic species were:

Diatoms:

- *Pseudosolenia (Rhizosolenia) calcar-avis;*
- *P. (R.) fragilissima*, *Thalassionema nitzchoides;* and
- *Chaetoceros wighamii.*

Dinoflagellates:

- *Prorocentrum cordatum;* and
- other *Prorocentrum spp.*

Blue-greens*:*

- *Oscillatoria spp.;* and
- *Lyngbya limnetica.*

In the locality of the Phase 2 developments, phytoplankton species composition (ERT, unpubl.) was similar to those listed above, and can be summarised as follows, in order of abundance (per group):

Diatoms:

- *P. (R.) fragilissima;*
- *Pseudosolenia (Rhizosolenia) calcar-avis;* and
- *Chaetoceros wighamii.*

Dinoflagellates:

- *Prorocentrum cordatum.*

Blue-greens*:*

- *Lyngbya limnetica;* and
- *Oscillatoria redekei.*

Abundances for the samples collected in February 2002 within the Phase 2 locations, were comparable with other offshore data.

Zooplankton

The comments with respect to the limitations of the available data for phytoplankton apply equally to that for the zooplankton, with only samples from 34 stations from 6 surveys. The species composition of the zooplankton communities in the offshore samples shows no major differences to the nearshore data. The characteristic species are as follows;

Cladocera:

- *Pleopis polyphemoides;*
- *Polyphemus exiguous;* and,
- *Evadne anonyx.*

Copepods:

- *Acartia tonsa;*
- *Calanipeda aqua dulcis;*
- *Eurytemora spp.;* and,
- *Limnocalanus grimaldi.*

Ctenophora:

- *Mnemiopsis leidyi.*

There are insufficient data to determine trends in terms of overall zooplankton abundance between offshore and nearshore environments.

The endemic cladocerans show greater seasonality in abundance that the other faunal groups, being present in low numbers during winter months. In the Phase 2 survey carried out in February 2002, no cladocerans were reported in the six samples from two stations (**Table 6.15** and **Table 6.24**). Copepoda is the most abundant taxon, with non-endemics being numerically dominant, though the endemic *Eurytemora spp.* continues to be present in the majority of samples.

For the sample analyses completed to date from the Phase 2 locations survey (West Azeri only), the following species are considered to be characteristic:

Copepoda:

- *Eurytemora grimmi*; and,
- *Acartia tonsa*.

Ctenophora:

- *Mnemiopsis leidyi*.

The relative contributions of each group and the proportions of endemic and non-endemic species have been summarised in **Table 6.24.** From this table, it is apparent that non-endemic species form the larger part of the zooplankton fauna.

Table 6.24: The relative numerical abundances of zooplankton groups (and endemic/non-endemic categories) from samples collected in East and West Azeri platform locations, February 2002 (ERT, 2002)

Taxonomic group	Station					
	WA8			WA15		
	surface	midwater	bottom	surface	midwater	bottom
Cladocera	0%	0%	0%	0%	0%	0%
Copepoda (excluding nauplii)	72%	20%	6%	66%	43%	24%
Ctenophora	28%	80%	94%	34%	57%	76%
Endemic	14%	4%	1%	11%	7%	8%
Non-endemic	86%	96%	99%	89%	93%	92%

6.5.3 Fish and Fisheries

There are some 124 species and subspecies of fish in the Caspian, dominated by endemic and freshwater species with few representatives of the Mediterranean Ichthyofauna (Kosarev & Yablonskaya, 1994). Many fish species within the Caspian have wide geographical ranges, with some migrating long distances to spawn in rivers and shallow water areas.

In general, the main distributions of fish species in the southern Caspian are typically in water depths of no more than 50m, however, during the winter a number of species reside in deeper water.

Table 6.25 summarises the distribution, presence and characteristics of the fish species, which may be present in the vicinity of the ACG Contract Area throughout the year. Additional species such as the Caspian lamprey (*Caspiomyzon wagneri*) and Caspian salmon (*Salmo trutta caspius*) have not been considered as they are either unlikely to be present in areas under discussion in significant numbers or for any appreciable length of time. Those species that have been listed have been organised into three groupings as explained below.

Migratory species

Sturgeon and shad generally only occur in the Contract Area and pipeline corridor area when they are en-route to spawning and overwintering grounds. Typically they overwinter (November to February) in the deep water areas of the South Caspian. This may include areas along the southern flank of the Contract Area. During March and April, seasonal migrations along the western coast, including relevant coastal areas, occur as the fish move north to their traditional spawning grounds.

Resident species

Several non-commercial species such as gobies (for example *Anatirostrum profundorum*) and the pipefish (*Syngnathus nigrolineatus*) are present within the nearshore and adjacent offshore waters of the South Caspian throughout the year. Therefore individuals may be present within the ACG Contract Area during all seasons.

Other species

Kilka and mullet species undertake shorter feeding and/or breeding migrations, from the South Caspian to overwintering areas in the Middle/South Caspian. Consequently, they are likely to have a more or less continuous presence in the area throughout the year, at least as one part of their life cycle (egg, larva, juvenile or adult). Kilka will generally be present only in relatively shallow waters outside of the overwintering period whilst mullet are present throughout the full water column depth.

Table 6.26 provides the results of a series of seasonal surveys for the presence of a number of fish species, and their age classes, in the Gunashli field. This table indicates that kilka were the most abundant species, particularly during spring and summer. Only a few individual sturgeon were caught, including during the winter period.

Fisheries

Fishing activity within the Contract Area is not considered commercially viable due to its remoteness from the fish landing ports. The closest fisheries to the ACG Contract Area are the kilka fisheries, concentrated on offshore banks along the western coast of the southern Caspian. The closest bank is Makarov Bank, which is approximately 115 km to the west of the Contract Area (**Figure 6.32**), but it is within 2km of the closest point along the proposed pipeline route. However, it should be noted that the Contract Area may be used by fishing vessels from other Caspian littoral states.

6.5.4 Offshore Birds

Of the birds that can be considered to be present in offshore areas the principal species are as follows:

- Great cormorant (*Phalacrocorax carbo*)
- Herring gull (*Larus argenteus*)
- Common tern (*Sterna hirundo*)
- Sandwich tern (*Sterna sandvicensis*)

These four species have been highlighted as being the most numerically abundant in published data for the Absheron Peninsula (Gambarov *et al*., 1958; Gambarov, 1960; Mustafaev *et al*. 1968) and the Shakhdilli-Pirallahi area (Sultanov and Kerimov, 1998, 1999). Counts for these species have been summarised in the Phase 1 ESIA (URS, 2002).

None of these species have currently been given notable conservation status and all breed in the region and can be expected to be present throughout the year, though population sizes will vary with some migration occurring. Birds in passage over offshore waters are discounted here as it is not anticipated that even those species with the ability to, will actually alight on the water (Andrews, 1997). See **Chapter 8**, **Table 8.17** for protection priority for species groups.

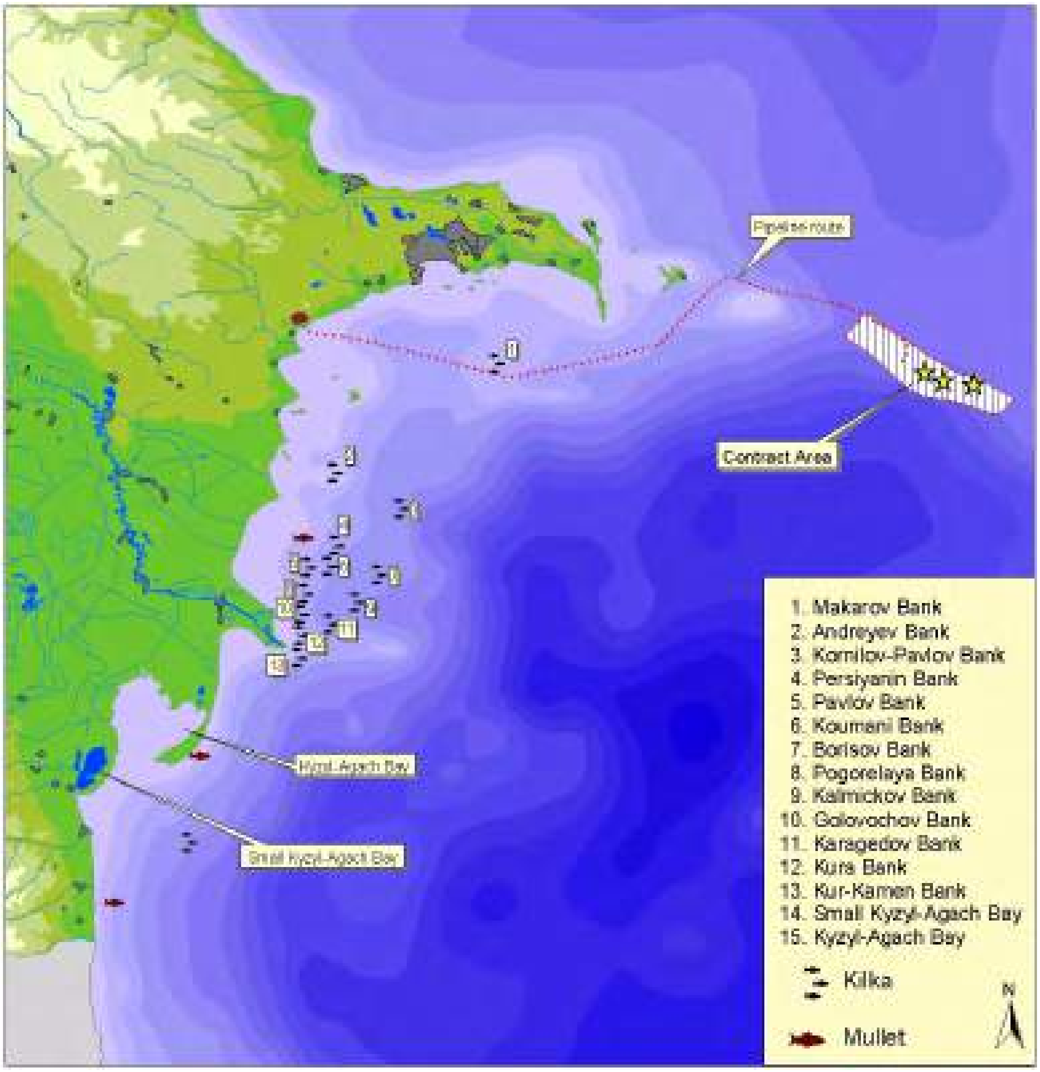


Figure 6.32: Schematic Diagram Showing Principal Commercial Fishing Areas for the Fishing Industry of Azerbaijan

Table 6.25: Anticipated fish species distribution, presence and characteristics in the vicinity of the ACG Contract Area

Family / Genus / Species	Distribution and presence in Contract Area throughout year	Importance
Migratory species		
Sturgeon (Acipenseridae): **Beluga (*Huso huso*)** **Russian (*Acipenser gueldenstaedtii*)** **Persian (*A. gueldenstaedtii persicus*)** **Spine (*A. nudiventris*)** **Stellate (*A. stellatus*)**	Five species and subspecies of pelagic and bottom feeding fish. Feeding predominantly on small fish and benthic invertebrates. Generally present in less than 50 m water depths except whilst overwintering in southern Caspian (20 to 200m). They are anadromous fish, migrating in the spring (March and April) to spawning grounds in several rivers including Volga, Ural, and Kura. Spawning cycle is not annual. Adults return to the southern Caspian during the autumn months of September to November. Very valuable as food fish and for caviar. Legal fishing for sturgeon is confined to the deltas and lower reaches of the rivers. Classed as endangered on IUCN Red List.	Most valuable commercial fish species within the Caspian both for caviar and food fish. All are classed as endangered on IUCN Red List.
Herring (Clupidae) **Shad (*Alosa spp.*)** **Caspian (*A. caspia*)** **Big-eyed shad (*A. saposhnikovi*)** **Blackback (*A. kessleri*)** **Dolginka shad (*A. brashnikovi*)**	Predators of kilka and other small fish, shad overwinter in the southern and south western Caspian between November and February at 30 to 100m depth. During March and April they undertake a spring migration to the northern Caspian to spawn. Adults return to the southern Caspian during the autumn months (September to November). They have also been collected in the contract area in August (see **Table 6.26**)	Valuable food fish.

Family / Genus / Species	**Distribution and presence in Contract Area throughout year**	**Importance**
Resident species		
Sandsmelt (*Atherina mochon pontica*)	Pelagic marine fish, plankton feeders. Present in southern Caspian throughout the year. Major concentrations in shallower coastal waters, only individuals found in offshore areas, usually at water column depths of 5 - 10 m. Spawning has been recorded in south-west part of northern Caspian, near the Buzachi Peninsula and in Kyzyl-Agach Bay during April / May.	Non-commercial. Constitutes diet for sturgeons, predatory shads and other species.
Pipefish (*Syngnathus nigrolineatus*)	Plankton feeding marine fish. Numerous but do not congregate in shoals. Majority in shallower coastal areas, only individuals found in deep water areas. Spawning all over Caspian during spring/summer period but mainly in coastal areas. Eggs not planktonic.	Non-commercial fish, however, provide food for sturgeons, zanders and predatory shads.
Gobies (Gobiidae) including *Anatirostrum profundorum*	Generally small benthic and predatory feeding marine fish. Over 30 species present in Caspian, majority are coastal species. Fish eggs and larvae present during April/May period. Spawn in shallow coastal waters, down to 70 m, during April / May. Eggs benthic.	Non-commercial fish, however, provide food for other fish and seals.
Other species		
Herring (Clupidae) **Big-eye kilka (*Clupeonella grimmi*)** **Anchovy kilka (*C. engrauliformis*)**	Pelagic zooplanktivores. Undertake diurnal and seasonal vertical migrations in the water column following their food source (Big eye: 20-80m spring/summer, 60-500m winter. Anchovy: 40-60m spring/summer, 200-750m winter). They overwinter in the southern Caspian before undertaking a short spring migration to spawning areas in the South and Middle Caspian at depths of between 20 and 200m, (Big-eye: January to September . Anchovy: May to November) which potentially impinge on the Contract Area (April and May). Adults return to the southern Caspian during the autumn months (September to November). Consequently they can be expected in the Contract Area all year round and spawning from April to November.	Important food for fish and seals. Also important commercially for canning, smoking and fish meal.
Mullet (Mugilidae) **Grey mullet (*Liza saliens*)** **Golden mullet (*L. auratus*)**	Omnivores found throughout water column and over a wide range of water depths. Migrate to northern Caspian in spring to feed and migrate south in autumn to overwinter. Migratory path follows the western and eastern coasts of the Caspian. Eggs and larvae present in the southern and middle Caspian during the period June – July (Grey) and August to September (Golden) and throughout the water column (Belyaeva *et al*., 1989). Pre-larval and larval stages at depths of 10 - 40 m. Larvae migrate from central Caspian towards shallower coastal areas.	Food fish.

Table 6.26: Catch data from sampling programme carried out in the Gunashli field.

Fish species	1999				2000				2001	
	April	August	October	December	April	August	October	December	April	August
Anchovy kilka	192 / 2-3	263 / 2-3	23 / 2-3	-	117 / 2	44 / 2	15 / 2	-	11 / 1-2	-
Bigeyed kilka	184 / 2-3	190 / 2-3	37 / 2-3	22 / 2	51 / 2	48 / 2	22 / 1-2	14 / 1-2	6 / 1-2	-
Sandsmelt	16 / 1-2	10 / 1-2	-	21 / 1-2	11 / 1-2	9 / 1-2	-	9 / 1-2	8 / 1-2	7 / 1-2
Blackback shad	15 / 3-4	26 / 3-4	8 / 3-4	-	6 / 3-4	2 / 3-4	-	-	-	-
Goby-*A. profundorum*	-	-	-	-	-	1 / 3	-	-	-	-
Sturgeon	-	-	1 / 12	2 / 14-16	-	-	-	1 / 14	-	-

Note: Numerator – number of samples (Ind); denominator – age of samples (years).

6.5.5 The Caspian Seal

The Caspian seal (*Phoca caspica*) is the only truly aquatic mammal in the study area. It is endemic to the Caspian and is the world's smallest species of seal, with a lifespan of up to 50 years. The exact number of Caspian seals is not presently known. However, in 1987 it was estimated to be 360000 to 400000 individuals (Krylov, 1989).

The World Conservation Union (IUCN) reviewed the status of the Caspian seal in 1996 and first classified it as '*vulnerable*' in the 1996 IUCN Red List, based on the degradation of the Caspian and the coastal habitats favoured as haul-out sites. Studies have since been conducted in the Azerbaijan sector of the Caspian to assess the general health of the Caspian seal population. In autumn 1998 Gadjiev and Aybatov carried out investigations in conjunction with helicopter surveys undertaken on behalf of AIOC between August 1997 and January 1998. Examination of dead seals washed up on shorelines revealed that 15-25% had purulent diseases of the lungs and 40-50% had parasitic worms (Aybatov, 1997). Earlier studies conducted by Alchin *et al.* (1997) identified high concentrations of chlororganic pesticides within the seal fat, and the presence of morbillivirus, the Canine Distemper Virus (CDV) that has not previously been recorded in the Caspian, but has caused extensive seal mortality in the North Sea, White Sea and Lake Baikal.

In response to the high mortality of Caspian seals on the coast of Kazakhstan starting in April 2000, the Ecotoxicology Project of the Caspian Environment Program (CEP) has assembled a scientific team to examine mortality along the Caspian coast that is part of the seals' summering grounds.

The team surveyed beaches along the Azerbaijan coast and known haul-out sites of Caspian seals. They took scientific samples of dead seals observed at these areas, and performed detailed postmortem examinations on any seals that had died recently. Apart from marked emaciation, which was found in all cases of dead seals, there was no clear pattern in the gross lesions observed to suggest a common cause of death.

The corpses were extensively sampled for histological, toxicological, virological, bacteriological, and parasitological examination. Similar information was obtained from Kazakhstan and Turkmenistan. The results indicate that a major contributing factor of the seal mortalities was CDV. The role of pollution in a distemper outbreak is not clear-cut, because distemper is a highly pathogenic virus that will cause mortality even in the absence of pollution. However, it is possible that an apparent failure of the population to develop immunity to continuing disease might be related to high levels of DDT compounds or other chemical pollutants found in the seals (CEP, Ecotoxicological Update, October 2000).

Despite its protected status, the Caspian seal is still exploited by the fur trade, with annual culling of the seal pups (up to the age of 20 days) being undertaken between 10th January and 10th February at the breeding sites in the Russian Sector of the northern Caspian. Typically the annual commercial culling quota is equivalent to approximately 15-20% of the seal pups, which equates to approximately 20000 individuals. The killing of the Caspian seal is prohibited by law outside of the Northern Caspian.

The majority of the seal population undergoes an annual breeding migration cycle. However, approximately 10-15% (40-60000 individuals) remain in the middle and southern Caspian all year round. This group typically includes juveniles and other non-breeding individuals.

Studies performed by Gadjiev and Aybatov in 1996 and 1997 revealed that the Absheron and Baku Archipelago, Shakdilli spit, and Ogurchinsk Island (Turkmenistan) are used as year-round haul-out sites by this group. Further, helicopter surveys of the coast and islands of the Absheron Peninsula, identified year-round haul-out sites on Shakdilli spit, Zilhoy Island, and other islands in the vicinity. Two thousand seals were recorded within these sites during the winter period between 1996 and 1997 (Gadjiev and Aybatov, 1998). **Figure 6.33** shows the location of seal haul-outs and breeding sites over the year for the whole of the Caspian Sea.

The majority of the seal population (85-90%) migrates during the late autumn / winter to the northern Caspian where they remain until early spring. The adults congregate here to whelp on the ice in late January and early February. After whelping, the seals then mate between mid-February and mid-March after which they moult before migrating southwards along the shelf zones to the feeding areas of the southern and middle Caspian. The location of the breeding sites varies according to the severity of the winter and the position of the sea ice front.

Upon reaching the feeding areas of the middle and southern Caspian, in April/May (dependent upon the severity of the winter period) the seals initially confine their feeding range to the coastal waters while replenishing their fat reserves, which have been depleted by up to 50% during the winter.

Once their reserves have been replenished and buoyancy restored, the seals will start moving into the deeper water areas of the middle and southern Caspian (during May to June), where the kilka populations are concentrated, returning periodically to their haul-out sites.

In October and November, the seals commence the return migration northwards, mainly to islands in the north east Caspian where they haul-out to wait for the sea ice to form and a new breeding season to begin.

The Caspian seal feeds predominantly on Caspian kilka although other fish are also taken. Summer is the main feeding season for the seals. Feeding activity is more limited in spring, autumn and winter (see **Figure 6.33**). During feeding, the Caspian seal typically dives down to a depth of 10 m, remaining underwater for approximately 4-5 minutes. However, it is capable of remaining underwater for up to 15-20 minutes, and of diving to depths of 100-120 m (Gadjiev and Aybatov, *pers. comm.*).

From the above discussion it can be seen that the Caspian seal population can be divided into a migratory and smaller non-migratory group.

During the winter and early spring (November-March) the majority of the seal population will be in the North Caspian. The only seals present in the South Caspian, during this period, are the non-migratory individuals (10-15% of the population) that congregate on the haul-out sites of the Absheron Peninsula, 90 km north east of the Contract Area, when not feeding. The need for foraging expeditions will result in these seals leaving their haul-outs and moving into the open water, however few seals will travel far offshore (Gadjiev and Aybatov *pers. comm.*).

During the late spring (April/May) migratory individuals from the north will begin to appear in the South Caspian and seal densities within the Contract Area will start to increase. Peak seal densities are likely to occur in the summer months, when the Caspian seal population congregates in the southern Caspian to feed on the kilka concentrations in this area. During late summer/autumn, seal densities will begin to decrease as the majority of the seals start their migration north.

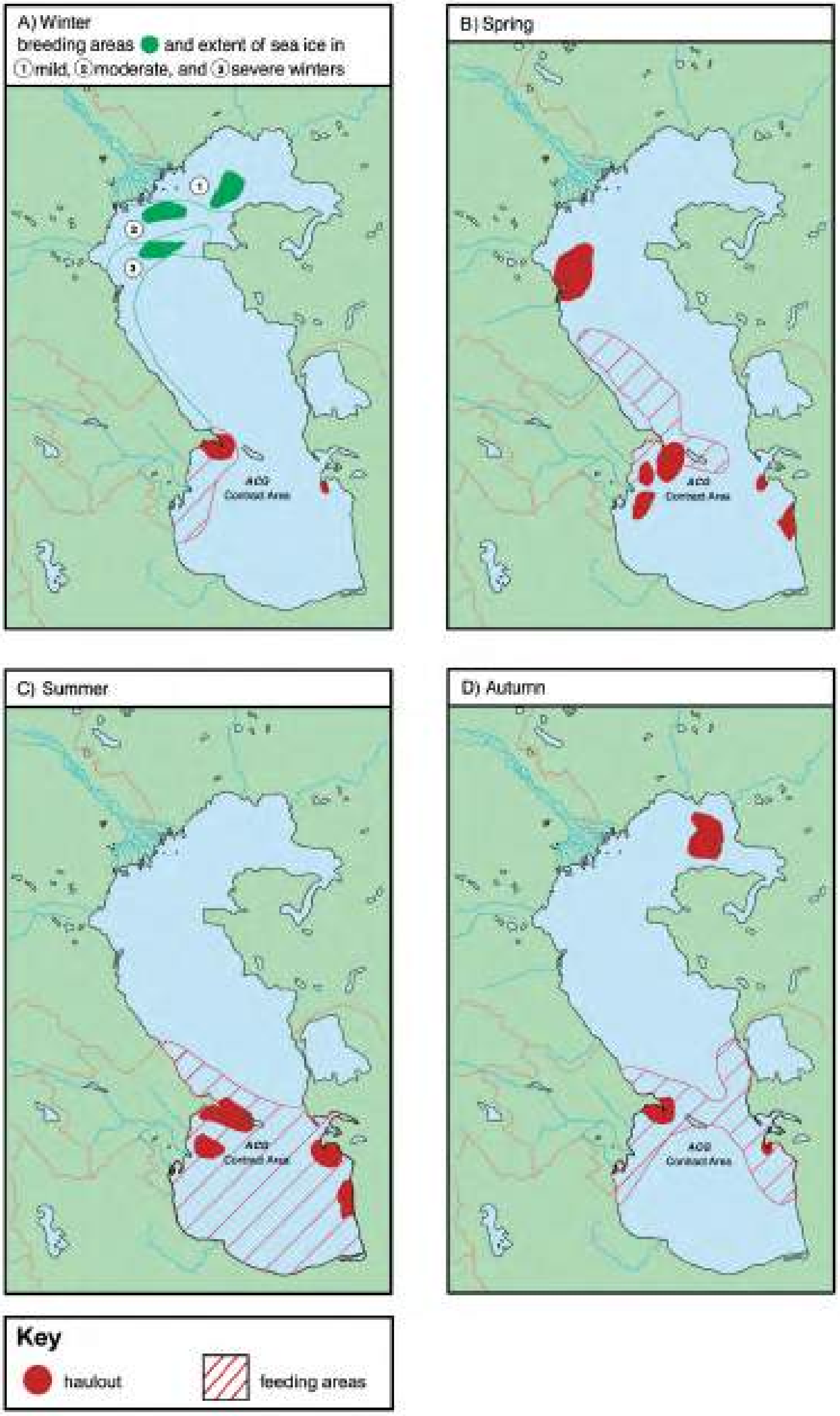


Figure 6.33: Approximate seasonal haul-out sites, breeding and feeding areas for the Caspian Seal

6.5.6 Benthic Environment

Sediment Character

The particle size distribution characteristics of the sediment are of significance in terms of both the associated fauna and contaminant loading. Sediment parameters have been summarised from a number of site surveys (**Table 6.27**), which illustrates the variability that occurs across the contract area. Further, the summarised data highlights the variability present within site survey areas, where stations are generally no more than one or two kilometres apart. The benthic environment of the ACG contract area can be broadly characterised by two sediment types, while accepting that there will inevitably be a continuum between the two;

- Fine sediments primarily consisting of mud (silt and clay); and,
- Mixed sediments consisting of a range of particles including shell fragments, gravel, sand and mud.

The distributions of these sediment types are not strongly correlated with water depth. This is a reflection of the complex topography and geomorphology of the area, including the presence of mud volcanoes. However, there is a tendency at least for the fine mud sediments to occur in the deeper water areas, particularly in the south eastern reaches of the Contract Area.

Table 6.27 also includes summary information from the site surveys at the two Phase 2 locations. It can be seen that the sediments generally fall into the second category, of mixed sediments, but with a broad range of variability in all parameters.

Table 6.27: Summarised ranges of sediment particle size parameters reported in surveys conducted in ACG Contract Area between 1996 and 2000.

Parameter		ACG Phase 2, 2002		EOP baseline 1996	GCA 3 & 4, 1997		Appraisal well 1 (GCA 1), 1997		Long-term monitoring stations, 1996	Chirag Phase 1 baseline, 1998	Chirag 1 post-drill survey, 1998	GCA7, 2001
		East Azeri	West Azeri		GCA 3	GCA 4	Predrill	Postdrill				
Mean diameter (μm)	Min	9	28	-	4	4	17	68	85	289	7.5	9
	Max	649	2135	-	122	28	2300	1800	450	1064	1589	505
Percent silt/clay (%)	Min	26	2	1	26	51	6	2.5		10	12	8
	Max	98	4	98	98	97	94	98		26	95	92
Wentworth scale	Min	Very fine silt	Very fine sand	Very fine silt	Very fine silt	Very fine silt	Fine silt	Very fine silt	Fine silt	Medium sand	Very fine silt	Fine silt
	Max	Coarse sand	Gravel	Very fine gravel	Very fine sand	Medium silt	Very fine gravel	Very fine gravel	Coarse sand	Coarse sand	Very coarse sand	Coarse sand
Sorting index	Min	Poor	Poor	Good	Good	Good	Moderate	Very good	Very good	Extremely poor	-	-
	Max	Extremely poor	Extremely poor	Extremely poor	Extre-mely poor	Very poor	Extremely poor	Extremely poor	Extremely poor	Extremely poor	-	-
Organic content (%)	Min	2	2	1	3	1	1	2	3	2	2	2
	Max	7	4	18	11	13	6	5	17	3	3	6

Sediment chemistry

Hydrocarbons

Total hydrocarbon content of the sediments sampled during the environmental surveys of the ACG Contract Area range from 19 $\mu g.g^{-1}$ – 10,291 $\mu g.g^{-1}$ (URS, 2001). The highest concentration was found close to the rim of an active mud volcano. Elsewhere in the contract area, the general level of total hydrocarbons was in the range 41 – 3,860 $\mu g.g^{-1}$ (URS, 2001). During the 1995 baseline survey, fresh (unweathered) hydrocarbon material was found in surface sediments in the vicinity of mud volcanoes and in the north western end of the Contract Area. **Table 6.28** summarises data from a number of surveys carried out in the contract area along with data from the 2002 survey of the Phase 2 platform locations. These data exclude stations located within the stated footprints (as defined in the relevant reports, typically some 200 to 250m from the well location) in order to provide an indication of background concentrations that at least have not been influenced by proximate, anthropogenic sources of hydrocarbons. Data from the earliest baseline surveys have not been included due to methodological differences precluding direct comparisons. In differentiating between sediment types, this table allows for a better comparison of data by taking into account the influence that sediment character has on the concentration of hydrocarbons in sediments. Comparison of the data indicates the following;

- Total hydrocarbon concentrations at both Phase 2 locations are low in comparison with other data;
- The hydrocarbon concentrations at the West Azeri platform location tended to be higher than at East Azeri; and,
- The proportion of total hydrocarbons made up of unresolved complex mixture (%UCM), for the East and West Azeri locations is within the range of the other stations (i.e. approximately 46-85%). This indicates that in general fresh petrogenic inputs are likely to be present at least at some of the stations, where the %UCM value was low. This, however, is comparable with the other survey data and no doubt is to a greater or lesser extent attributable to natural seepage associated with the mud volcano complexes present in the Contract Area.

These data, therefore, indicate the baseline conditions at the two Phase 2 locations. Although values for total hydrocarbons tended to be higher at the West Azeri location than the East Azeri platform location, composition, as reflected by %UCM, was comparable between the two locations. As hydrocarbon material is often preferentially associated with the fine fraction of the sediment, the differences between East and West Azeri samples can be attributed to differences in the proportion of the silt-clay fraction.

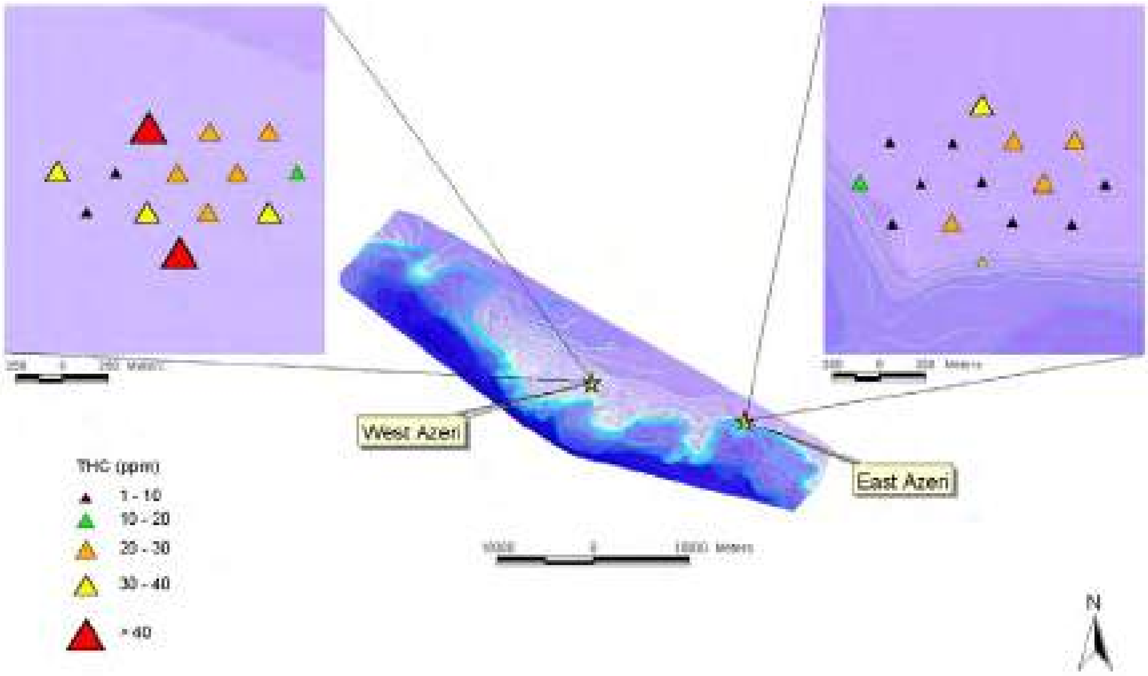


Figure 6.34: Total hydrocarbon concentration in sediments (µg.g-1) around the Phase 2 platform locations

Trace metals

Sediment trace metal concentrations have been determined in samples from a number of Contract Area surveys conducted between 1992 and 2002 including most recently at the two Phase 2 locations (**Table 6.29**). This table has excluded data from stations proximate to well sites and thus represents natural background concentrations. Further, the data discriminate between the two sediment types described above. This reduces the influence that sediment character has on the concentration of trace metals in sediments, with fine sediments possessing a relatively greater surface area onto which metals can adsorb. Further, the mineral content of fine sediments will differ from the coarser fractions, which, for example, will consist of a greater proportion of carbonate particles such as shell fragments.

Generally speaking, the mixed sediments have a marginally lower trace metal burden than the fine muds. Mean metal concentrations in continental crust (Wedepohl, 1995) have been included for comparison.

Examination of **Table 6.22** indicates some degree of metal enrichment compared to continental crust levels. Of particular significance in the context of the East and West Azeri locations are the elevated levels of barium, which are indicative of contamination with drilling muds. **Figure 6.35** presents the barium concentrations of the sediments sampled at the Phase 2 platform locations.

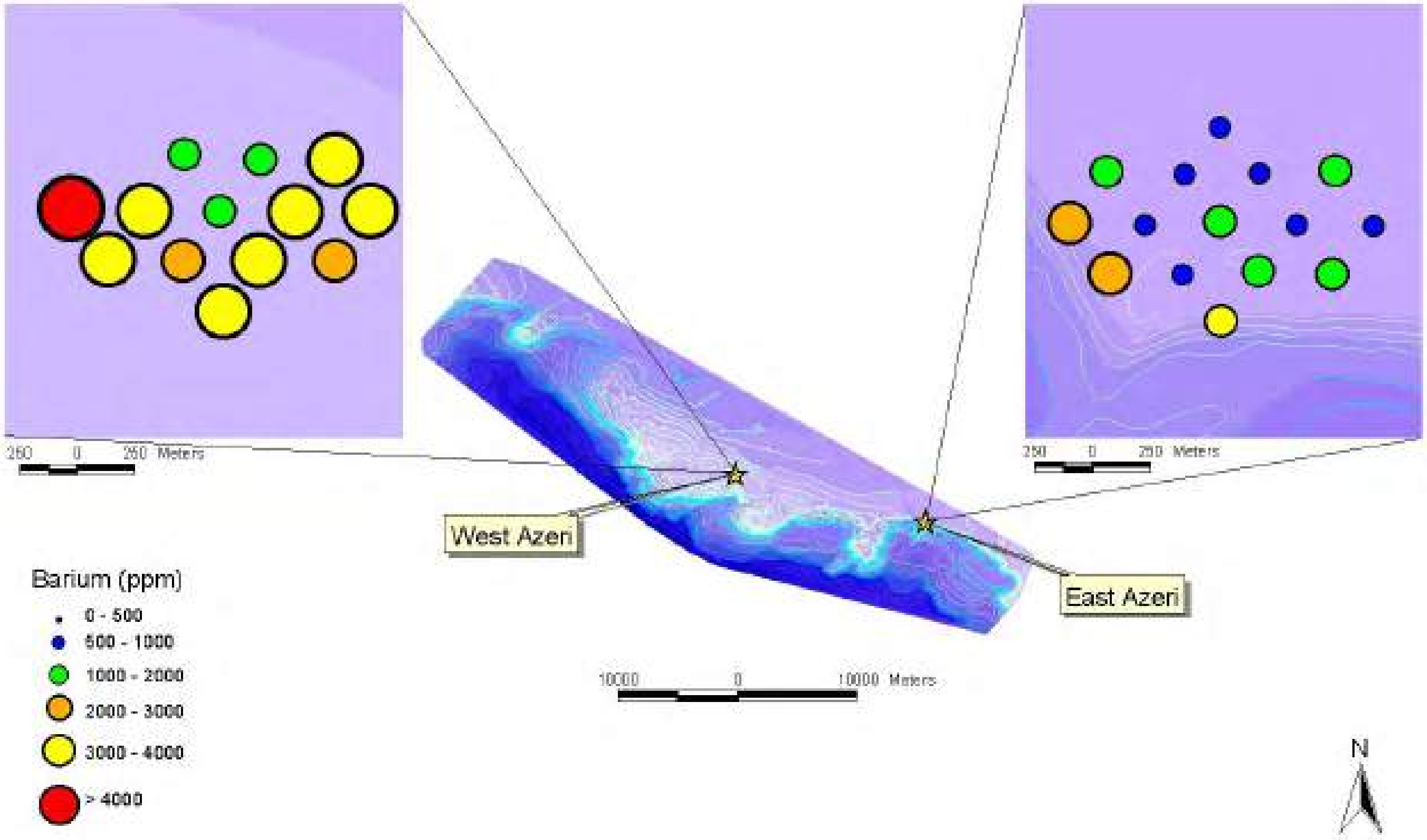


Figure 6.35: Sediment barium concentrations at the Phase 2 platform locations

Radioactivity

Radioactivity in sediments were measured in the Chirag 1 post Saraline survey (2000), the GCA 5 and GCA 6 Post well survey, and the Chirag 1 - Sangachal sub sea pipeline survey (2000). Ranges observed for selected isotopes were;

^{241}Am (60 kev): 1 – 4 Bq/kg;

^{137}Cs (662 kev): 0.6 – 25 Bq/kg; and,

^{210}Pb (Uranium series 46 kev): 23 – 111 Bq/kg.

(Source: AIOC ACG Monitoring Database.)

In a survey of sediment quality carried under the auspices of the Caspian Environmental Programme (Mora and Sheikholeslami, 2002) all sediments in the Azerbaijan sector of the Caspian Sea contained <5 $\mu g.g^{-1}$ uranium (consistent with crustal abundance).

Table 6.28: Summarised ranges of sediment total hydrocarbon concentrations (µg.g-1) reported in surveys in the ACG Contract Area and along pipeline corridor between 1997 and 2002. Percentage of unresolved complex mixture (UCM) also given.

	Parameter	GCA 5 (not in footprint)	GCA 3 & 4, 1997		Chirag pipeline 2000 (offshore only)	Chirag 1, 2000 (not in footprint)	ACG phase 2, 2002	
			GCA 3	GCA 4			West	East
Mud/gravel	Total hydrocarbons	30	-	-	14-465	18-1070	4.9-86	1.5-69
	%UCM	68	-	-	72-88	12-617	3.6-69	0.9-52
Muds	Total hydrocarbons	10-20	30-219	22-390	15-552	-	-	-
	%UCM	37-51	62-77	59-79	73-88	-	-	-

Table 6.29: Summarised ranges of sediment trace metal concentrations ($\mu g.g^{-1}$) reported in surveys conducted in ACG Contract Area between 1992 and 2002. Values in brackets represent outliers.

	Metal	**Mean Conc. in Continental Crust* ($\mu g.g^{-1}$)**	**GCA 5 (not in footprint)**	**GCA 3 & 4, 1997**		**Chirag Pilot study, 1992**	**Chirag pipeline 2000 (offshore only)**	**Chirag 1, 2000 (not in footprint)**	**ACG phase 2, 2002**	
				GCA 3	**GCA 4**				**West**	**East**
Mud/ gravel	Barium	630	3804	-	-	630-3002	397-623	-	933 - 3133	656-2538
	Cadmium	0.1	<1.25	-	-	-	-	-	0.14-0.35	0.14-0.18
	Chromium	126	42	-	-	30-105	27-62	-	18-33	39-59
	Copper	25	23	-	-	16-32	14-24	-	13-30	22-32
	Iron	43200	41961	-	-	-	12621-34973	-	15540-23705	16706-27960
	Lead	14.8	51	-	-	6-33 (72)	21-25	-	16 - 39	15-32
	Mercury	0.04	0.03	-	-	0.02-0.08	0.03-0.18	-	0.02-0.03	0.01-0.03
	Nickel	-	-	-	-	1-145 (261)	-	-	20 - 33	30-38
	Zinc	65	80	-	-	32-117	38-93	-	24 - 56	38-61
Muds	Barium	630	256-998	351-2394	189-1560	661-1063	379-5736	1232-11000		
	Cadmium	0.1	<1.25	<1-1	<1-2	-	-	<1.25		
	Chromium	126	57-89	37-52	31-48	41-81	54-72	27-62	-	-
	Copper	25	20-28	21-46	15-47	(6) 42-63	25-32	14-32	-	-
	Iron	43200	22388-42961	18730-33410	14320-23690	-	28054-43577	19166-44365	-	-
	Lead	14.8	15-20	12-68	14-489	10-26	19-39	15-29	-	-
	Mercury	0.04	0.01-0.03	0.02-0.24	0.1-0.31	0.01-0.06	0.016-0.394	0.02-0.05	-	-
	Nickel	-	-	32-46	12-45	45-48	-	-	-	-
	Zinc	106	70-105	<1-28	16-34	43-98	78-102	74-155	-	-

* From Wedepohl (1995)

Benthic fauna

The macrobenthic fauna populating the sediments of the Contract Area and offshore pipeline corridor are characterised by a combination of invertebrate species that are wide ranging in occurrence (except in the largely afaunal deep water mud, see below) and those that have a more restricted distribution.

Species that represent the wide-ranging category include:

Polychaetes:

- *Hypania invalida;* and
- *Hypaniola kowalewskii.*

Oligochaetes:

- *Psammoryctes deserticola;*
- *Isochaetides michaelseni;* and
- *Stylodrilus spp.*

Amphipods crustaceans:

- *Gammarus pauxillus;*
- *G. warpochowsky;*, and
- *Corophium spp.*

Cumacean crustaceans:

- *Schizorhynchus eudorelloides;* and
- *Stenocuma diastyloides.*

Species that demonstrate an intermittent occurrence in samples include:

Polychaetes:

- *Manayunkia caspica.*

Amphipod crustaceans:

- other *Gammarus spp.;*
- *Dikogammarus spp;*
- *Pandorites deserticola;*
- *Corophium monodon;* and
- *C. mucronotum.*

Cumacean crustaceans:

- other *Stenocuma spp.*

Insect larvae:

- *Chironomus albida.*

Gastropod molluscs:

- *Pyrgula spp.*; and
- *Turricaspia spp.,*

Bivalve molluscs:

- *Dreissena rostriformis*; and
- *Didacna spp.*

Collectively, these species are characteristic of the mixed, muddy gravel sediments that are common throughout the contract area and the offshore component of the pipeline corridor.

Faunal assemblages that have been discriminated in benthic survey reports (**Table 6.1**) have been characterised by the relative abundance of the ubiquitous taxa between sample stations and the intermittent occurrence of other taxa with a more restricted distribution. For example, the EOP data (1996) discriminated six faunal assemblages (plus another consisting of nearshore stations), which have been summarised in **Table 6.30**. The faunal assemblages of the majority of stations fell into the first two groups. Other than those from deep water mud sites, discussed below, each were broadly similar with respect to the common occurrence of some or all of the ubiquitous species. Differences were largely a consequence of the presence of infrequently occurring species, the presence of which, though difficult to correlate with sediment character, must in some way be a reflection of it. For example, species such as the bivalve molluscs are found where substrate allows physical attachment, which in the offshore sediment environment is typically, shell fragments. Conversely *Manayunkia* and *Chironomus* tend to be more frequent and abundant where the proportion of organic matter or silt is higher. The faunal assemblages reported for the Phase 2 baseline survey (ERT unpublished), described below most closely match the first two group.

Table 6.30 Faunal groups reported in EOP baseline survey, 1996 (EOP 1996)

Group	Depth (m)	No. taxa	No. individuals	% mud	% gravel	Key species
1	126 - 230	19-33	600 - 3500	9-79	13-60	*Corophium spp.*, *G. pauxillus*, *Pandorites podoceroides*, *H. invalida*, *H. kowalewskii*
2	161 - 395	18-29	211-900	43-84	3-17	*M.caspica*, *Pyrgula spp.*, few *H.invalida* and *Gammaurs spp.*
3	33	18	841	1	3	*Corophium spinulosum*, *Niphargoides quadrimanus*
4	250-332	6-10	17-28	97-98	0	Low abundance, few *I. michaelseni*
5	100-266	11-15	211-264	66-72	9-24	*Caspiocuma*, few amphipods, few gastropods
6	138-207	10-12	667-1005	48-72	0.2-4	Few amphipods, high no's *I. michaelseni*

Early results from the Phase 2 baseline survey indicate that the faunal assemblages described above are also present for these localities, with many of the so-called ubiquitous taxa being numerically abundant as follows:

Polychaetes:

- *Hypania invalida.*

Oligochaetes:

- *Isochaetides michaelseni;*
- *Psammoryctes deserticola;* and
- *Stylodrilus spp.*

Amphipod crustaceans:

- *Gammarus pauxillus;*
- *G. warpochowskyi;*
- *Gammarus spp.;* and
- *Corophium spp.*

Cumacean crustaceans:

- *Schizorhynchus eudorelloides;* and
- *Stenocuma diastyloides.*

Other species, listed above as intermittently occurring, that are numerically abundant at several of the Phase 2 sampling stations are as follows:

Amphipod crustaceans:

- *Gammarus ischnus;* and
- *Pandorites deserticola.*

Insect larvae:

- *Chironomus albida.*

Gastropod molluscs:

- *Turricaspia caspia.*

Bivalve molluscs:

- *Dreissena rostriformis;* and
- *Didacna spp.*

Within the overall assemblage of species outlined above, a number of differences in the faunal composition between the East Azeri and West Azeri platform locations can be seen by scrutinising the raw data (ERT unpublished). These are predominantly merely changes in the relative abundance of the ubiquitous species, though some species present at one location were not found at the other. The principal differences have been highlighted in **Table 6.31**.

Table 6.31: Comparison between East and West Azeri macrobenthic fauna data

Species	East Azeri	West Azeri
Gammarus spp. indet	fewer	More
Gammarus warpachowskyi	fewer	More
Niphargoides spp.	several species present	almost absent
Corophium monodon	frequent	infrequent
Cumaceans	abundant and diverse (7 species)	infrequent and 2 species only
Dreissena rostriformis distincta	infrequent	abundant

Correlations between the macrobenthic data and the physical and chemical parameters have been found to be weak, though it is recognised that minor differences in sediment character between the two locations are the main mediating parameters. ERT (unpublished) indicate that in particular the distribution of cumaceans suggests a preferential association with the finer sediments, most frequently occurring at the East Azeri location, and the bivalves to be preferentially located where sediments are coarsest, which are most commonly encountered at the West Azeri location (**Table 6.27**).

In comparison to the East and West Azeri locations, the deep water mud sediments, such as those in areas of Chirag (395-525m) and in the vicinity of appraisal wells GCA 3 and 4 (230-290m) are characterised by the absence of nearly all species. In the muddiest sediments the faunal assemblage comprises at most a few oligochaete individuals. Even where some of the species listed above occur, general numerical abundance and species diversity is markedly lower than in the mixed sediments. In such samples the fauna is dominated by polychaete worms such as *Hypania invalida* and *Hypaniola kowalewski* and oligochaete worms *(Psammoryctes deserticola).* Occasionally, the cumacean crustacean *Schizorhynchus eudorelloides* is also present. Notable in these sediments is the near total absence of amphipod crustaceans and molluscs.

6.6 Environmental Sensitivities

The previous sections of this chapter provide a summary of the environmental characteristics of the onshore, nearshore and offshore areas, which may be affected by the construction, and operation of the ACG Phase 2 project. This section provides a further summary of the species and habitats, which have temporal sensitivities, and the tables below are used in the assessment of impacts (**Chapter 8**). The sensitivities are split by geographical location, as the previous sections.

6.6.1 Terrestrial

The peak sensitive times for mammalian and herpetofauna species are during the mating season and pregnancy. High stress levels (e.g. from anthropogenic disturbances) during the former decrease the chance of successful pairing and during the latter are known to either cause spontaneous abortions or foetal re-absorption. **Table 6.32** below details the mating and pregnancy times for the mammal and herpetofauna species encountered during both the Phase 1 and Phase 2 survey activities.

Table 6.32: Periods of sensitivity for mammal and herpetofauna species encountered during both the Phase 1 and Phase 2 survey activities

Common name	**Event**	**Month**											
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Reptiles													
Caspian turtle	Breeding				■	■	■						
	Incubation							■	■				
Spur-thighed tortoise	Breeding				■	■	■						
	Incubation						■	■	■				
Grass snake species	Breeding				■								
	Incubation						■	■	■				
Whip snakes	Breeding					■	■						
	Incubation							■	■				
Eremias spp.	Breeding				■	■							
Snake-eyed lizard	Incubation					■	■	■					
Caspian Gecko	Breeding					■	■						
	Incubation							■	■				
Caucasian Agama	Breeding					■	■	■					
	Incubation							■	■				
Amphibians													
Marsh frog	Breeding				■	■							
Green toad Tree frog	Incubation / metamorphosis						■	■	■				
Mammals													
Horseshoe bat	Breeding								■	■			
	Pregnancy				■	■							
Asian Barbastelle bat	Breeding								■	■			
	Pregnancy				■	■							
Kuhl's bat	Breeding												
	Pregnancy				■	■					■		
Wolf	Breeding	■											■
	Pregnancy		■	■									
Golden jackal	Breeding										■	■	
	Pregnancy	■	■										■
Red fox	Breeding	■											■
	Pregnancy		■	■									
Badger	Breeding		■	■	■	■							
	Pregnancy	■											■

NB: All rodent species sighted breed year round.
The brown hare *Lepus europeus* breeds year round.

In the onshore description (**Section 6.3**) the ornithological interest of the Terminal site and its coastal surrounds are described. Birds would be most sensitive is an oil spill that could impact a larger area of the coast than simply the vicinity of the Terminal. The temporal sensitivities of bird populations are therefore described in the coastal vulnerability section (**Section 6.6.4**).

6.6.2 Nearshore and Offshore

The fauna and flora of the marine environment undergo stages in their life cycle that may either expose them to a potential impact or take them away from one. Similarly at various times of the year certain biological activities may increase their sensitivity to particular impacts. Consequently it is appropriate to indicate the periodicity of key stages in their respective life cycle to inform the impact analysis process **Table 6.33** and **Table 6.34** highlight the following;

- when particular fauna will be present in the ACG Phase 2 project area; and,
- what activity will be occurring at a specific time in the project area.

The solid blue areas indicate peak times, whilst the blue cross-hatched areas indicate periods with lower activity.

Table 6.33: Nearshore marine ecological components

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Sturgeon	Migrating												
Shad	Migrating												
Mullet	Feeding												
Resident fish	Feeding												
	Breeding												
Caspian Seal*	Feeding												
Plankton	Growth												
Seagrass and red algae	Growth												
	Dormant												
Macrobenthos	Full life cycle												

* - a small number of non-breeding seals remain in the south Caspian during the winter

Table 6.34: Offshore marine ecological components

Common name	Event	Month											
		J	F	M	A	M	J	J	A	S	O	N	D
Sturgeon	Migrating												
Shad	Migrating												
Kilka	Feeding												
	Breeding/ spawn												
Mullet	Feeding												
	Breeding												
Caspian Seal	Feeding												
Plankton	growth												
Macrobenthos	Full life cycle												

The economic sensitivity of commercial fisheries is governed by the relative abundance of component species: Kilka, mullet and shad. Their overall abundance is greatest during spring (**Table 6.35**).

Table 6.35: Economic sensitivity

Economic activity	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Commercial fisheries												

6.6.3 Coastal Sensitivity to Oil spills

While the above sensitivity sections (onshore, nearshore and offshore) provide information on the ecological components which may be impacted by routine operations. The shoreline types which could be impacted by spilled oil reaching the coastline of the Caspian are shown in **Section 6.2.2.** Coastal vulnerability based on shoreline type is shown in **Chapter 8**, **Figure 8.22**.

6.6.4 Coastal Bird Sensitivities

Breeding

The main breeding season for birds occurring in the nearshore and offshore environments is from late March through April. Nesting gulls, terns and cormorants are restricted to mainly uninhabited islands and abandoned oil rigs, though small numbers of breeding terns (common and little terns) were observed on the shores of Sangachal Bay in 2001 (URS, 2002). Other species such as ducks, swans and pygmy cormorant, prefer reeds and small water bodies. Of the red list species that breed on or near water, a number are known to breed within the area of potential impact from an oil spill, particularly in the Kyzyl-Agach delta, for example the pygmy cormorant. The marbled teal is considered also likely to breed in Azerbaijan (EOP, 1996).

Moulting

A number of waterfowl will carry out seasonal moulting whilst in Azerbaijan, and several of these species will be rendered flightless for a number of weeks whilst this process takes place. Such species include: grebes, ducks, geese and swans. The flightless period during moulting when birds may be resting on the nearshore water ranges from February to April and June to December.

Gulls, terns and raptors undergo a sequential moult and hence retain the capacity to fly at all times.

Table 6.36 summarises the key sensitive periods for bird species in the nearshore/ coastal areas in the general vicinity of the Sangachal Terminal, but this table can also be taken to represent the temporal sensitivities of species in the wider area of the south Caspian.

Table 6.36: Key periods for birds in the Sangachal area

Event	Month											
	J	F	M	A	M	J	J	A	S	O	N	D
Breeding in nearshore coastal areas												
Moulting in nearshore/coastal areas												
Spring migration. Bird populations peak numbers within nearshore / coastal areas												
Autumn migration. Bird populations peak numbers within nearshore / coastal areas												

The vulnerability of species groups of birds to oil spills and their protection priority are shown in **Chapter 8**, **Table 8.17**.

6.6.5 Valued Ecosystem Components

Valued Ecosystem Component (VECs) have been selected based on the sensitivities as described above. This process is described fully in **Section 8.2**.

7. SOCIO-ECONOMIC BASELINE

This section describes the socio-economic baseline, including health. The Phase 2 ACG project has macro-economic implications at the national scale. However, the likely significant demographic, health and local–level economic impacts occur mainly at the level of Garadagh district and, specifically at the three nearest settlements to the terminal location and the Shelfprojekstroy (SPS) construction yard. The baseline description covers all three levels, however, it focuses on Garadagh district and the three settlements. In addition, two construction yards based in Baku (Fels and Zykh), may be used for construction, or may serve as a catchment for workers commuting to the Sahil/Sangachal locality. Therefore, a brief review of socio-economic conditions within the Sabayil district (Fels) and Khatai district (Zykh) in Baku is also included.

7.1 Methodology for Obtaining and Analysing Baseline Data

The approach taken to obtain and analyse baseline data consisted of the following activities;

- Selection of key data from previous ESIAs related to earlier phases of the ACG development;
- Examination of secondary data in the form of reports. These reports included some not available at the time of the Phase 1 ESIA;
- Re-examination of key documents such as the 2001 Azerbaijan-Holland Friendship Society report (AHFS) containing the results of its survey of Sahil, Sangachal and Umid settlements[1];
- Collection of the most recent data sets on health and economic and demographic profiles from the Ministry of Health and Garadagh Executive Power;
- Discussions with experts within AIOC;
- Consultations with selected stakeholders and other parties with specialist knowledge (the names of individuals and organizations consulted are presented in **Annex 1** to this Chapter); and,
- A Field visit.

These activities enabled the Phase 1 ESIA baseline data to be updated in a comprehensive manner. However, there remain some areas where data are scarce and, even when data exist, their accuracy is questionable.

7.1.1 Introduction and National Context

General

Azerbaijan is the largest of the three Trans-Caucasian republics of the former Soviet Union. The Republic has a total land area of 86,600 sq. km and it includes lowlands, mountain ranges and river valleys. Azerbaijan borders the Russian Federation to the north, Georgia to the north west, Armenia to the west and Iran to the south. The Caspian lies to the East. The largest city in Azerbaijan is Baku, the capital, with a population of nearly 2 million. Other large towns in the republic include Ganja, Sumgait, Mingacevir and Nakhchivan. Azerbaijan is a country rich in ancient history and culture once being part of the Sassanid dynasty of the Persian Empire.

[1] The Azerbaijan Holland Friendship Society conducted a quantitative survey of Sahil, Sangachal and Umid. The purpose of the survey was to identify existing social problems within the settlements and provide a direction for the social investment programme. The sample sizes were 780 from Sahil, 170 from Sangachal, and 50 from Umid representing a sample of between 4 and 5% of the total population.

Azerbaijan gained independence from the former Soviet Union in 1992. Since independence, Azerbaijan has faced unprecedented political, military, economic and social problems including direct military aggression by Armenia (Armenia currently occupies 20% of the country). Other important problems have been under-utilization of its economic potential; ineffective budgetary and foreign trade policies and an unstable political situation (Government of Azerbaijan: Interim Poverty Reduction Strategy Paper, May 2001).

Population

Since 1990, Azerbaijan has experienced a declining population growth rate as a result of social and economic hardship, substantial emigration, military conflict with Armenia, a decreasing birth rate and a declining life expectancy. The total population was 7.9 million in 1999 and is expected to stabilise at approximately 9.5 million in 2025 (CDC/ADRA, 2001). Of the total population, some 52% reside in urban areas and 48% in rural areas (AIOC, 2000b). The ethnic mix is dominated by Azeri's and follows a trend of increasing homogeneity since independence. Ethnic minorities such as Russians, Armenians and Lezghins now make up approximately 10% of the total population. Most of the Russian minority lives in the Baku area. 93% of the total population are Muslim with the remainder being either Orthodox Christian or Jewish.

The World Bank (1997) estimated that 68% of the population could be classified as poor. However, NGOs suggest this figure could be much higher and perhaps 20% of families are severely vulnerable to small threats to their livelihoods. The main cause of poverty is a reduction in social welfare system support and economic decline. It is also a consequence of political unrest and an uneasy peace in the region. This has led to the need to accommodate approximately 800,000 internally displaced persons and refugees (approximately 10% of the population) from the Armenian occupied area of Azerbaijan and from Armenia (in 1988) and Uzbekistan (in 1989).

Economy

Until recently the economy has been suffering a substantial decline that began in 1989. Gross Domestic Product (GDP) in 1995 was estimated at 34% of the 1989 level and the first positive growth (1.3%) was not recorded until 1996 (AET, 2001). In 2000, an 11.3% growth in GDP was recorded. GDP by sector is presented in **Table 7.1**. It shows that trade and transport and communications have continued to steadily increase year on year between 1996 and 2000 whereas the construction sector has declined in recent years following an increase in growth between 1995 and 1998.

Table 7.1: GDP by main sectors

Year	Industry	Construction	Agriculture	Transport & Communications	Trade	Others	Indirect taxes	Total
1995	27.3%	3.7%	25.1%	17.4%	4.8%	14%	7.7%	100%
1996	25.8%	9.3%	24.7%	10.2%	5.2%	14.6%	10.1%	100%
1997	25.2%	11.7%	20%	10.5%	5.8%	19.5%	7.4%	100%
1998	22%	13%	17.9%	12%	5.9%	25.1%	4.1%	100%
1999	28.2%	10.9%	18.4%	10.7%	7.1%	20.8%	4%	100%
2000	32%	4.4%	18.1%	14.4%	6.1%	21%	4%	100%
2001Q1	39.6%	3.1%	2.2%	18%	7.3%	24.9%	4.9%	100%
2001Q2	42.1%	3.6%	16.7%	9.5%	7.8%	15.2%	5.1%	100%
2001Q3	29.1%	2.9%	33.2%	14.9%	5.2%	9.9%	4.8%	100%

Source: Azerbaijan Economic Trends, Economic trends Quarterly Issue Azerbaijan July – September 2001 p23 (AET calculations from data provided by ASSC)

Despite the problems since independence the political situation in Azerbaijan has been more stable since 1995. A cease-fire in the Armenian conflict and the implementation of an economic programme supported by the World Bank and International Monetary Fund (IMF) have helped to make significant progress in restoring financial stability in the country. The budget deficit of 1.1% in 2000 was considerably lower than the levels of 4-5% present in 1998-99.

Stability is also strongly influenced by oil revenues and this is increasingly the case as dependence on these revenues has increased over time. This is reflected in the growth of the private sector share of GDP that rose from 32% in 1995 to 46% in 1998. The total state revenue for 2000 was AZM 4.137 trillion of which oil accounted for AZM 1.511 trillion (ASSC, 2001) (in 2000 $1 = AZM4420). A current concern focuses on the likelihood that growth within the petroleum sector, compared with other sectors, may damage the long-term sustainability of other sectors leading to an appreciation of the real exchange rate and possible adverse economic changes and subsequent social impacts (see **Chapter 10**: Cumulative Impacts).

Azerbaijan has a significant ‘unregistered’ economy and significant ‘unused’ fiscal resources within the economy. Actual aggregate consumption in 2001 exceeded GDP by 3-5 % (official figures) and some estimates project that it is as much as 17-20% (Government of Azerbaijan, Interim Poverty Reduction Strategy, 2001).

Employment and Production

Agriculture is the most important sector in terms of employment with around 30% of the workforce engaged in agricultural production. Production has been stable since 1995 at 59% crop production (cotton production being a significant component) and 41% livestock production (AIOC, 2000a). This contrasts with industrial production, which has collapsed to less than one-third of its 1991 levels. The total rate of growth for gross industrial output in 1999 was 3.6% (ASY, 2000). Oil production has developed in importance over recent years particularly as a result of a growth in offshore production, but for Azerbaijan as a whole, production has declined over the past 15 years due to a drop in output from onshore fields.

Other industries such as fishing and shipping also contribute to Azerbaijan’s economy. Official figures of fish catches suggest that there has been a significant decline in the productivity of the Caspian in the last ten years although the data is unreliable as it is believed that legally caught fish amounts to only 30% of fish actually caught. 90-95% of the world resources of sturgeon are concentrated in the Caspian (Global Ecological Fund, 1994,) and consequently it is a significant resource. Catches of sturgeon fell by 92.7% between 1999 and 2000.

Shipping levels have varied over the past ten years as they are strongly correlated with factors outside Azerbaijan since Baku is a major transport hub for the entire Caspian. Total cargo levels have increased from 4.14 million tonnes in 1995 to 5.44 million tonnes in 1997. Passenger traffic has decreased from 47,900 in 1995 to 37,000 in 1997 (URS, 2002).

Azerbaijan’s access to external markets has continually been disrupted by regional political turmoil as it is dependent upon its neighbours for the transport of imports and exports. Barriers to trade have eased recently and exports have grown. In 1999, Azerbaijan’s merchandise export had a growth rate of 53.2%. The import growth rate in 1999 was –4.1%.

Foreign Investment

Foreign investment in Azerbaijan has made little impact on the economy. Continued state ownership has limited direct foreign participation in improving and expanding the main utilities and infrastructure assets. Most foreign investment has focused on the oil sector. Despite foreign investment reaching $1.15 billion in 1998, it fell by 26% in

1999. Through efforts by the International Monetary Fund (IMF) in the mid-nineties, a privatisation programme began in 1997 and a significant proportion of enterprises were privatised by the end of 1998. This includes privatisation in the agricultural sector. The share of households and private farms in total agricultural production rose from 67% in 1996 to 94% in 1998 (URS, 2002).

Infrastructure

Most of Azerbaijan's infrastructure (gas, water, electricity, roads, communication etc.) is in poor condition due to inadequate investment. 80% of the population lives in areas without modern water or sewage networks and clean water is scarce. Health infrastructure is also poor with deteriorating medical facilities and near collapse of emergency services and primary care in most rural areas. A high proportion of medicine, medical equipment and supplies are provided through international humanitarian assistance. The decline in preventive care and epidemic control measures has resulted in an increasing incidence of tuberculosis and outbreaks in malaria (Government of Azerbaijan, Interim Poverty Reduction Strategy, 2001).

Education

Azerbaijan has a strong education system and a long history and tradition of learning. 86% of workers are educated to the level of higher, secondary or incomplete secondary education and there is almost universal literacy. This system is jeopardised by current funding problems and weaknesses in the education system (UNDP, 1999). Azerbaijan is experiencing a net emigration rate of approximately 7/1000 (likely to include a high proportion of skilled workers) *per annum*, the opposite to the situation in the 1980s (UNICEF, 2000).

7.1.2 Socio-Economic Characteristics of Sabayil (Fels) and Khatai (Zykh) Districts, Baku

General

The Fels and Zykh yards are located within Baku city limits, but in different administrative districts (see **Figure 7.1**). Information on the areas within which the yards are located has been taken from data held by the two Executive Power authorities. Both areas have a similar history and share some socio-economic characteristics, but there are significant differences. Both were early locations for onshore oil production and as a result the small existing settlements grew as the population expanded and, subsequently both areas became subsumed within Baku city. The population in the vicinity of the Zykh yard is 243,600 compared to 74,270 in the vicinity of the Fels yard. The Zykh area population is rising, as a result mainly of a rising birth rate, whereas the population around the Fels yard is stable. There are indications of a net inflow of migrants, but not involving large numbers.

The economies of both areas are diverse, but underpinned by the oil and gas sector, with relatively high populations of ethnic minorities, especially Russians. The numbers of employed people in the Fels yard vicinity declined from 1996 to 1998 and since then there has been a gradual increase to a level still approximately 12% lower than the 1996 figure. In the vicinity of the Zykh yard, by contrast, the number of jobs has continued a pattern of decline, except for a large increase in employment in the gas industry, which has offset the overall decline in employment.

Figure 7.1: Location of the Fels and Zykh yards in Baku

Health

In Sabayil district the most common causes of mortality (2001) for men and women arise from cardiovascular diseases and cancers. The pattern in Zykh is similar except that diseases of the central nervous system are more prevalent and those relating to strokes are much less common. In Sabayil, mortality in under 2s is three times higher than that for under 5s. For under 2s the biggest killers are diseases of the central nervous system and bronchopneumonia and for under 5s the most important killers are cardiovascular diseases, accidents and diseases of the central nervous system. The data on incidences of diseases and other health threats parallels the main causes of mortality for adults, but with injuries being the most dominant ‘illness’ for children under 15 followed by diseases of the central nervous system. In Khatai, acute intestinal diseases are a more common cause of mortality, whereas accidents are less prevalent than in Sabayil.

7.1.3 Demographic Characteristics: Garadagh District and Settlements

According to the statistics available in 2001 the overall population of Garadagh District was 98,141 with a sex ratio of 51% female and 49% male. **Figure 7.2** and **Table 7.2** illustrates the distribution of the population within the baseline area.

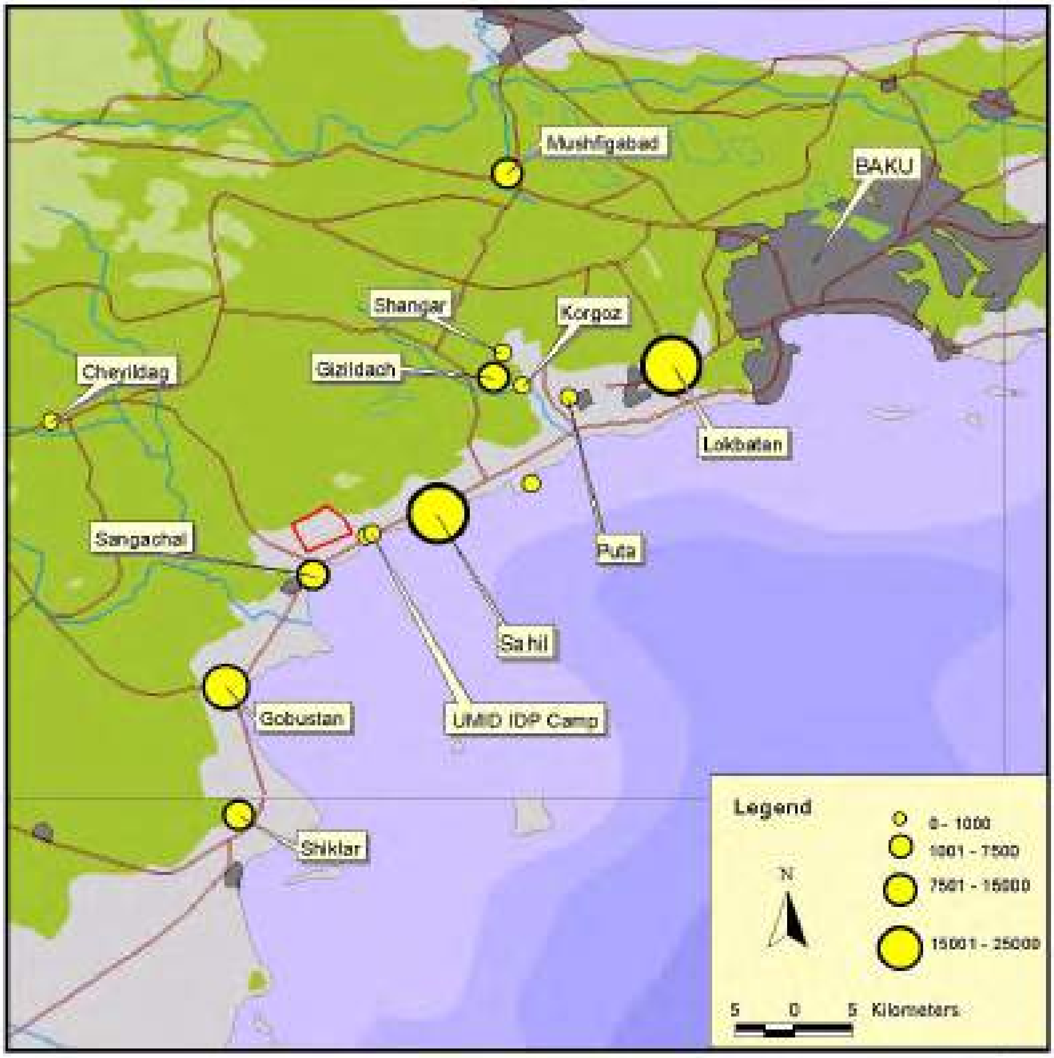
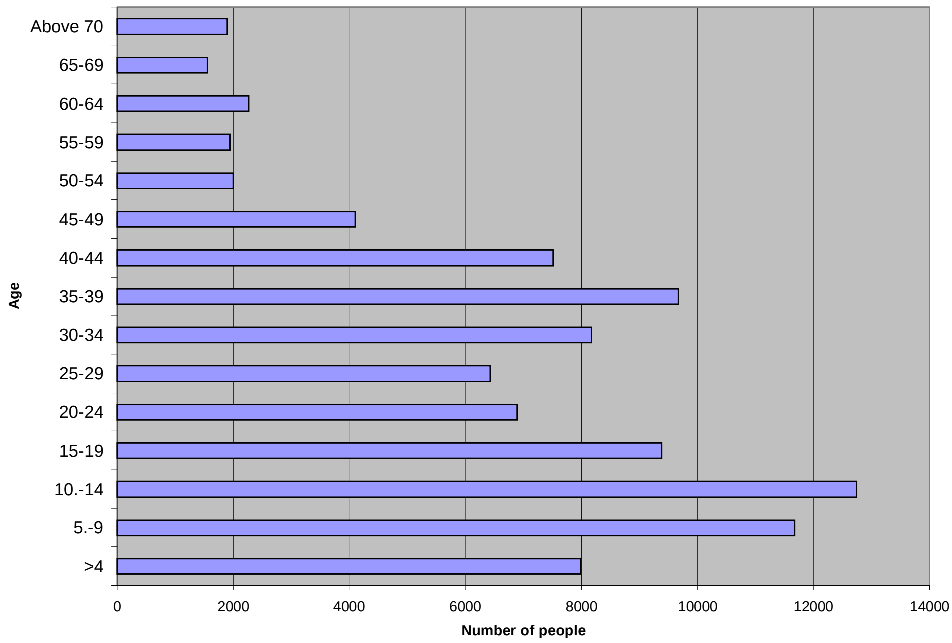


Figure 7.2: Distribution of population within Garadagh District

Table 7.2: Actual Populations within Garadagh District

Settlement	Population Total
Lokbatan	36,655
Sahil	21,239
Gobustan	12,968
Elet	11,897
Gizildash	3,983
Mushfigabad	8,047
Sangachal	3,559
Buta	1,018
Cheyildag (previously Umbaku)	1007
Korgoz	1,926
Shangar	542
Umid	1300
Total	98,141
Source: Garadagh District Executive Power Department of Statistics (2001).	

The population of Garadagh is primarily Azeri (91.22%). Additional groups within the Garadagh population include: Russian (3.17%), Lezghin (2.82%), Tatar (1.33%), and Ukrainian (1.17%). Several groups consist of less than 1% of the population including Kurd, Turkish, Armenian, Talish and Jewish. Therefore, Garadagh reflects Azerbaijan as a whole in terms of ethnic mix. As illustrated in **Figure 7.3** the population characteristics of Garadagh district are typical of Azerbaijan and other countries with emerging economies in that there is a high percentage of the population under the age of 18.



Source: Garadagh Executive Power, Department of Statistics (2001)

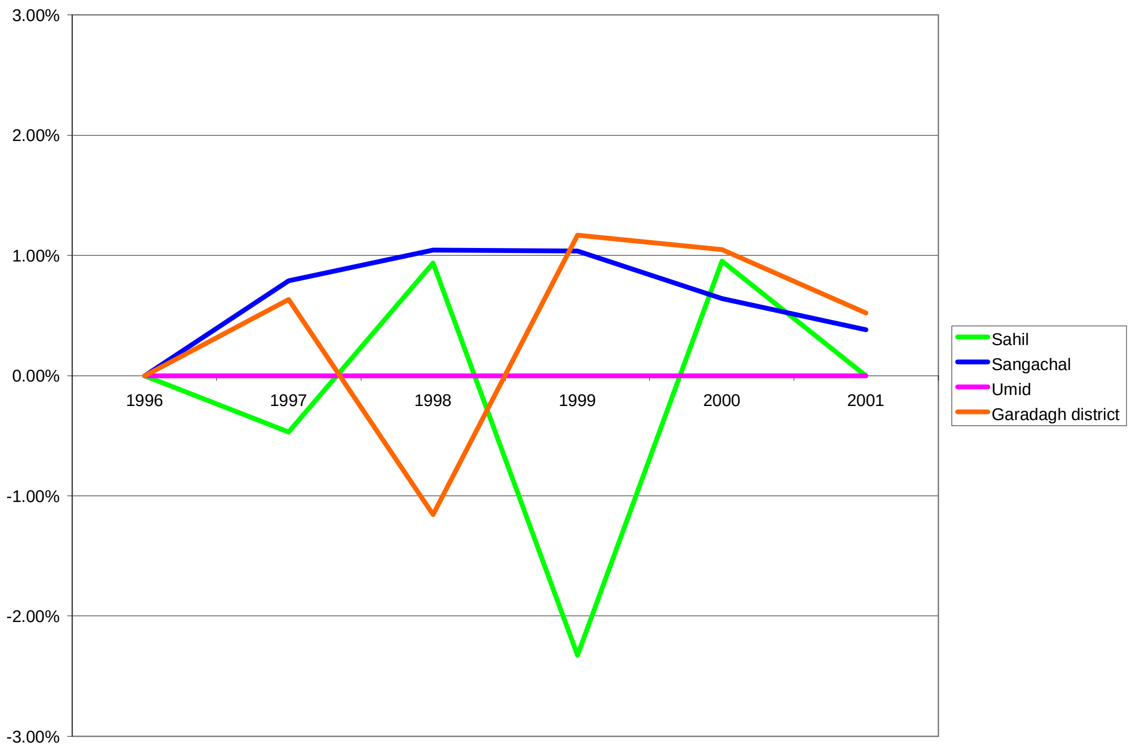
Figure 7.3: Age distribution within Garadagh District

The balance between male and female, using 2001 data is within +/- 1 % for all settlements except for Lokbatan which has 48.2% male/ 51.8% female and Umid which has 46.2% male/53.8% female. For these communities the balance is likely to be different due to male members of the population seeking employment outside the community.

Over the period 1996 – 2001 the population of Garadagh district increased by approximately 2000 individuals, most of this increase is due to the inclusion of data from the Umid settlement (population of 1300) since the year 2000. In 2001 the number of "out-migrants" was higher than the number of "in-migrants", both in Sahil and in Garadagh district (**Table 7.3**). However, as **Figure 7.4** illustrates, there is no long-term trend of either inward or outward migration. The net change over the district is also small, but with out-migration slightly predominating. These figures tend to suggest that there has not been any in-migration to the district or the settlements as a result of the job and other economic opportunities present associated with oil and gas-related activities.

Within the district, many of the settlements contain internally displaced people (IDP). In particular Umid has been established three years ago as an IDP camp. Within Sahil there are 4,000 IDPs. This population lives in hostels located in the settlement, and is somewhat separated from the rest of the community. Within Sangachal, approximately 520 (almost 13%) residents are classified as IDP. Most of these residents arrived in Sangachal in 1992 although people continued to arrive throughout 1993 and 1994.

IDPs within Sangachal are temporarily housed in either public buildings or abandoned homes.



Source: Garadagh Executive Power, Department of Statistics (2001)

Figure 7.4: Annual percentage change in population within Garadagh District

Table 7.3: Inward and outward migration from Sahil, Sangachal, Umid and Garadagh

Year	Sahil		Sangachal		Umid		Garadagh district	
	In-migrants	Out-migrants	In-migrants	Out-migrants	In-migrants	Out-migrants	In-migrants	Out-migrants
1996	109	333	33	22	-	-	527	981
1997	159	192	3	14	-	-	675	552
1998	133	205	17	3	-	-	724	629
1999	145	122	1	6	-	-	613	514
2000	158	189	-	-	-	-	535	498
2001	57	121	-	1	-	-	257	302

Source: Garadagh Executive Power, Department of Statistics (2001)

7.1.4 Income Level

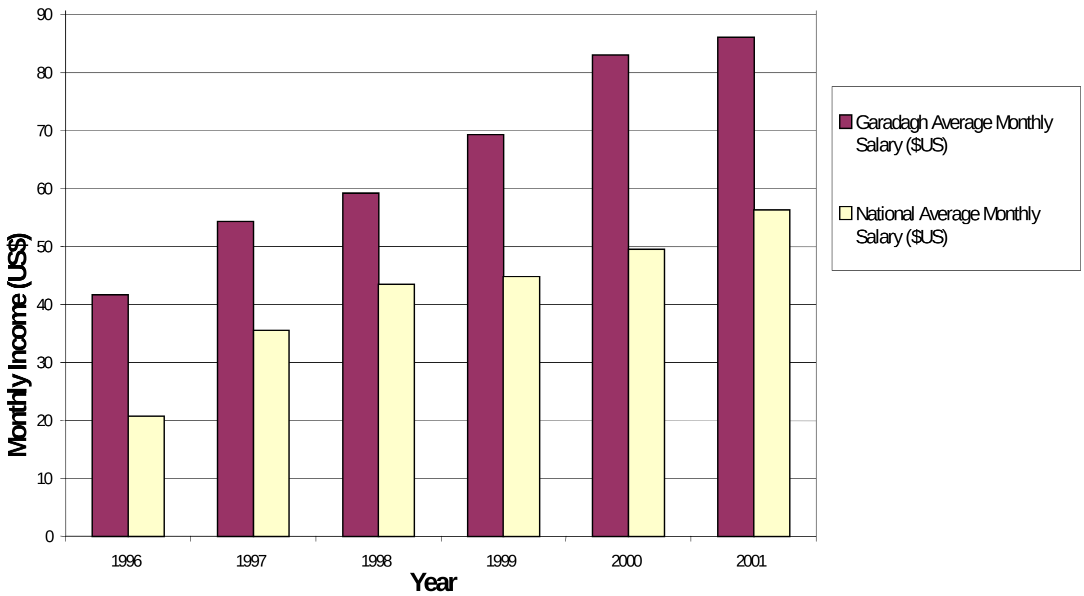
At the national level, it is estimated that about 40% of household income is derived from wages, 8% from social transfers such as pensions and the remainder from informal employment, sales of agricultural products and other sources. Monthly pensions for elderly and disabled pensioners, which were doubled in August 1997, average around AZM 56,000 (US$14.50 in 1998). These are often received after substantial delays. The pension amount varies according to the recipient's work experience. In addition, pensions are higher for women who have many children or disabled children (AET, 2001).

In the area likely to be affected by the Phase 2 ACG project the following sources of 'black economy' income complement formal wages and salaries;

- Remittances from migrant workers;
- Income from petty trading and sale of horticultural products; and,
- Income from shares in the Garadagh cement factory (basically workers in Sahil made redundant during restructuring of the factory).

It is not possible to determine the relative contribution of these diverse 'black economy' income sources to overall income levels for each settlement. Finally, non-monetary income accrues to some individuals through fishing.

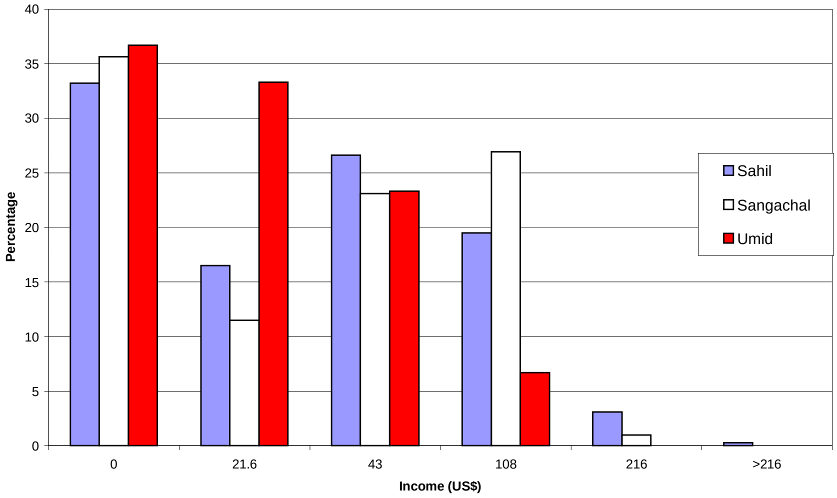
Figure 7.5 illustrates the average monthly income within both Garadagh and Azerbaijan. As a result of the presence of the oil sector in the area, and the proximity to employment opportunities in Baku, the Garadagh average income is considerably higher than the national average.



Source: Garadagh Executive Power Office Department of statistics (2001) and AET (2001) using ASSC data. Note: These figures are based on nominal wages. However if a similar assessment is conducted to calculate real wages at 1994 rates, the same national trends are evident.

Figure 7.5: Average monthly wages in Garadagh and in Azerbaijan

The data in **Figure 7.6** illustrates that the direct sources of income for the residents of Sahil, Sangachal and Umid are lower than both the Garadagh and the national average.



Source: Azerbaijan - Holland Friendship Society (2001). The figures are based on a questionnaire requesting monthly income to the nearest 100,000 manat. The figures have been converted to US dollars.

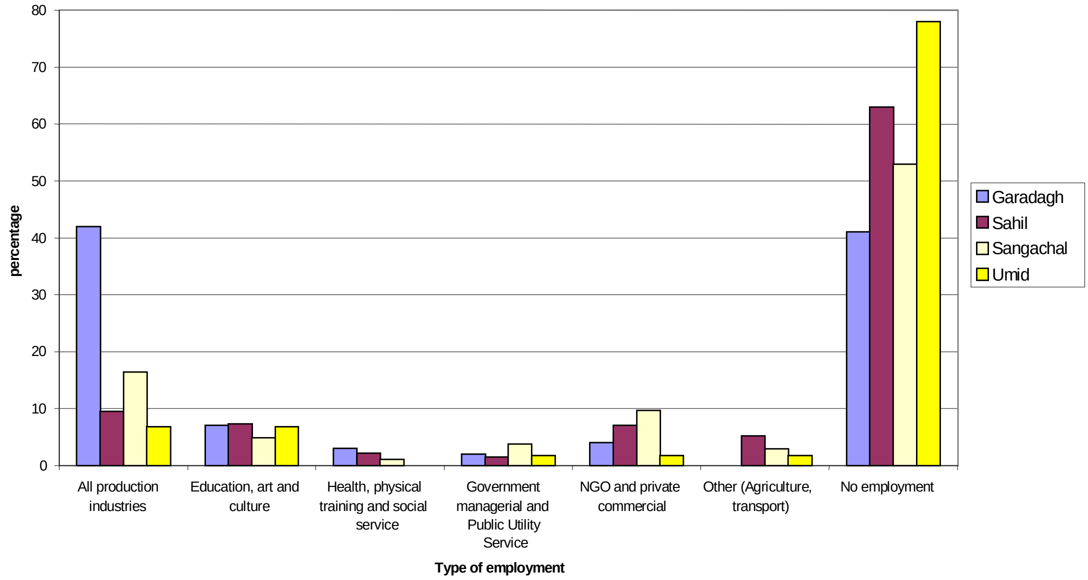
Figure 7.6: Distribution of income in Sangachal, Umid and Sahil

In 1990, households spent less than half of their income on food products. However, since 1994, they have spent nearly 70% on food annually (AET, 1999). This concentration of expenditures on food products is associated with a sharp reduction of households' ability to pay for other categories of products (e.g. medical care, education, clothing and recreation). IDPs have reduced expenditure as they receive free medical services and education, although they do have to pay for medication.

7.1.5 Sources of Employment

General

Based on the information shown in **Figure 7.7**, out of an estimated total labour force of Garadagh district of 54,186, the number of employed people is 31,803 and 23,000 of these work in the production sector. Agriculture is less important in this area although the desert and semi-desert areas provide important winter pasture for migrant herders. There is very little arable farming due to the poor climatic and soil conditions. Some small market gardens are evident around settlements, but no intensive farming activities are present. Some people are also involved in fishing on both a commercial and a subsistence level.



Source: Garadagh Executive Power, Department of Statistics (2001) and Azerbaijan–Holland Friendship Society (2001)

Figure 7.7: Sources of employment in Garadagh

Both **Figure 7.5** and **Figure 7.6** indicate that a large percentage of the population has no formal source of monetary income. Those without employment make use of a range of strategies in order to maintain a basic livelihood including small scale trading, remittances, small-scale fishing and horticulture. Many of the unemployed are IDPs. In Sangachal for example, only 3 or 4 (or approximately 0.5%) of the IDPs are employed, specifically by the Narimanov Gas and Oil Production Office and in Sangachal School (Garadagh Executive Power; 05/07/01).

Livelihoods from Fishing

The fishing industry is relatively limited in Garadagh District with fishing activity concentrated around Elet, Sangachal and Lokbatan. Fish species in Sangachal Bay are described in **Section 6.4.3**. The only authorised commercial fishing in Sangachal Bay is to support the nearby fish hatchery. This augments the salmon population numbers in the Caspian Sea by stock supplementation.

The numbers of salmon in Sangachal Bay have been dwindling in recent years. In 1997, approximately 110 salmon were caught in the Bay all of which were given to the fish hatchery. In recent years no salmon have been caught. This trend of drastically reduced fish catches over the past five years has extended across all species. For example, between the 96/97 fishing season and the 97/98 season, two separate species of fish fell from 76 to 5 specimens and 49 to 0 specimens caught in the bay respectively.

Salaries in the fishing sector are determined on a quota basis and in 1997 the monthly salary of a fisherman was AZM 23,000 (i.e. approx. US$6). The fishermen were allowed to keep a portion of their catch as an additional income source. It is estimated that approximately 25-30 individuals are employed in the fishing industry in the area between Baku and Gobustan, the majority of whom are employed by a division of the Ministry of Environment and Natural Resources (formerly Azerbalyg) at its fish hatchery at Sahil.

Fishing activities in the bay are both recreational and subsistence, rather than for commercial purposes. At present, the two nets used by the Ministry-employed fishermen have not been re-deployed following the agreement to re-site them to allow pipeline-related work to be done. There are alternative sites for the official Ministry nets that would not compromise their effectiveness. Also, there are a number of illegal nets in the area to catch fish for subsistence and for sale. The number of 'fishermen' involved, their domicile, catch size and composition and the contribution of the catch to their livelihoods and incomes is not known accurately. It is possible that they may number between 150-200 in total. These individuals are vulnerable to accidental destruction of their nets. AIOC has announced publicly that nets in certain areas are at risk. Therefore opportunities have been provided in time to enable the net to be moved to a 'safe' position.

Beyond the fishing for the hatchery, the only other authorised fishing undertaken within Sangachal Bay is for leisure purposes. Rod fishing is the only type of fishing allowed for leisure purposes and nets are banned. Fishing takes place primarily at weekends either from the jetty built for the Early Oil Project in Sangachal Bay or from the fishing platforms that are situated slightly further out into the sea. There are six platforms, which are in a state of disrepair, but provide a useful position from which to fish.

Fishing vessels also catch kilka approximately 40-60 km from the shore. The fish are caught using a combination of lights and nets to attract the sprats. Historically, between 140-150 boats were active fishing for sprats, but this level has now decreased to approximately 100 boats (URS, 2002) and the fleet is in the process of restructuring. The main fishing ports are Baku port, Neftchala, Lenkoran and Siyazan.

Livelihoods from livestock herding

The area surrounding the existing Sangachal Terminal has historically been winter grazing land for a number of trans-humant herders, their families and animals. There are two herding settlements within the vicinity of the terminal. One is in the central north area (Central North herding settlement) and another is situated at the foot of the west hills (West Hills herding settlement). The West Hills herding settlement lies just on the boundary of the "no development zone" for the proposed ACG Phase 1 terminal expansion.

The total area of the 'farm' associated with the West Hills herding settlement is 1,636 ha of which 1500 ha is suitable for grazing and 256 ha of this has already been lost to the existing EOP terminal. The loss for the other settlement is much less. The nutritional value of the grazing loss is considered to be high by the herder's leaders.

The Central North herding settlement, is used by herders during both the winter and summer seasons. Herders also use the West Hills herding settlement during the winter months. The herders spend around 7 months a year at the settlements from approximately 1 October to mid-May each year. The rest of the year is spent at the summer pastures. There are approximately 5-6 herders who, together with their families, number approximately 31 people, and within each settlement the herders are inter-related.

The Central North herding settlement consists of two main buildings and a number of out houses, including converted shipping containers. There are approximately 10 buildings in total in the West Hills herding settlement, some of which are used for housing animals, whilst others are for living purposes. There are no water, gas or electricity services supplied to either of the herding settlements. Water is sourced in the vicinity of the settlements and is carried back to the camp. When water is unavailable for the animals at the West Hills herding settlement it is brought in by truck.

Those living in the Central North herding settlement sustain a living through grazing sheep and cattle and this has been their livelihood for several generations. Adult members of the settlement are not in paid employment. Their nutritional needs are primarily met from their dairy products and meats from the animals they keep. Some of the wool is used to meet personal needs. The herders generally earn a meagre living from selling their own produce, such as cheese and wool in Sangachal. Their income from this is around $60-65 per month per family.

7.1.6 Other Industries in Garadagh District

Employment in Garadagh District is dominated by its proximity to the industrial and economic centre of Baku and also by industry in Sahil, especially the SPS fabrication yard and the nearby Garadagh Cement Plant. These sectors have grown consistently over the previous five years.

The oil and gas industries support large numbers of workers, relative to the employment base in the area and have traditionally contributed significantly to productivity. Associated with these industries are the cargo and passenger traffic on the Caspian. The commercial seaports in Azerbaijan are all based close to Baku and Garadagh and are shown in **Table 7.4.**

Table 7.4: Commercial Seaports in Azerbaijan

Location	Name	Activities
Absheron	Dubendy	Bulk oil cargo
Baku	Zykh	Oil field services and construction yards
	Refinery	Crude oil and oil products
	East port	General cargo and ferries
	Military port	Military base, ship repair
	South dock (Fels)	Ship repair, construction yards, oil spill response and supply base
Sahil	Shelfprojekstroy (SPS)	Construction yard and oil field supply base
	Sahil	Offshore oil field supply base

Source: ERT 1998

In addition, there is a substantial military presence in Sangachal.

7.2 Infrastructure

The infrastructure in the areas includes transportation, housing, utilities, community centres, markets and health care facilities which are discussed in **Section 7.4**.

7.2.1 Utility Lines and Pipelines

A number of utility lines and pipelines are routed along the coast parallel to the highway and railway line. These utility lines provide electricity, communications, oil, gas and water as detailed in **Table 7.5.**

Table 7.5: Utility lines Garadagh District

Description	Owner/User
Communication Cable (flooded)	SOCAR Onshore Oil &Gas Production Association's Communication Department
Communication Cable (destroyed)	Baku Telephone Network Production Association
Communication Cable	SOCAR MOLPA
Communication Cable	Unidentified
Communication Cable (2 cables)	Technical Unit of Cable Trunks
Gas pipeline (5 lines, 1 cut)	CJSS AZERIGAS
Gas pipeline	SOCAR BULA OFFSHORE
Oil pipeline (2 lines)	SOCAR MOLPA
Condensate Line	SOCAR BULA OFFSHORE

Description	Owner/User
Water Pipeline (5 lines, 1 abandoned)	Absheron Water Company
Water Pipeline	SOCAR Amirov O&GPD
High Voltage Overhead Line (HOVHL)	Azerbaijan Railways
High Voltage Overhead Line (HOVHL) (4 lines)	JSC AZENERGI
Unidentified pipelines (3 lines)	Unidentified

Source: Shah Deniz and ACG Third Party Pipelines, Road and Rail Crossings. Information Pack; Shah Deniz Gas Export Project (Doc. BRCDZZZZCMGUI0006 Rev A1).

7.2.2 Communication

Azerbaijan's telephone system is a combination of old Soviet era technology used by Azerbaijani citizens, small to medium-size commercial establishments and modern cellular telephones used by an increasing middle class, large commercial ventures, international companies, and most government officials. Internet and e-mail services are available in Baku (Nations in Transit, 2000).

7.2.3 Education

Table 7.6 illustrates, there is a capacity for 22,725 students and 25,216 children to study in these schools. Overcrowding is managed through the schools operating in two shifts each day. This situation is consistent with data at a national level that indicates a lack of available buildings and equipment within the education system.

Table 7.6: Comparison of Education 'Norms' and Actual Figures for Garadagh District and the Individual Settlements

	Sahil		Sangachal		Umid		Garadagh district	
	Norm	Actual	Norm	Actual	Norm	Actual	Norm	Actual
Number of teachers per 10, 000 people	176	158	176	155	176	158	176	181
Number of schoolchildren per 10,000 people	2200	2206	2200	2315	2200	1191	2200	2472
School places (two shifts)	5024	5206	932	1150	240	200	23750	22755
Actual attendance		5407		926		143		25216

Source: Garadagh Executive Power, Department of Statistics (2001)

In 2000, 1,260 students graduated from secondary school in Garadagh District, of which, 460 (36.5%) are continuing their education in colleges and other higher schools (Garadagh Executive Power; 23/7/01). There are also colleges offering qualifications relating to the oil and construction industries, as well as driving, welding, painting and carpentry. In 2001, some 1,355 pupils applied to professional technical and higher schools (Garadagh Executive Power; 23/7/01).

7.2.4 Transportation

The Baku-Tbilisi-Astara highway routed along the Sangachal Bay coast passes to the south of the terminal location. This section of road is a main highway in Azerbaijan. It is part of the main transportation route north from Baku to Boyuk and to Kesik at the Georgian border (a total of 510 km) and south from Baku to Astara (a total length of 313 km) to the Iranian border. Both routes carry two-thirds of all road freight through Azerbaijan.

Data from the TACIS TRACECA Programme in 1999 and reported in the Phase 1 ESIA Report (TACIS TRACECA Programme; Azeravtoyol and Azerbaijan State Department of Railways, 2001 and URS, 2002) indicate that 9,581 vehicles passed along this highway during that year, an increase on the 1998 figure of 4,763 vehicles. The road is undergoing upgrading at the moment so it is anticipated that the traffic level will continue to increase, but perhaps at a reduced rate. The Baku-Alyat electric railway, owned and operated by Azerbaijan Railways, runs parallel to the highway through the Garadagh District and is part of the main transportation route for Azerbaijan in terms of its capacity. This section of the railway is part of three main rail routes;

- Baku-Boyuk-Kesik railway: This route is used for carrying passengers and cargo through Boyuk to Kesik on the Georgian border. This railway continues into Georgia to ports on the Black Sea, in particular the port of Batumi;
- Baku-Agbend/Ordubad/Velidag railway: This route was formerly used to carry passengers and cargo to Agbend (a settlement of the Zengilin Administrative District of Azerbaijan) onto Oruband in Armenia, through Armenia to Velidag in Natchivan. The route has not been working since 1993 due to the occupation of Zengilan and part of the Jebrayil Administrative Districts by Armenia; and,
- Baku-Astara railway: Runs from Baku to Iran.

The maximum carrying capacity of the Baku-Alyat railroad amounts to 109 million tonnes per annum or up to 180 trains in each direction every day. The railway is however, significantly under-utilised. Figures from 1997 recorded the actual transportation along the Baku-Boyuk-Kesik route amounted to 2.19 million tonnes and along the Baku-Astara route amounted to 0.227 million tonnes. In total, the Baku-Alyat section of the transportation load in 1997 was approximately 4 million tonnes or nine trains in each direction daily.

7.2.5 Infrastructure in Sahil, Umid and Sangachal

There are very few roads in and around Sangachal and most of these are covered in gravel. It takes approximately one hour to travel by bus to Baku and costs AZM 1,000 for a one-way trip.

According to official sources all houses in the town have electricity and gas and supplies are regular, reliable and sufficient. Wood is not used for heating or cooking. The cold water supply is piped into the town. There is no hot water supply to Sangachal and this is normal for the area. Bottled water is not used for drinking, washing or cooking (Garadagh Executive Power; 05/07/01).

The sewage system is basic with enclosed canals taking sewage out of the town to where it is collected near the sea. These canals are open between the town and the collection point. From the collection point, sewage is transported out to sea without any treatment. There are five garbage disposal sites in the town and they are emptied once or twice a week, depending on the site, and taken to the main landfill disposal site near Sangachal. The material is either burnt or simply covered.

In Umid there were originally two separate settlements, i.e. the IDP camp and a camp linked to the nearby Garadagh Cement Plant. Their expansion in the last few years has meant that they are now virtually one settlement. Expansion can only occur where permission has been obtained. As a result the camps cannot currently expand further towards the proposed terminal site. The new houses being built in the ‘cement camp’ area are being built on the opposite side of the camp to the proposed terminal site. Untreated sewage waste from the camp is transported via a simple open drainage ditch away from Umid.

Sahil is a town consisting of numerous housing blocks constructed during the Soviet era. It has a cultural centre, a hospital, and many small shops, and is located on the shore with an impressive seafront promenade and gardens.

7.3 Cultural Heritage

7.3.1 Onshore

Features of archaeological significance in the Sangachal area were documented, for the Phase 1 ESIA (URS, 2002) through a survey undertaken by individuals from the Azerbaijan Academy of Sciences, Institute of Archaeology and URS in May-June 2001. Numerous items were discovered, the most significant of which are summarised below. The Phase 1 ESIA Report provides a more detailed account regarding results of the survey.

Items of significance were spread out widely on the terrain assessed, with the most significant items concentrated north west of the existing terminal in the West Hills. Archaeological features and carvings similar to those found at Gobustan Protected Area (15km to the south) were discovered among the hills (see **Figure 7.8**). From the apparent level of pre-conception[2], artistry, and likeness to the carving found in Gobustan, it is estimated that these images might have been carved around the 2nd Century B. C. Other features discovered on and around the West Hills have been dated to approximately the 1st Century A. D.

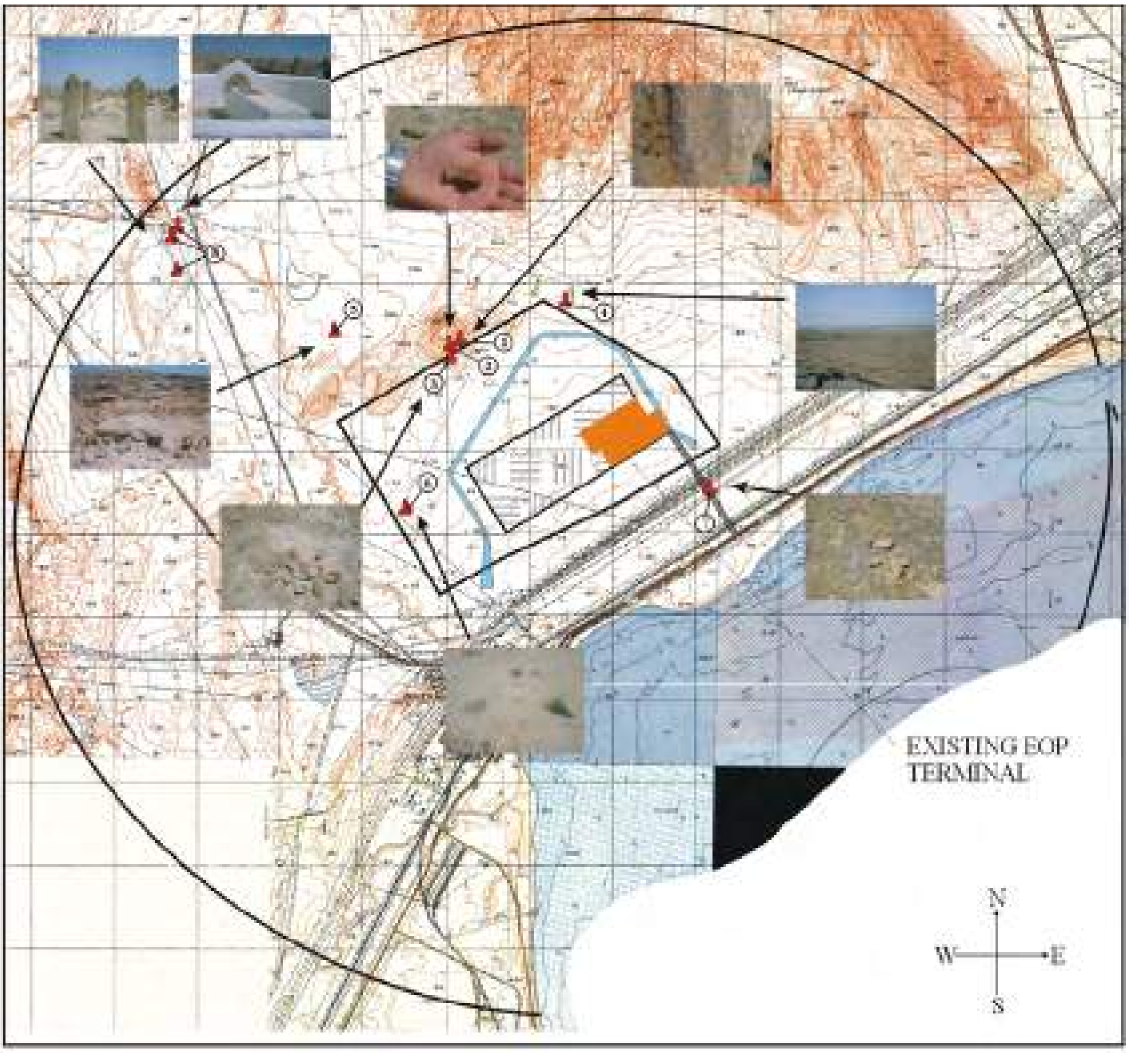
To the north west of the site, a cemetery was found and is considered to be archeologically ‘rich’. The cemetery encompasses an area of 20 hectares and is reported to date back to the 13th century A.D., with Christian graves pre-dating those of Muslim origin. The cemetery has historically been a place of worship and this tradition continues today as one of the relatives of Muhammad is believed to be buried there.

7.3.2 Nearshore and Offshore

The changes in the sea level of the Caspian have resulted in changes to the position of the coastline. In a 200 year period centred on 1200 AD it is understood that the water level was several metres lower than at present. In other areas of the Caspian (at Derbent in Dagestan, Bailov near Baku and possibly at Bandovan, 50km south of Sangachal) there is evidence of submerged archaeological features. Within the immediate coastal area of the ACG pipeline there is no evidence from surveys completed to date of any features of archaeological significance.

There are no known wrecks in the vicinity of the ACG Fields, or along the pipeline route. It is expected that due to the number of surveys, which have taken place in the Field and along the pipeline route, any wrecks would already have been discovered, however there still exists the possibility for undiscovered wrecks to be present in these areas.

[2] ‘Pre-conception’ refers to the thought put into the drawing before making it i.e. the more an artist has thought about the details and artistry of the picture the higher the level of pre-conception.



KEY	
	Boundary of no development zone
	Extent of land/clearance and grading works
	Proposed drainage channel
	Proposed access road
	Survey area (2.5 km radius)

ARCHAEOLOGICAL FINDINGS	
1. Drawing in cove	5. Three room building
2. Ancient pipe bowl.	6. Jug or plate debris
3. Jug and plate debris.	7. Plate debris
4.XI century settlement	8. XII century cemetery

km 0 0.25 0.5 0.75 1 1.25 1.5 1.75 2 2.25

250 meters per centimeter

Figure 7.8: Location of identified cultural heritage features

7.4 Health

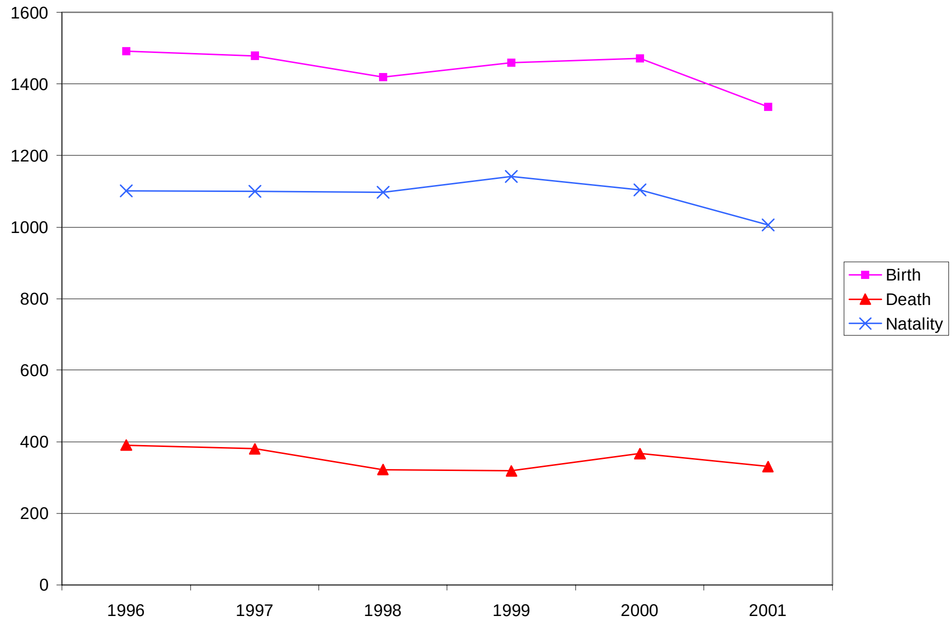
7.4.1 General

The Azerbaijan health care system consists of a complex, hierarchical network of medical structures inherited from the Soviet years. The lack of resources available to the health sector has resulted in deteriorating medical buildings and equipment and significant reduction in availability of emergency services and primary care in most rural areas.

Health receives 4.5% (about $30 per person per annum*)* of the state budget (AET, 2001, p71). This allocation does not satisfactorily meet minimum requirements. In addition, current facilities cannot be maintained or improved and there are key medicine and equipment shortages. Programmes are being established on several health care fronts including immunisation, anti-TB campaigns, drug addiction treatment, family planning and measures against infectious diseases. This is supported by substantial assistance from international humanitarian assistance programmes.

The Ministry of Health is committed to improving Primary Health Care (PHC) in Azerbaijan and recently has adopted measures in collaboration with UNICEF and World Health Organization to improve PHC in Azerbaijan. This will mean standards in diagnosis and treatment, even at the most basic levels, will be adhered to after extra training for doctors, nurses and health care workers.

Male life expectancy in 1997 was 67.4 years and female life expectancy 74.6 years. The birth rate was 17.4 per 1000 (a drop from 26.4 per 1000 in 1989) and deaths, 6.2 per 1000 people. Child mortality under age one has remained constant between 12 and 16 per 1000 per year within Garadagh district according to official statistics. These statistics probably under-report infant and child mortalities, UNICEF (2000) has estimated that the actual figure for infant mortality in 2000 was 79 per 1000. **Figure 7.9** illustrates that there is a minor trend of a reduction in the absolute birth and death figures (despite the probable disparity between official and estimated mortality rates the trend is likely to be similar).



Source of data: Garadagh Executive Power, Department of Statistics (2001)
Note: Natality is a calculation of birth rates less death rates.

Figure 7.9: Garadagh district birth and death indicators

The leading causes of mortality in Azerbaijan, in order of magnitude, include cardiovascular disease, cancer, respiratory infections, and accidents. Other important health problems include, hepatitis A, diarrhoea, sexually transmitted diseases, botulism, tuberculosis, tetanus and malaria (ERM, undated).

In Soviet times, the reduction in incidence of communicable diseases had been successfully reduced. Over the past decade however, the steep decline in funding available for preventive care has resulted in epidemics of polio, diphtheria, and malaria. There has also been an increase in the incidence of rabies, brucellosis, anthrax, tuberculosis and other infectious diseases (GOA IPRSP, 2001 and Government of Azerbaijan, Interim Poverty Reduction Strategy, 2001, page 12).

HIV/AIDS and STD incidences are increasing in Azerbaijan with only 18 cases reported prior to 1997, but 182 HIV cases confirmed by December 1999 (ANCRA, 1999). Of these, 111 cases are reported in Baku. It is predicted that over 10 times this figure are infected with HIV. One of the drivers increasing the HIV/AIDS infection rate is labour migration and mobility with workforces being disconnected from their families. The number of AIDS cases connected with drug addiction has also increased since the late 1980s. Of all the causes of infection, 41% were due to intravenous injection, 27% Heterosexual, 28% unknown, 5% from mother (UNAIDS, 2001).

Due to changes in testing policy and economic constraints, the number of HIV tests performed has decreased from more than 300,000 per year (excluding blood donations) in the early 1990s to 38,000 in 1999 (1999 figures from the Ministry of Health, Azerbaijan Republic, 1999).

7.4.2 Health Infrastructure in Garadagh

National standards such as number of doctors per head of population, number of nurses per head of population and number of medical auxiliaries are not developed yet in Azerbaijan. Therefore, the ‘old’ Soviet standards still exist as indicative norms. The actual data for Garadagh district and Sahil, Sangachal and Umid settlements, are presented below in **Table 7.7** with data on the country, Baku and Gobustan district presented for comparison. The scale of health care provision is lower in Garadagh District compared to both the neighbouring districts (Gobustan and Baku) as well as the national average.

The inhabitants of Sahil, Sangachal, and Umid obtain medical care at United City Hospital No. 23. This hospital has 20 physicians and 52 paramedic staff and is currently being renovated with the assistance of the Garadagh Cement Plant. This hospital has lower levels of staffing and beds available compared to Garadagh District.

Table 7.7: Comparison of health care provision statistics

Indicators	National level	Baku	Gobustan district level	Garadagh district level	United Hospital No.23 (Sahil, Sangachal and Umid)*
Number of physicians per 10,000 population	33,7	82,5	7,5	22	20
Paramedic staff per 10,000 population	72,5	107,4	32,1	58	52
Number of hospital beds per 10,000 population	83,4	116,5	57,8	47	26
Number of hospitals	714	95	3	11	1

* The figures in this column refer to the hospital only and should not be compared with figures in the other columns

Within Garadagh district there are 11 medical services organizations including 4 united state hospitals, 2 united children hospitals, 2 state city polyclinics, 1 dental care clinic, 1 maternity hospital and 1 children's cardio-rheumatic health centre. These provide the area with 470 beds (**Table 7.8**). Medical-ambulance stations are located within settlements in the Garadagh District. These stations together provide a potential to serve 3,400 people during one shift (i.e. 3.5% of the total population for Garadagh District).

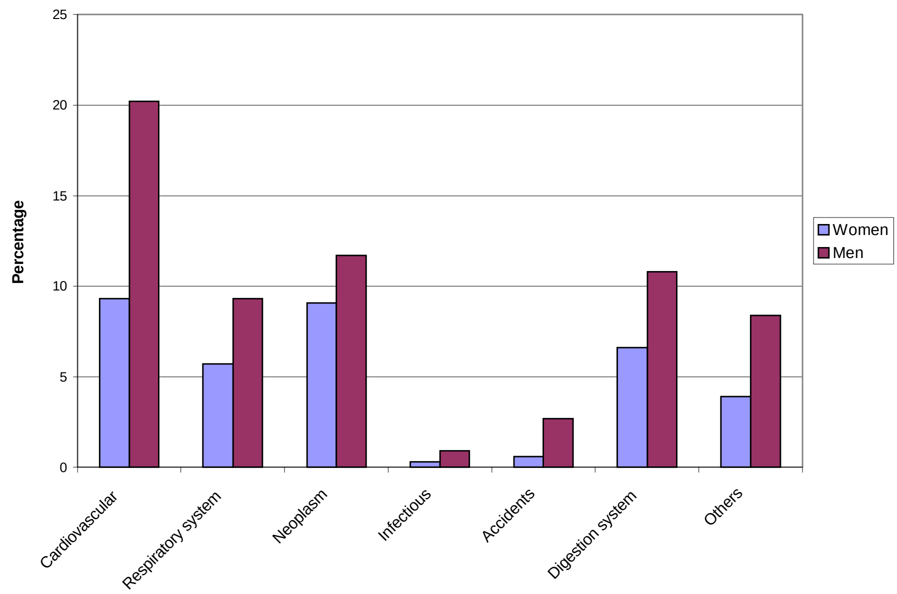
Table 7.8: Number of hospital beds

Hospital	Number of beds
United City Hospital No.19	100
United City Hospital No.23	65
United City Hospital No.17	40
United City Hospital No.9	35
United Children Hospital No4	50
United Children Hospital No.9	50
Maternity Hospital No.4	80
Cardio-rheumatic medical centre	50
TOTAL	470

Source: Garadagh Executive Power, Department of Statistics (2001)

7.4.3 Overview of Illness in Garadagh District

The most common causes of mortality in Garadagh are illustrated in **Figure 7.10**. As the figure indicates, cardio-vascular illness is the primary source of mortality, significantly affecting men compared to women. This is followed by illness to the digestive system and neoplasm (tumours). By comparison, mortality from respiratory illnesses is relatively low accounting for nearly 9% of deaths. From the evidence available the Garadagh health situation, in terms of mortality and morbidity, is broadly similar to the national situation.



Source: Garadagh Executive Power, Department of Statistics (2001)
Note: N = 331. Neoplasm refers to tumours

Figure 7.10: Most common causes of mortality in Garadagh District in 2001

The distribution of mortality affects different age groups in different ways. For babies less than 1 year old, prenatal conditions, and respiratory illness are important; for 1-4 year olds in addition to respiratory infection injuries, poisoning and nervous system related diseases are important. Significant adult diseases include circulatory system problems (including heart disease), tumours (neoplasm), endocrine, nutritional, metabolic and immunity disorders. These mortality rates are illustrated in **Table 7.9** below. The trends in these figures are different for each age group;

- For Garadagh, in the under 1 age group, the proportions of different diseases have stayed approximately the same. However there is a consistent trend of reducing numbers of deaths from a total of 30 in 1998, to 14 in 1999 to 12 in 2000 to 11 in 2001. For Hospital No. 23, no more than two cases were reported in any year and there is no discernible trend;
- For Garadagh, in the 1-4 age group, the trend is reversed. There were no cases of infant mortality in 1998 and 1999 with seven in 2000 and four in 2001. For Hospital No. 23, only the year 2000 had any child mortality with two deaths; and,
- For Garadagh, in the over 18 group, there is no discernible trend. However, the 1998 figures for tumors (neoplasm) were higher. The pattern also occurred in Hospital No. 23.

Table 7.9: Most common causes of mortality and number of cases in Garadagh District (GD) and United Hospital (UH) No. 23*

Diseases	2000						2001					
	Under 1 year		1-4 years		18 years and above		Under 1 year		1-4 years		18 years and above	
	GD	UH 23	GD	UH 23	GD	UH 23	GD	UH 23	GD	UH 23	GD	UH 23
Prenatal Conditions	7						4					
Congenital anomalies	3						6					
Respiratory system	2		4	1	11	2	1	1	2		5	3
Injuries and poisoning			1						1			
Nervous system and sense organs			2	1				1	1		6	
Circulatory system					282	57					285	54
Neoplasm					53	19					47	13
Endocrine, nutritional, metabolic and immunity disorders					22	15					22	10
Digestive organs					12	6						1
Other		1					1		1			

Source: Source: Garadagh Executive Power, Department of Statistics (2001)
Notes: GD = Garadagh District and UH 23= United Hospital No 23
Figures are numbers not rates

The most significant illnesses relate to the respiratory system, injuries and poisoning, nervous system/sense organs related illness and infectious diseases. The types of infectious diseases likely to occur within the region also occur at the national level and are discussed in **Section 7.4.1**. This data is illustrated in **Table 7.10** below. It is likely that the recording method between the district and the United Hospital does not completely match. It is also likely Hospital No. 23 has more infectious diseases than is reported in the table.

The main trends that are illustrated in the table include a rise in respiratory disease from 2000 to 2001. There are also proportionally more accidents and nervous disorders in United Hospital No. 23 than respiratory diseases compared the Garadagh district statistics.

The main causes of morbidity for under 17 year olds are shown in **Table 7.10**. It can be seen that both respiratory and infectious diseases are significant with an increase in prevalence between 2000 and 2001.

Table 7.10: Morbidity rates for under 14 and 15-17 year olds in Garadagh and United Hospital No. 23

	Morbidity rates for 15-17 year olds			Morbidity rates for Under 14 year olds	
Diseases	**Year**	**Garadagh**	**United Hospital No.23**	**Garadagh**	**United Hospital No.23**
Respiratory system	2000	1052	18	13819	1314
	2001	1155	20	15162	1425
Injuries and poisoning	2000	59	23	1008	233
	2001	60	28	631	247
Blood and hemopoietic tissues	2000	85	14		83
	2001		15		112
Nervous system and sense organs	2000	73	19	1285	61
	2001	75	23	1090	
Infectious and parasitic	2000	262		2981	
	2001	463		1935	65
Skin and hypodermic cellular issue	2000				74
	2001				85
Symptoms, signs and ill-defined conditions	2000			620	
	2001			615	
Digestive organs	2000		15		
	2001		16		

Source: Garadagh Executive Power, Department of Statistics (2001)
NB: Morbidity is the relative incidence of a particular disease in a specific locality.

7.4.4 Health Status in Sangachal, Umid and Sahil

Common forms of morbidity for under 2 years and under 5 years in 2001 are shown in **Table 7.11**. It should be noted that data for 18+ years in the individual settlements are not available. The distribution of diseases between Sangachal, Sahil and Umid follow similar patterns for Garadagh district as a whole and United Hospital No. 23.

Table 7.11: Common causes of morbidity for Sahil, Sangachal and Umid in 2001

Diseases	Children under 2 years			Children under 5 years		
	Sahil	Sangachal	Umid	Sahil	Sangachal	Umid
Pneumonia	25	4	2	8	3	2
Respiratory	836	110	84	1020	123	110
Congestive heart failure (Dropsy)	26	3	-	5	1	5
Mumps	19	2	-	6	1	6
Hepatitis "A"	1	1	-	-	1	-
Hepatitis "B"	1	1	-	-	1	-
Sepsis	1	-	-	-	-	-
Appendicitis	30	3	3	4	2	4
Salmonellosis	3	1	-	1	1	1
Meningitis	1	1	-	-	1	-
TOTAL	943	126	89	1044	134	128

Source: Garadagh Executive Power, Department of Statistics (2001)

There are differences in the total incidence of disease between the settlements. As **Table 7.12** below illustrates, for children under 5, there are about twice as many reports of morbidity per person in Umid compared to Sahil, and nearly three times compared to Sangachal.

Table 7.12: Comparison of morbidity within Sahil, Sangachal and Umid

	Children under 5 years		
	Sahil	Sangachal	Umid
Total number of incidences of morbidity	1044	134	128
Population of Settlement	21239	3559	1300
No of reported cases divided by settlement population	0.049	0.038	0.098

Source: Data from previous table and Garadagh Executive Power

There are a range of factors that can explain the differences between the settlements in terms of levels of morbidity. As discussed in previous sections, there are demographic and economic differences between each settlement. Umid is an IDP camp and as a result the quality of housing and sanitation is poorer.

Even though the health services are limited within Sangachal, Garadagh Executive Power is of the opinion that existing services are good and are improving. There are initiatives such as immunisation campaigns being undertaken within the town, administered by the doctors from the United Hospital in Sahil that address issues related to the rising incidence of communicable disease (Garadagh Executive Power; 5/7/01). However, there is no hospital or pharmacy within Sangachal. There is however, an ambulance station that provides basic first aid and an emergency ambulance service.

For the Umid Camp, medical services within the camp are limited with only a basic first aid post. For more serious health problems, residents use the hospitals at either Sahil or Baku. Given the unreliable public transport system this is not ideal as a health service option.

All of the children from the IDP Umid Camp are immunised by doctors from Sahil hospital within the settlement. Whilst the medical facilities are free, there is a limited supply of medicine. There is however, a general belief that the health services are getting better. Assistance from international organisations is infrequent and not relied upon (Head of Garadagh Executive Power Representation, Umid Settlement; 05/07/01).

In Sahil, the United Hospital is located on site and has better sewage treatment facilities compared to Umid (which uses a simple open drainage ditch) and Sangachal (enclosed canals take sewage out of the town). The hospital however, is adjacent to the Garadagh cement plant that in the past has deposited large quantities of particulates on Sahil. As a result there may be some legacy effects such as respiratory illness.

ANNEX 1

Consultations: ACG Phase 2 ESIA: Socio-Economic Component: Baseline data (24 –28 March 2002)

Linda Hayes, Mercy Corps,

Ibish Gharamanov, Elder of Sahil,

Dr. Rasul Bakshaliev, Head Doctor, United Hospital No. 23 , Sahil,

Chris Siliski, Country Director, CHF International,

Dr. Oktay Akhundov, Head of Bureau of Health Information and Statistics, Ministry of Health,

Rob Martin, Alternative Fuels Manager, Garadagh Cement Plant

8. ENVIRONMENTAL IMPACT ASSESSMENT

This Chapter presents the overall findings of the Environmental Impact Assessment for the ACG Phase 2 Project. For both Normal Operations and Accidental Events the following issues are covered;

- *Assessment methodology and impact criteria;*
- *A screening of all operations and selected accident scenarios to identify sources of impact, mitigation measures in place and to categorise residual impacts; and,*
- *A further detailed discussion of key issues identified in this process together with issues of concern raised by stakeholders.*

Also included is an overview of some issues where a number of solutions are possible and which at present are still under evaluation.

8.1 Introduction

This chapter together with **Chapter 9** presents the findings of the overall assessment of the potential environmental and socio-economic impacts of the ACG Phase 2 development programme. Different approaches and assessment criteria have been adopted for the environmental and socio-economic assessments respectively. This has been done in order to reflect the differences in issues and mitigation measures that need to be addressed.

An overview of the approach for the assessment of environmental impacts is presented in **Section 8.2**.

The findings of the aspects and impacts assessment for Normal Operations is presented in **Section 8.2.1** The central part of this Section is **Table 8.4** which systematically addresses the operations and their associated aspects, indicates mitigation measures and assesses the significance of residual impacts (the process in described in full in **Section 8.2**). At the end of **Table 8.4** a summary is given of all issues that are taken forward in further discussions and indicates where these discussions are to be found in the report.

In a similar fashion **Section 8.2.2** deals with Accidental Events (including methodology specific to this type of assessment). The central part of this Section is **Table 8.6** that systematically deals with selected accidental scenarios and once again the key issues are summarised at the end of the Table.

The detailed assessment of the key issues identified is presented in **Section 8.3** for Normal Operations and **Section 8.4** for Accidental Events.

The findings of the socio-economic impact assessment are presented in **Chapter 9**.

The aim of **Figure 8.1** is to provide an overview of the environmental interactions of the ACG Phase 2 Project as a background to the environmental impact assessment discussion. The figure shows the project and its surrounding environment together with important activities, aspects and associated environmental interactions. It indicates interactions related to both Normal Operations and Accidental Events.

8.2 The Assessment Process and Assessment Criteria

The assessment of environmental effects is an iterative process forming an integral component of all stages of project design and implementation, from concept selection through to operations management and site abandonment and, where relevant, reinstatement.

Alternative design options for the Phase 2 Development were the subject of a number of

Best Practicable Environmental Option (BPEO) studies (**Chapter 4**). This Environmental Impact Assessment focuses on the environmental aspects of the selected technical solution for the project (**Chapter 3**).

In general terms the impact assessment requires;

- the definition of the receiving environment (**Chapter 6**);
- a review of national and international legislative requirements and constraints (see **Chapter 2**) and industry best practice;
- the identification and quantification (as far as practical) of all sources of discharges and emissions to the environment from Normal Operations (**Chapter 5**);
- the identification and development of scenarios for Accidental Events, specifically marine and onshore oil spills (included in **Chapter 8**); and,
- the assessment of the relative significance of residual effects taking into account both the sensitivities and vulnerabilities of Valued Ecosystem Components (VECs) (**Chapter 8**).

The residual effects are those that remain following the implementation of suitable control and mitigation measures to either eliminate or minimise the effects of the proposed project.

For practical purposes the concept of VECs has been introduced in order to identify particularly valued or sensitive components of the environment (e.g. populations of species or specific habitats). These are then utilised as indicators of environmental damage, and as a tool for assessing the ecological significance of environmental damage and gauging subsequent rates of recovery.

An overview of seasonal sensitivities for ecological components is summarised in **Tables 6.32 - 6.36** (**Section 6.6**). The tables relate to the wider middle Caspian area encompassing the ACG platform location, the offshore and onshore pipeline corridors, the coastline south to Kyzyl-Agach and the environment in the vicinity of the Sangachal Terminal.

Using these sensitivities together with the knowledge of the discharges and emissions resulting from the ACG Phase 2 Project, a number of VECs have been identified for use in the assessment process. In addition, issues identified in public consultations as areas of concern have been used in the rationale for VEC selection. As examples these include impacts of mud and cuttings discharges on fish migration routes and impacts of sewage discharges on offshore plankton communities. VECs that may additionally or solely be impacted by Accidental Events have also been identified.

The VECs together with the impacts from the ACG Phase 2 Project that have been the basis for their selection are shown in **Table 8.1.** All these potential impacts are discussed further in the remainder of **Chapter 8**.

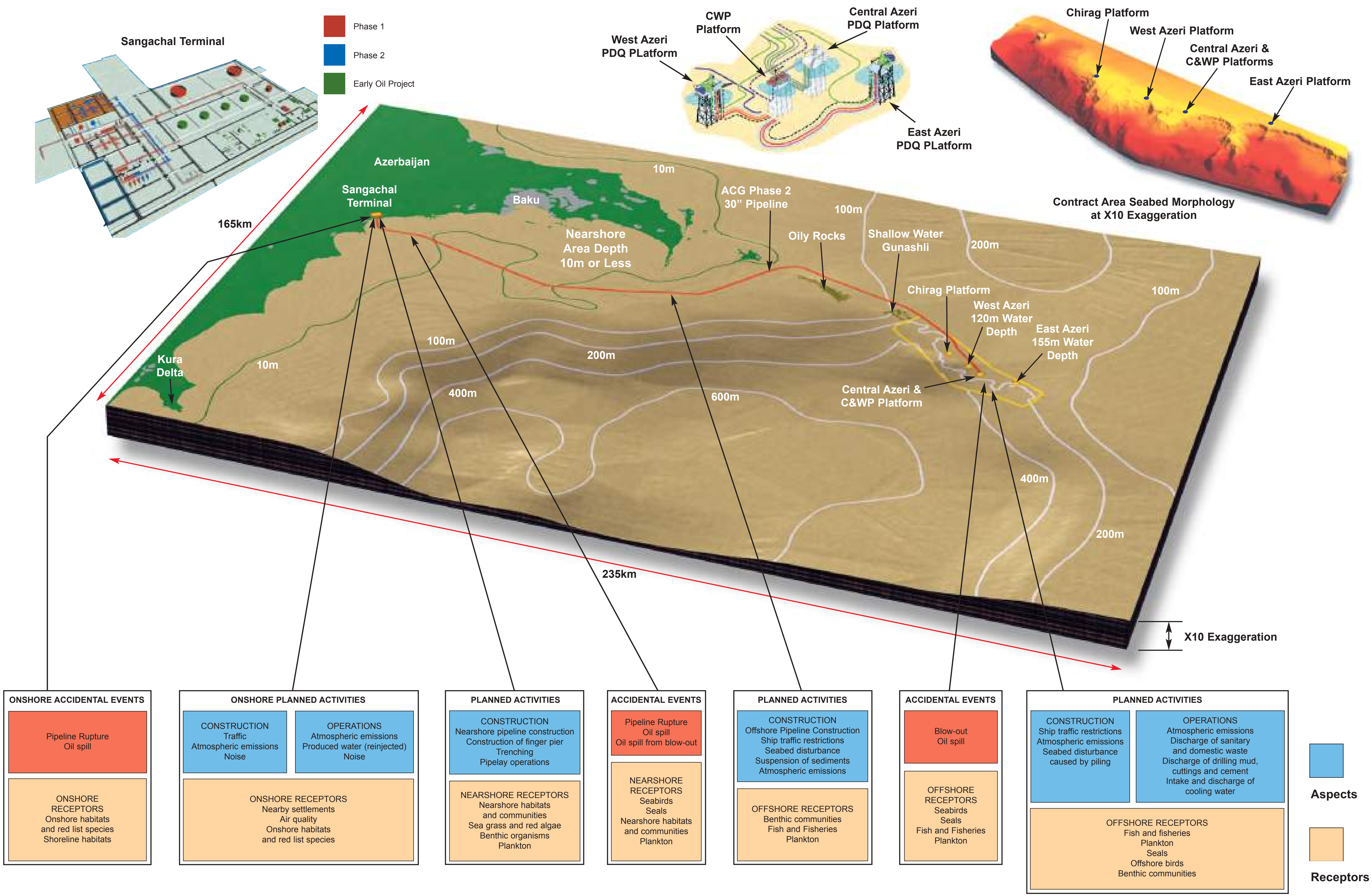


Figure 8.1 Environmental Interactions Associated with the ACG Phase 2 Project

Table 8.1: VECs and Potential Impacts

VEC	Potential Impacts/Selection Basis
NORMAL OPERATIONS	
Sublittoral macrobenthic communities	Impacted as a result of habitat loss related to construction activities as well as physical smothering caused by operational discharges of mud and cuttings.
Spawning and nursery areas for fish species	Potentially impacted as a result of habitat loss related to construction activities, as well as effects of mud and cuttings discharge in the water column.
Fish migration routes	Potential impacted by construction activities, presence of installations and operational discharge of mud and cuttings. Issue of concern for local stakeholders.
Nearshore habitats and communities associated with seagrass and red algae	Impacted as a result of habitat loss related to pipeline construction activity and any coastal erosion resulting from presence of installations.
Air quality onshore and offshore	Potentially impacted by atmospheric emissions from construction and in particular operational activities.
Peak population abundance and distribution patterns for phytoplankton and zooplankton	Potential impacts related to operational discharges from offshore platforms, water column turbidity resulting from construction activities.
Flora and fauna (particularly red data book species) along the pipeline route from the landfall to the terminal	Impacted as a result of habitat loss and possible disturbance related to pipeline construction activities.
Flora and fauna (particularly red data book species) in the vicinity of the terminal	Potentially impacted by as a result of habitat loss and possible disturbance caused by the general construction activities in the area.
ACCIDENTAL EVENTS	
Shoreline habitats	Potentially impacted by an accidental oil spill. Impact and impact duration will vary according to shoreline type.
Nearshore habitats and communities associated with seagrass and red algae	Potentially impacted by an accidental oil spill. Particularly vulnerable are organisms such as crustaceans and fish larvae.
Bird breeding, migration, feeding and moulting areas	Potentially impacted by an accidental oil spill since large numbers of birds may be found in the nearshore coastal areas.

VEC	Potential Impacts/Selection Basis
Sublittoral macrobenthic communities	Potentially impacted by an accidental oil spill if conditions result in sedimentation of oil onto the seabed.
Feeding and haul-out areas for seals	Potentially impacted by an accidental oil spill if haul-out sites or feeding areas are contaminated.
Spawning areas for fish species	Fish eggs and larvae in the water column are potentially impacted by an accidental oil spill generally related to dissolved toxic components of the oil.
Peak population abundance and distribution patterns for phytoplankton and zooplankton	Potentially impacted by an accidental oil spill in the same way as for fish eggs and larvae.
Flora and fauna (particularly red data book species) along the pipeline route from the landfall to the terminal	Potentially impacted by onshore accidental oil spills, actual impacts will be dependent on location, size and duration of a spill.

In addition, public consultations have identified a general concern relating to the potential for radioactivity resulting from AIOC operations to impact upon the flora and fauna and human health. This issue is therefore also dealt with in the following sections.

8.2.1 Assessment for Normal Operations

The assessment of impacts on VECs from normal operations is presented in a table comprising three columns (**Table 8.4**).

The operations that constitute the project have been entered on the table in their planned order of occurrence as subdivision headings (01-09). The identified environmental aspects and their sources of impacts of each operation have been listed in the left hand column (A1-A73).

Engineering or management controls, applied to eliminate or minimise environmental impact from each source, have been listed in the middle column. The types of residual impact after mitigation, if any, have been noted for each aspect.

The scale and nature of predicted residual impacts has been listed in third column, with particular emphasis on impacts affecting VECs. Each aspect has been graded (high, medium or low) according to the significance of the residual impacts. The appropriate term has been entered in the third column against each aspect.

The significance levels for residual impacts are derived using a two-stage process. Firstly impact categorisation is obtained using the criteria shown in **Table 8.2**. These criteria are used for normal operations as well as abnormal operations and accidental events. The impact category is also given a number as a cross-reference to the Environmental Risk Matrix for accidental events (**Figure 8.2**), which is further, described in **Section 8.2.2.**

Table 8.2: Impact Categorisation Criteria

Description	Impact Category (Number designation)
• Large scale and extensive damage to the ecosystem. • Habitat restitution time >10 years and requiring substantial intervention. • Potential for continuous non-compliance with environmental regulations and/or company policy.	**MAJOR (4)**
• Local ecosystem damage or extensive low-level damage. • Habitat restitution time 1-5 years (possible limited and local areas up to 10 years) with potential for full recovery and limited or no intervention required. • Potential for short to medium term non-compliance with environmental regulations and/or company policy.	**MODERATE (3)**
• At worst, local and limited short-term ecosystem damage. • Full recovery in < 1 year without intervention required. • Any potential non-compliance with environmental regulations and/or company policy would be minor and short-term.	**MINOR (2)**
• Ecosystem damage not discernable or measurable. • Compliance with environmental regulations and/or company policy at all times. • Possible beneficial effect or ecosystem improvement.	**NEGLIGIBLE (1) OR BENEFICIAL (0)**

It is possible that when utilising the descriptions in **Table 8.2** for any given source of impact a combination of Impact Categories may be obtained. For example local and limited short-term ecosystem damage (**MINOR**) damage could be the result of a medium term non-compliance with environmental regulations and/or company policy (**MODERATE**).

Overall Significance Levels are therefore derived as shown in **Table 8.3**.

Table 8.3: Impact Categorisation and Significance Levels for Normal Operations

Impact Categories	Significance Level & Symbol
Any combination containing a **MAJOR** categorisation	HIGH ●
MODERATE categorisation or any combination including both **MODERATE** and **MINOR** categorisations	MEDIUM ◆
All categories **MINOR** or **NEGLIGIBLE**	LOW ■

The residual impacts that have a Significance Level of 'high' or 'medium' as shown in **Table 8.4**, or are of particular stakeholder concern are summarised at the end of the Table and discussed in further detail in **Section 8.3**. In cases where impacts are considered to be cumulative these are discussed further in **Chapter 10**. Some of the issues identified are under evaluation at the time of writing. These are noted in **Table 8.12** and the various options under evaluation are described further in **Section 8.3.6**. The question of strategies for waste handling and management is an issue of particular Management Concern; this is indicated in the Table and discussed further in **Chapter 12**.

A number of the aspects associated with pre-drilling with the semi-submersible drilling rig *Dada Gorgud* are similar, but smaller in scale to those related to platform operations. For completeness these are indicated in **Table 8.4** (A5 –A11), but in order to avoid unnecessary repetition cross-reference is made to later sections of the table where these aspects associated with platform operations are addressed.

Table 8.4: Impact Assessment of Normal Operations

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
O1. Pre-Drilling and Platform Drilling		
A1. Mobilise semi-submersible drilling rig	**Residual Air Emissions**	**Environmental Significance: Low**
• Interference with other sea users	• Notify marine authorities of route and schedule • Watchkeeping, navigation lights and radar	Air Emissions • Minimal contribution to overall air emissions from Project
• Energy use and exhaust emissions	• Recorded vessel engine maintenance programme	
A2. Mooring of semi-submersible drilling rig	**Residual Air Emissions** **Residual seabed disturbance**	**Environmental Significance: Low**
• Seabed disturbance	• Predetermined anchor patterns • Written procedures for anchor laying	Air Emissions • Minimal contribution to overall air emissions from Project Seabed disturbance • Small area of seabed disturbed. • Rapid recovery after anchors lifted
• Interference with other sea users	• Buoyed 500m marine exclusion zone round rig	
• Energy use and exhaust emissions	• Recorded vessel engine maintenance programme	
A3. Ballast Water Pump seawater to/from ballast tanks to trim rig. .	**Residual Ballast Water**	**Environmental Significance: Low**
• Intake of organisms	• Filtered water intake	Intake of organisms • Larger organisms will not be entrained, planktonic organisms may suffer mortality but with no impact on populations,
A4. Physical presence of semi-submersible drilling rig	**No Residual Impact**	
• Interference with other sea users	• Notify marine and fisheries organisations of locations • Navigation aids present on rig	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A5. Supply Vessel Activity (See A 64)	**Residual Air Emissions**	**Environmental Significance: Low**
A6. Generate fresh water (See A 54)	**Residual Brine Discharge**	**Environmental Significance: Low**
A7. Accommodation and catering (See A 55)	**Residual Black and Grey Water** **Residual Galley Waste** **Residual Solid Waste**	**Environmental Significance: Low**
A8. Drain Systems (See A 56)	**Residual Waste Water Discharge**	**Environmental Significance: Low**
A9. Cooling Water (See A 57)	**Residual Cooling Water**	**Environmental Significance: Low**
A10. Fire Water (See A 58)	**Residual Waste Water Discharge**	**Environmental Significance: Low**
A11. Power generation (See A 53)	**Residual Air Emissions**	**Environmental Significance: Low**
A12. Pile driving 36" conductor • Noise	**Residual Subsea Noise** • Intermittent pile driving of relatively short duration	**Environmental Significance: Low** Subsea noise • Any marine organisms sensitive to noise will adopt temporary avoidance behaviour

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A13. Drilling in 26" sections	**Residual Solid Waste**	**Environmental Significance: Low** ■
• Generation of solid waste	• Optimise casing programme • Waste management strategy in operation • Site selection process to minimise any impact of landfill	Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna. **ISSUE OF MANAGEMENT CONCERN** **WASTE MANAGEMENT IS DISCUSSED IN CHAPTER 12**
• Disturbance of seabed, subsurface	• Template defines well position • Platforms have no satellite drilling centres	
A14. WBM Cuttings generation in 26" section (base case for this well section is use of seawater and viscous sweeps, but WBM is assessed as it is still a contingency option)	**Residual Formation Cuttings** **Residual Cement cuttings** **Residual WBM Discharge**	**Environmental Significance: Medium** ◆
• Discharge of cement cuttings	• Cuttings distributed by sea currents	Formation/Cement cuttings • Localised smothering of benthic communities WBM Discharge • WBM discharge can cause localised water column turbidity with possible localised impacts. No toxicity related to mud chemicals anticipated. **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.3.2)**
• Discharge of shale formation cuttings with attached WBM	• Cuttings disintegrate and disperse in water column • Use of barite with low heavy metal content • WBM diluted before discharge to reduce chloride levels to below 4 x ambient, further rapid dispersion in water column • WBM components are HOCNF class E/D and are therefore non-toxic	
A15. Drilling in lower hole sections	**Residual Solid Waste**	**Environmental Significance: Low** ■
• Generation of solid waste	• Optimise casing programme • Site selection process for landfill to minimise any impact	Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.
• Disturbance of subsurface and aquifers	• Directional wells with multilateral sidetracks	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A16. NWBM cuttings and centrifuge solids in lower hole section	**Residual Air Emissions**	**Environmental Significance: Low**
• Generation of oil contaminated solid waste	• Contain solids from first 2 pre-drilled wells at each location and transport to shore • Re-inject cuttings into dedicated wells offshore	Air Emissions • Minimal contribution to overall air emissions from Project
• Energy use and emissions related to re-injection of cuttings	• Recorded engine maintenance programme	
A17 NWBM Cuttings transport to shore and storage	**Residual Air Emissions** **Residual Hazardous Waste**	**Environmental Significance: Low**
• Transport and storage of hazardous waste	• Written procedures for transfer and storage • Cuttings only transported from 4 wells • Site selection process for landfill to minimise any impact	Air Emissions • Minimal contribution to overall air emissions from Project Hazardous waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.
• Energy use and exhaust emissions	• Recorded engine maintenance programme	
• Storage of hazardous waste	• Storage in approved facility • Site selection process for landfill to minimise any impact	
• Disturbance of onshore subsurface and aquifers	• Storage in lined landfill cells • Site selection process for landfill to minimise any impact	
A18. Running wireline logs	**No Residual Impact**	
• Radioactive emission	• Use approved radioactive sources • Procedures for handling sources • Short duration downhole use of sources	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A19. Cement Jobs	**No Residual Impact**	
• Discharge of cement slurry	• Re-inject with cuttings	
A20. Transport to shore of NWBM mud	**Residual Air Emissions**	**Environmental Significance: Low**
• Transport of hazardous material	• Written procedures for transfer and storage	Air Emissions • Minimal contribution to overall air emissions from Project
• Energy use and exhaust emissions	• Recorded engine maintenance programme	
A21. Well Test	**Residual Air Emissions** **Residual Oil Discharge** **Residual Light and Noise**	**Environmental Significance: Low**
• Energy use and air emissions	• Minimise test duration and flow rate	Air Emissions • Emissions are temporary and the location is distant from any sensitive receptors Oil discharge • Oil sheen will disperse into water and may cause limited and local impacts to planktonic organisms. However, any sheen will rapidly evaporate and disperse. Light and noise • Light may attract birds to flare at night, with possibility of mortality of some individuals. Noise not anticipated to have any ecological impact
• Discharge of oil droplets to water surface	• Use high efficiency flare burners • Function test well test unit before use	
• Noise and Light	• Start well test during daylight	
A22. Suspend wells	**No Residual Impact**	
• Generation of solid waste	• Re-inject drilled cement with cuttings	
A23. Completions	**Residual Solid Waste**	**Environmental Significance: Low**
• Generate solid and packaging waste	• Contain waste. Recycle scrap metal. • Site selection process for landfill to minimise any impact	Solid waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
O2 Import Logistics		
A24. Barge Transport • Energy use and air emissions • Introduction of exotic species	**Residual Air Emissions** • Regular maintenance of equipment • Use of CIS flagged barges and observance of de-ballasting conventions	**Environmental Significance: Low** Air Emissions • Minimal contribution to overall air emissions from Project
A25. Rail Transport • Energy use and air emissions	**Residual Air Emissions** • Regular maintenance of engines	**Environmental Significance: Low** Air Emissions • Minimal contribution to overall air emissions from Project
A26. Road Freight • Energy use and air emissions • Disturbance to road users and residents	**Residual Air Emissions** **Residual Disturbance** • Selection of route avoiding steep grades • Vehicles subject to periodic exhaust testing • Route selection to avoid residential areas	**Environmental Significance: Low** Air Emissions • Minimal contribution to overall air emissions from Project
O3 Fabrication, Construction and Assembly of Template and Platforms		
A27 Yard power generation • Energy use and air emissions • Noise • Storage of hazardous material	**Residual Air Emissions** • Maintain engine to meet regulatory standards • Locate engine in sound insulated housing • Operate hearing protection zones in yard • Procedures for fuel bunkering • Use bunded tank above ground • Run periodic environmental audits	**Environmental Significance: Low** Air Emissions and noise • Choice of construction yard is still to be made but Project will ensure that air emissions and noise will comply with national and international standards.

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A28. Yard sewage treatment	**Residual Waste Water** **Residual Sewage Sludge**	**Environmental Significance: Low**
• Waste water discharge	• Appropriate controls applied in HSEMS • Regular audit	Waste water and sewage sludge • Choice of construction yard is still to be made but Project will ensure compliance with national and international guidelines
• Sewage sludge disposal	• Appropriate controls applied in HSEMS • Regular audit	
A29. Fabricate drilling template, jacket and topsides. Installation of equipment on C&WP deck.	**Residual Air Emissions** **Residual Solid Waste**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Emissions will comply with national and international air quality standards. Minimal contribution to overall air emissions from Project Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna
• Generation of solid waste	• Recycle scrap metal • Segregate wastes for recycling or landfill • Archive waste transfer records • Site selection process for landfill to minimise any impact.	
• Storage and disposal of paint	• Use dedicated paint store • Send waste paint for incineration	
A30. Test and commission topsides	**Residual Air Emissions** **Residual Waste Water Discharge**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Emissions will comply with national and international air quality standards. Minimal contribution to overall air emissions from Project Cooling Water • Will only have possible temporary and localised impact on organisms.
• Wastewater discharge	• Contain, treat and re-use hydrotest water	
• Waste lube oil	• Inject in waste oil system	
• Diesel for level indicator testing	• Contain and re-use	
• Cooling water discharge	• Discharge to suitable water body	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
O4 Pipeline Installation		
A31. Construct finger pier	**Residual Seabed Disturbance and habitat destruction** **Residual Increased Turbidity** **Residual Hydrodynamics** **Residual Air Emissions**	**Environmental Significance: Medium** ◆
• Seabed disturbance (smothering)	• Limited footprint on seabed	Seabed disturbance and habitat destruction • The habitat beneath the finger piers temporarily destroyed Turbidity • Increased turbidity may reduce growth of plankton, benthos and vegetation Hydrodynamics • Disturbance of currents in Sangachal bay may impact benthic communities and vegetation. Air emissions • Temporary activity - minimal contribution to overall air emissions from Project **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.3.1)**
• Increased turbidity	• Short/intermittent nature of dumping activity	
• Presence causes alteration in coastal hydrodynamic processes	• Removal of finger piers after completion of construction operations	
• Energy use and air emissions	• Maintain engines to meet regulatory standards	
A32. Preparation beach pull site	**Residual Disturbance to Vegetation** **Residual Disturbance to Soil** **Residual Air Emissions**	**Environmental Significance: Low** ■
• Disturbance of vegetation and soil	• Store turf and topsoil for site restoration	Disturbance to vegetation • Small area of habitat temporarily removed, but may take some years to recover Disturbance to soil • Segregated storage will allow restitution of soil Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Temporary disturbance of beach	• Mark/fence off worksite • Minimise width of beach disturbance	
• Energy use and air emissions	• Maintain engines to meet regulatory standards	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A33. Construction of nearshore trench	**Residual Air Emissions** **Residual Seabed Disturbance and habitat destruction** **Residual Increased Turbidity**	**Environmental Significance: Medium** ◆
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Seabed disturbance and habitat destruction	• Limit width and depth of trench • Store spoil beside pipeline track for backfilling	Seabed disturbance and habitat destruction • Habitat will be removed by trenching process. Sediment will rapidly fill trench by natural processes. Recolonisation by benthic organisms will occur after cessation of activity.
• Increased turbidity	• Minimise jetting operations	Turbidity • Increased turbidity may temporarily affect plankton, benthos and vegetation downstream of trench. **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.3.1)**
A34. Pull operations	**Residual Air Emissions** **Residual Seabed Disturbance** **Residual Beach Disturbance**	**Environmental Significance:** Low ■
• Energy use and air emissions	• Regular maintenance of winch and vessel engines	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Disturbance to seabed	• Short duration of activity	Seabed disturbance • Laying the pipeline in the trench may result in localised disturbance and compaction of sediments
• Disturbance to beach	• Minimise width of beach disturbance	Beach disturbance • Cofferdam construction will cause temporary disturbance of the beach, but restoration after pipelaying will allow rapid re-colonisation

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A35. Onshore pipeline trenching, boring, laying	**Residual Air Emissions** **Residual Soil Disturbance** **Residual Disturbance** **Residual Waste**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Disturbance of vegetation and soil • Noise • Generation of waste • Disturbance to road users/residents	• Pile spoil beside pipeline track for backfilling • Minimise width of worksite	Soil Disturbance • Backfilling and replacement of topsoil with careful re-seeding may stimulate rapid re-colonisation by vegetation, insects, birds and mammals Noise • Noise of short duration may cause temporary disturbance to wildlife and road and rail users. Solid waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna. Site selection process to minimise any impact
A36. Nearshore pipe-laying	**Residual Seabed Disturbance**	**Environmental Significance: Low**
• Seabed disturbance	• Activity of short duration	Seabed disturbance • Minimal disturbance compared to trenching and finger pier construction.
• Turbidity		
A37. Install stabilisation mattresses for pipeline crossings	**Residual Air Emissions** **Residual Seabed Disturbance**	**Environmental Significance: Low**
• Energy use and air emissions	• Recorded vessel engine maintenance programme	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Seabed disturbance	• Small area of seabed covered	Seabed Disturbance • Area of habitat covered by mattresses is small in relation to available habitat

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A38. Pipelay operations and anchor laying	**Residual Air Emissions** **Residual Seabed Disturbance**	**Environmental Significance: Low**
• Energy use and air emissions	• Recorded vessel engine maintenance programme	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project Seabed disturbance • Anchor impressions are expected to fill with silt in a few hours allowing rapid recolonisation • Vegetation and benthos will only be affected in a narrow corridor.
• Seabed disturbance	• Short term disturbance • Gradual progress along route	
• Interference with other sea users	• Marine exclusion zone round pipelay vessel • Watchkeeping, navigation lights and radar	
A39. Hydrotest complete pipeline	**OPTIONS BEING EVALUATED**	**Environmental Significance: TO BE EVALUATED**
• Disposal of 500,000 bbls of hydrotest water containing biocide and oxygen scavenger		**ISSUE FOR FURTHER EVALUATION** **See Section 8.3.6**
A40. Corrosion protection	**Residual Metal Discharge**	**Environmental Significance: Low**
• Release of metals to sea	• Anodes mainly aluminium and zinc	Metals • Extremely gradual release of low levels of heavy metals is unlikely to cause noticeable impacts.
A41. Install infield pipelines and power cables	**Residual Air Emissions** **Residual Seabed Disturbance**	**Environmental Significance: Low**
• Energy use and air emissions	• Recorded vessel engine maintenance programme	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project Seabed disturbance Area of seabed take insignificant with no significant impact on benthic communities
• Seabed disturbance	• Limited area involved	
A42. Hydrotest infield pipelines	**Residual Hydrotest Water Discharge**	**Environmental Significance: Low**
• Leaks of hydrotest water	• Monitor pressure and observe leaks	Hydrotest Water • Small leaks of biocide and corrosion inhibitor may cause minor localised impacts to plankton or benthos. • Reinjection eliminates environmental impacts
• Disposal of hydrotest water	• Reinject hydrotest water offshore	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A43. Physical presence of the pipeline	**Residual Interference with Fishing**	**Environmental Significance: Low**
• Interference with other sea users	• Pipeline buried down to 5m contour • Pipeline strong enough to withstand snagging nets • Pipeline follows route of existing pipeline	Interference with other sea users • Pipeline routes already known to fishermen
A44. Pipeline inspection and maintenance	**No Residual Impacts**	
• Generation of pigging waste	• Waste from 30” oil line: contained for onshore disposal and recycled by waste contractor	
	• Waste from infield pipelines contained for onshore disposal. • Pigging waters reinjected into reservoir	
O5 Template & Platform Installation and C&WP Upgrade		
A45. Jacket and topsides float-out & float-over	**Residual Air Emissions** **Residual Seabed Disturbance**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project Seabed disturbance • Area of seabed take insignificant with no significant impact on benthic communities
• Interference with other sea users	• Notify marine authorities of route and schedule • Watchkeeping, navigation lights and radar	
• Ballast water discharge	• Use coated tanks and untreated ballast water	
• Seabed disturbance	• Small footprint of jacket legs	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A46. Piling of drilling template and jacket	**Residual Air Emissions** **Residual Subsea Noise**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project
• Noise	• Distance from sensitive receptors and residents • PPE provided for workforce	Subsea Noise • Noise may disturb seals for short time. Seals will adopt avoidance behaviour
• Subsea noise	• Short piling programme	Seabed disturbance • Area of seabed take insignificant with no significant impact on benthic communities
• Disturbance of sediments	• Activity of short duration	
A47. Physical Presence of platforms	**Residual Seabed Disturbance** **Residual Interference with Sea Users**	**Environmental Significance: Low**
• Seabed disturbance	• Small area in contact with jacket legs	Seabed Disturbance • Small area of seabed taken by jacket legs • No significant impact on benthic communities
• Visual Impact	• Distance from observers/resident populations	Interference • Mariners accustomed to avoidance of oil installations • In otherwise featureless seas, installations may attract shoals of fish, and provide resting places for birds
• Interference with other sea users	• 500 m radius marine exclusion zone round platforms	
O6 Sangachal Terminal Extension		
A48. Clear and grade ground	**No Residual Impact**	
• Disturbance to land and aquifers	• Use land already graded in Phase I	
A49. Run construction camp (continuation of Phase 1 activities)	**Residual Solid Waste** **Residual Sewage Sludge**	**Environmental Significance: Low**
• Solid domestic waste	• Waste management system • Site selection process for landfill to minimise any impact	Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
• Domestic waste water	• Waste water treatment by a water stabilisation pond system • Water effluent disposed by use for irrigation (tress and shrubs) or for dust suppression (after chlorination) during construction.	Waste water effluent • Irrigation beneficial to trees and shrubs, dust suppression beneficial for construction workers
• Sewage sludge	• Maturate and landfarm	Sewage Sludge • Land farming of maturated sewage sludge is an accepted practice, which may be beneficial for farmland
A50. Construction and installation of Phase 2 equipment	**Residual Air Emissions** **Residual Noise** **Residual Solid Waste**	**Environmental Significance: Low**
• Energy use and air emissions	• Maintain engines to meet regulatory standards	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project Noise • Temporary activity - noise from this activity will not disturb residents off the site Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.
• Noise	• Maintain engines to meet regulatory standards	
• Generation of solid waste	• Contain, re-use and recycle, incinerate • Site selection process to minimise any impact	
A51. Test and commission equipment	**Residual Air Emissions** **Residual Hydrotest Water**	**Environmental Significance: Low** **TO BE EVALUATED FOR HYDROTEST WATER**
• Energy use and air emissions	• Short duration of test	Air Emissions • Temporary activity - minimal contribution to overall air emissions from Project Hydrotest water **ISSUE FOR FURTHER EVALUATION** **See Section 8.3.6**
• Hydrotest water discharge – disposal of 800,000 bbls of hydrotest water	**OPTIONS UNDER EVALUATION**	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A52. Physical Presence	**No Residual Impact**	
• Land use	• Shares site with Phase I	
O7 Offshore Production		
A53. Power generation including water injection and gas lift	**Residual Air Emissions**	**Environmental Significance: Medium** ◆
• Energy use and exhaust emissions	• Regular maintenance of turbines	Air Emissions • Modelling indicates an insignificant contribution to air quality issues at onshore receptors • Large scale emissions throughout the Project make the most significant contribution the Project's overall Greenhouse Gas emissions • Significant BP policy issue. **ISSUE FOR FURTHER ASSESSMENT** **(see Chapter 10: Cumulative Impacts)**
• Noise	• Distance from receptors and residents • Use of PPE on Platform	
A54. Generate fresh water	**Residual Raised Salinity Water Discharge**	**Environmental Significance: Low** ■
• Extraction of sea water • Intake of organisms	• Dilution with 660m^3/hr of seawater return	Intake of organisms • Larger organisms will not be entrained, planktonic organisms may suffer mortality but with no impact on populations, Waste water discharge • Dilution will bring the salinity level back to ambient in the close proximity of the discharge and no significant impact to the marine environment is anticipated.
• Discharge of water with raised salinity	• Dilution with large volume throughput	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A55. Accommodation and catering	**Residual Black and Grey Water** **Residual Galley Waste** **Residual Solid Waste**	**Environmental Significance: Low**
• Discharge of treated black water (max. 50m^3/day per platform) mixed with grey water	• Maceration, electro-chlorination, dilution with warm seawater to reduce residual chlorine • Discharge via sewage caisson at a depth of –15m	Waste water • Residual chlorine level 1.0 mg l^{-1}. • TSS < 150 mg/l (average), < 150 mg/l (peak average) • pH 6 to 9 • Faecal coliforms < 200MPN/100 ml
• Discharge of galley domestic waste (food waste)	• Macerate to pass 25mm filter • Discharge via sewage caisson	Galley waste • BOD of macerated waste discharge may cause local reduction in dissolved oxygen level but this will be confined to the immediate vicinity of the discharge point and will have no significant impact on populations of marine organisms.
• Generate solid domestic waste	• Segregate for recycling • Compact and backload to waste transfer station for landfall disposal • Site selection process to minimise any impact	Solid waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna • ISSUE OF STAKEHOLDER CONCERN **ISSUE FOR FURTHER ASSESSMENT** **(see Section 8.3.4)**

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A56. Drain Systems	**Residual Waste Water Discharge**	**Environmental Significance: Low**
• Discharge of oil contaminated water	• Non-Hazardous Open Drains, PDUQs: water and hydrocarbons will be reinjected with cuttings in the CRI system, or when the system is inoperative conveyed to the Open Drains Caisson. Water within the caisson is released to the sea at a depth of –50 m. Oil will be pumped out (on level control) and recycled into the process system. • Hazardous Open Drains, PDUQs: water and hydrocarbons will be conveyed to the Open Drains Caisson and handled as described above. • Drilling Open Drains, PDUQs: all drainage from the Drilling Support Module and Drilling Equipment Set will be conveyed to the Drilling Oily Drains Tank and thence to the CRI system. In the case of CRI outage the drainage will be held in the drainage tank (volume 120 m^3 – equivalent to 10 hours worst-case rainfall). For volumes above this, the overflow will be directed to the Open Drains Caisson and handled as described above. • Non-hazardous and hazardous Open drains, C&WP: all drains are sent to the Open Drains Caisson. Oil will be recovered and sent to the Central Azeri PDUQ for recycling. Water within the caisson is discharged at –50 m (as on the East and West Azeri PDUQs).	Waste water • Any residual dissolved components in the Open Drains Caisson will rapidly be diluted and disperse on discharge and no impacts on populations of marine organisms are anticipated.
• Discharge of chemically contaminated water	• Prevent discharge by good housekeeping • Bunding around storage and process vessels • Environmental audit	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A57. Abstraction of seawater by s eawater systems on the East and West Azeri PDUQ and C&WP.	**Residual Cooling Water** **Residual Antifoulant Discharge**	**Environmental Significance: Low**
• Intake of aquatic organisms entrained in the extracted seawater • Elevated temperature of seawater return flow to the Caspian (25ºC) (Thermal effluent). • Discharge of copper and chlorine antifoulant to the marine environment via the seawater return flow	• Coarse filtration of seawater lift caisson. • Plume modelled and shown to meet the HSE Design Standard requirement of a temperature of < 3ºC above ambient within 100m from outlet. (Defined in accordance with the IFC standard). Synergetic use of two antifoulants reduces quantities	Intake of organisms • Larger organisms will not be entrained, planktonic organisms may suffer mortality but with no impact on populations. Thermal effluent discharge: • Rapid dilution will ensure that any impacts will be limited to the immediate vicinity of the discharge and will not be significant. Antifoulant discharge • The discharge to the marine environment contains copper and chlorine at very low concentrations and is not expected to result in noticeable changes to the ecosystem. • COMPLIANCE ISSUE AND ISSUE OF STAKEHOLDER CONCERN **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.3.3.)**
A58. Fire Systems Testing	**Residual Waste Water** **Residual Foam**	**Environmental Significance: Low**
• Water discharge • Foam discharge	• Minimise duration of system tests – water directed overboard without contact with any contaminated areas • Foam generally only tested on commissioning. Foam is biodegradable and non-toxic to aquatic organisms.	Waste water • Water expected to be uncontaminated. For foam, rapid dilution will ensure that exposure time to planktonic organisms will be brief and any impact will be confined to the immediate vicinity of the discharge and there will be no significant impact on populations of marine organisms.

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A59 Gas dehydration on East and West Azeri PDUQs and C&WP	**Residual Air Emissions**	**Environmental Significance: Low**
• Liberation of VOCs, (CH_4 and BTEX) within dehydration package off-gas	• Off-gas sent to LP flare system and combusted. There is no venting of off-gas to the atmosphere	Air Emissions • Oxidation of CH_4 to CO_2 at the flare tip reduces overall contribution of GHG emissions from the Project. (Global Warming Potential of CH_4 is 21 times that of CO_2 on a weight basis)
A60 Operation of flare systems (purge and pilot) on East and West Azeri PDUQs and C&WP	**Residual Air Emissions**	**Environmental Significance: Low**
• Emission of gaseous combustion products to atmosphere	• Metered volumes of gas ensure flow is minimised	Air Emissions • Relatively small volumes of combustion gas are not expected to cause noticeable environmental change locally, but contributes to regional air quality issues
A61. Removal of produced sand from process vessels on East and West Azeri PDUQs	**No Residual Impact**	
• Disposal of Sand	• Sand injected with drill cuttings in CRI system. If the CRI system is unavailable the sand is bagged and returned to shore for disposal	
A62. Chemical injection on East and West Azeri	**No Residual Impact**	
• Antifoam, demulsifier, corrosion inhibitor and reverse demulsifier in the produced water stream	• Routinely re-injected into reservoir	
• Wax inhibitor in oil stream	• Remains in produced oil stream	
A63. Corrosion protection	**Residual Heavy Metal Discharge**	**Environmental Significance: Low**
• Discharge of heavy zinc and heavy metals	• Gradual release of aluminium-zinc-indium anodes	Heavy metals • Extremely gradual release of low levels of heavy metals will cause negligible impacts

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A64. Well maintenance/work-over	**Residual Air Emissions** **Residual Brine Discharge** **Residual Solid Waste**	**Environmental Significance: Low**
• Increased energy use and air emissions	• Run off rig power	Air Emissions • Temporary but regular activity - minimal contribution to overall air emissions from Project Brine discharge • Small volumes of brine discharged intermittently are not expected to cause noticeable environmental change Solid waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.
• Discharge of work-over brine	• Dilute to < 4 times ambient chloride level	
• Generation of waste	• Contain waste, recycle scrap metal, incinerate • Site selection process to minimise any impact	
O8 Logistics		
A65. Supply and stand-by vessel operation	**Residual Air Emissions** **Residual Waste Water** **Residual Galley Waste** **Residual Solid Waste**	**Environmental Significance: Low**
• Energy use and air emissions	• Recorded vessel engine maintenance programme	Air Emissions • Minimal contribution to overall air emissions from Project Waste water/Galley Waste • Compliant wastewater discharge is not expected to cause any significant impacts on marine organisms. Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.
• Interference with other sea users	• Notify marine authorities of route and schedule • Watchkeeping, navigation lights and radar	
• Transport hazardous materials	• Labelling of hazardous goods/MSDS sheets • Written procedures for handling and storage	
• Waste water discharge	• Discharge to comply with MARPOL and vessel consents	
• Galley waste	• Discharge to comply with MARPOL and vessel consents	
• Solid waste	• Contain and dispose onshore • Site selection process to minimise any impact	

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A66. Helicopter operations • Energy use and air emissions	**Residual Air Emissions** • Regular engine maintenance.	**Environmental Significance: Low** Air Emissions • Minimal contribution to overall air emissions from Project
O9 Onshore Production		
A67. Electrical power generation via gas turbines • Emissions of gaseous combustion products to the atmosphere • Noise	**Residual Air Emissions** **Residual Noise** • Use of aero-derivative gas turbines ensures efficiency of power generation and minimises emissions • Use of low-NO_x burners minimises NO_x emissions. • Sound insulated housings around turbines • Use of PPE at Terminal	**Environmental Significance: Medium** Air Emissions • Greenhouse Gas emissions • Potential for non-compliance with air quality standards at onshore receptors. Noise • Modelling predicts noise from routine operations within guidelines **ISSUE FOR FURTHER ASSESSMENT** **(Chapter 10 Cumulative Impacts)**
A68. Process heating via crude oil heaters • Emissions of gaseous combustion products to the atmosphere	**Residual Air Emissions** • Use of low-NO_x burners minimises NO_x emissions.	**Environmental Significance: Medium** Air Emissions • Greenhouse Gas emissions • Air emissions modelling indicates compliance with air quality standards at onshore receptors. **ISSUE FOR FURTHER ASSESSMENT** **(Chapter 10 Cumulative Impacts)**
A69. Gas dehydration • Liberation of VOCs (CH_4 and BTEX)	**No Residual Impact** • Off-gas recovered in flare gas recovery system	
A70. Removal of produced sand from process vessels • Disposal of Sand	**Residual Solid Waste** • Sand is cleaned, bagged and sent for disposal. • Site selection process to minimise any impact	**Environmental Significance: Low** Solid Waste • Land take for landfill cells causes small reduction in terrestrial habitat for flora and fauna.

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A71. Contaminated Open Drains System	**Residual Waste Water Discharge**	**Environmental Significance: Low**
• Treated waste water discharge	• First 10 minutes of drainage water segregated in Oily Water Sump and pumped to Produced Water tank for disposal along with Produced Water. Free oil in water recycled to the process. • After 10 minutes water is filtered through a sand filter and sent to the Central Drainage Channel	Waste water • 'Clean' rainwater run off (filtered to meet oil-in-water content of < 10 mg/l on a monthly average and < 19 mg/l on a daily basis), discharged to Central Drainage Channel will generally evaporate and is not expected reach any sensitive receptors.
A72. Sewage treatment	**Residual Sewage Sludge**	**Environmental Significance: Low**
• Black and grey water	• While construction camp in operation, transfer to camp sewage system for treatment in stabilisation ponds • Thereafter, use appropriate sewage treatment for terminal operation workforce	Sewage Sludge • Practices designed to ensure that there is no negative health impact • Use as fertiliser may have a positive benefit
• Sewage sludge	• Maturate and landfarm or backfill stabilisation ponds	
A73. Fire Water Test	**Residual Waste Water**	**Environmental Significance: Low**
• Contaminated water run off	• Will be contained by Contaminated Drains system	Waste water • See Contaminated Drains system (A71)
A74. Operation of flare systems	**Residual Air Emissions**	**Environmental Significance: Low**
• Emission of gaseous combustion products to the atmosphere	• Flare gas recovery package on LP flare system permits recovery of up to 1 mmscfd of purge, pilot and flash gas.	Air Emissions • Small volumes of flaring (of gas flows in excess of 1 mmscfd is not expected to cause noticeable environmental change locally, but contributes to regional air quality issues
A75. Produced water storage and disposal	**OPTIONS UNDER EVALUTION**	**Environmental Significance: TO BE EVALUATED**
• Discharge into environment		**ISSUE FOR FURTHER EVALUATION** **See Section 8.3.6**
A76. Removal of H_2S from oil/gas	**Residual Solid Waste**	**Environmental Significance: TO BE EVALUATED**
• Disposal of sulphur waste (levels still to be determined)	• Waste Management Plan to be designed	**ISSUE FOR FURTHER EVALUATION** **See Section 8.3.6**

NORMAL OPERATIONS Operation, Aspect Potential Source of Impact	Residual Sources of Impact Mitigation and Control Measures	Environmental Significance Ecological Impact
A77. Oil storage	**Residual Air Emissions**	**Environmental Significance: Low**
• Emissions to the atmosphere of hydrocarbon vapours resulting from the storage of crude oil product	• Use of floating roof tank with primary and secondary seals and low loss fittings minimises the release of hydrocarbons.	Air Emissions • VOC emissions from floating roof tanks are not expected to contribute significantly to air quality issues.

SUMMARY OF KEY ISSUES		
ISSUE	**ASPECT REFERENCE**	**TYPE OF ISSUE** **REFERENCE TO FURTHER DISCUSSION**
Generation of waste	**A13, A15, A16,A17,A23,A29,A35, A49, A50**	**ISSUE OF MANAGEMENT CONCERN** **Chapter 12**
WBM Cuttings generation	**A14**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.2**
Construction of finger pier	**A32**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.1**
Construction of nearshore trench	**A33**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.1**
Hydrotest of 30 inch pipeline	**A39**	**ISSUE FOR FURTHER EVALUATION** **Section 8.3.6**
Hydrotest onshore installations	**A51**	**ISSUE FOR FURTHER EVALUATION** **Section 8.3.6**
Power generation, crude oil heaters	**A53, A67**	**ISSUE FOR FURTHER ASSESSMENT** **Chapter 10**
Discharge of domestic and sanitary waste offshore	**A55**	**ISSUE OF STAKEHOLDER CONCERN** **ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.4**
Sea water intake and discharge offshore	**A57**	**ISSUE OF STAKEHOLDER CONCERN** **ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.3**
Produced water disposal onshore	**A75**	**ISSUE FOR FURTHER EVALUATION** **Section 8.3.6**
Possible removal of H_2S from oil/gas	**A76**	**ISSUE FOR FURTHER EVALUATION** **Section 8.3.6**

8.2.2 Impact Assessment of Accidental Events

The impact assessment of abnormal operations and accidental events is presented in a three-column table as for normal operations (**Table 8.6**). Worst case scenarios have been formulated under the headings of pre-drilling, PDUQ installation, drilling, cuttings injection, offshore production, utilities, supply, oil export, Sangachal Terminal, Lokbatan, waste management and natural disasters. The scenarios are listed in the left hand column (C1-C29), together with a list of sources of environmental impact associated with each scenario. The scenarios have been developed using a number of sources:

- The Risk Assessment carried out for the ACG Phase 1 development (URS, 2002) – see also **Section 8.4.2**;
- The Reliability, Availability and Maintainability (RAM) report produced for ACG Phase 2 (BP, 2002); and,
- General experience with oil field development and production.

The middle column has listed mitigation and control measures, which may reduce the likelihood of the event or reduce the severity if the event does occur. The predicted frequency of each scenario occurring, despite the mitigation measures, is given in the middle column in bold text.

The scale and nature of the residual impacts has been listed in the right hand column, with particular emphasis on impacts affecting VECs. The environmental risk of each scenario has been graded High, Medium or Low as described below.

For abnormal or accidental events, the likelihood of an unscheduled event occurring is an important consideration. This introduces an element of Environmental Risk Assessment to the impact assessment procedure, which combines likelihood of occurrence with the impact categorisation (taken from **Table 8.3, Section 8.2.1**). The matrix presented in **Figure 8.2** is used to grade the environmental risk.

Impact Category	<<<1	<<1	<1	1	>1
4	M	M	M	H	H
3	M	M	M	M	H
2	L	M	M	M	M
1	L	L	M	M	M
0	L	L	L	L	L
	Likelihood				

Figure 8.2: Environmental risk matrix for abnormal operations and accidental events

The impact categorisation takes into consideration, where appropriate, seasonal differences in vulnerability, i.e. the likelihood of the presence of VECs if an event should occur. This is discussed in further detail in **Section 8.4.2** in the context of the Oil Spill Risk Assessment.

The term for likelihood of occurrence is drawn where possible from Quantitative Risk Assessment studies, generic human error quotients or oilfield experience. The matrix discriminates five degrees of likelihood: as shown in **Table 8.5**.

Table 8.5: **Likelihood Definitions for Abnormal or Accidental Events**

Predicted event frequency	**Symbol**
1 in 1,000-10,000 years	<<<1
1 in 100-1,000 years	<<1
None of the above categories is expected to occur during the life of the project	
1 in 10-100 years	<1
Less than 1 in 10 chance per year	1
The above categories may be expected to occur during the life of the project	
Greater than even chance	>1
This category is expected to recur during the life of the project.	

Taking into account the Impact Category and Likelihood of Occurrence each Abnormal or Accidental Event can be positioned in the Matrix and an Environmental Risk Level allocated. In the assessment tables the Environmental Risk Level is designated:

HIGH ●

MEDIUM ◆

LOW ■

The colour coding reflects the allocated position in the Matrix for each Abnormal or Accidental Event (**Figure 8.2**).

Residual effects that are categorised as having a ‘high’ or ‘medium’ significance level (planned operations) or risk level (accidental events) together with associated programs for mitigation are then examined in more detail (see **Section 8.3**).

Table 8.6: Aspects and Impacts Assessment of Environmental Effects Associated with Accidental Events and Abnormal Operations

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
Pre-Drilling		
C1. Mooring system fails in bad weather leaving MODU drifting for 24 hours	**Predicted frequency: <<1**	**Environmental Risk: Low**
• Interference with sea users	• Routine inspection and maintenance of mooring system	• No impact on biota • Disturbance of other sea users
C2. Drainage system failure releases 10m^3 water with 100ppm oil	**Predicted frequency: <<1**	**Environmental Risk: Low**
• Waste water discharge	• Routine inspection and maintenance • Reporting system for observed leaks • Routine tank level monitoring and recording • Transfer pumps inside bunded areas	• Transient localised changes to seawater quality • Localised impact on planktonic organisms however exposure times will be short due to dilution and dispersion of the release
C3. 200 paint tins not segregated from non hazardous solid waste.	**Predicted frequency: <1**	**Environmental Risk: Low**
• Chemical spill to aquifer • Contaminated land	• Environmental management system • Regular waste management audits	• Possible soil contamination inside landfill • Non-conformance with corporate waste management system
C4. P-Tank ruptures blowing 10m^3 cement powder onto sea surface.	**Predicted frequency: <<<1**	**Environmental Risk: Low**
• Release of chemical dust	• P-Tanks fitted with pop-off valves • Written procedures for P-Tank use • P-Tanks operated by trained personnel	• Transient localised contamination of the water column and of the air • Possible minor localised impact on planktonic organisms
C5. Mud pit failure releases 20m^3 NWBM mud into sea	**Predicted frequency: <1**	**Environmental Risk: Low**
• Marine spillage of oily mixtures	• Routine recorded inspection and maintenance of tank, valves and seals. • Monitor levels in tanks continuously • Work permit system for mud pit dump valves	• Small spill of weighted NWBM likely to coalesce and descend through the water column the seabed. • Possible localised impacts on planktonic organisms in the water column and on benthic communities over a very limited area

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
C6. Well test flame-out causes 200 litre oil spill	**Predicted frequency: <<1**	**Environmental Risk: Low**
• Release of VOC downwind • Marine oil spill	• Written procedures for well testing • Observers positioned during well test • Automatic shut off on well test unit • Function test burners before test • Commence well test during daylight • Consider pre-deploy oil spill booms	• Localised hydrocarbon pollution of sea, which will rapidly disperse. Temporary minor impact on planktonic organisms • Temporary oil sheen could impact birds but offshore populations are low
Drilling		
C7. Stuck-pipe freed with 12 hours jarring	**Predicted frequency: 1**	**Environmental Risk: Low**
• Noise and Vibration Energy use, emissions and utility waste water discharge during extension of drilling programme	• Intermittent low intensity noise • Set limit to jarring duration	• Jarring may be felt at the seabed, but is unlikely to cause significant disturbance to marine organisms • The increased duration of the drilling programme extends the impacts from routine utility and accommodation sources..
C8. Fishing for Bottom Hole Assembly (drill bit, etc.) for 4 days	**Predicted frequency: 1**	**Environmental Risk: Low**
• Energy use, emissions and utility waste water discharge during extension of drilling programme	• Use coated or NDT tested drillpipe • Drillers to monitor for drill pipe washouts	• The increased duration of the drilling programme extends the impacts from routine utility and accommodation sources.
C9. 7 days cuttings re-injection downtime	**Predicted frequency: 1**	**Environmental Risk: Low**
• Energy use and emissions from ship-to-shore • Hazardous waste handling and storage	• Routine inspection and maintenance of cuttings injection system • Maintain a stock of spare parts for cuttings injection system at the PDUQ • Cuttings injection to be run by trained engineers • Cuttings ship-to-shore equipment to be on stand by	• Contained cuttings will not impact on the offshore environment, but will require storage in onshore hazardous landfill. • Transport of cuttings involves the risk of spillage to sea from a crane, or spillage during loading at the dock.

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
C10. Downhole mud loss of 500m^3 NWBM mud	**Predicted frequency: <1**	**Environmental Risk: Low**
• Increased use of material resources • Increase in drilling programme duration • Contaminated land	• Regulate mud density • Keep stocks of LCM on the PDUQ • Keep sufficient reserve mud • Contingency plans to plug and side-track	• No direct impact on biota, but mud may migrate from loss zones to overlying horizon. • The increased duration of the drilling programme extends the impacts from routine utility and accommodation sources.
C11. Shallow gas causing loss of buoyancy forces rig from location	**Predicted frequency: <<<1**	**Environmental Risk: Low**
• Energy use, emissions and utility waste water discharge during extension of drilling programme • VOC emissions	• Conduct geo-physical survey of location • Drill pilot hole before first well at each location • Run diverters from conductor casing • Written procedures for shallow gas	• Additional atmospheric gas emissions • The increased duration of the drilling programme extends the impacts from routine utility and accommodation sources..
C12. Kick causes flaring of 50m^3 oil and gas.	**Predicted frequency: <1**	**Environmental Risk: Low**
• Extra barite and mud material use • Emissions from flare • Noise from flare	• Barite reserve kept on PDUQ • Mud logging for early identification of kick • Use of BOP • Written kill procedures • Released gas flared	• Local air quality affected by additional flaring • Additional contribution to project's GHG emissions
C13. Blowout of 3338 tonnes oil and gas/day lasting 42 days	**Predicted frequency: <<<1**	**Environmental Risk: Medium**
• Marine oil spill • Emissions from ignited reservoir fluids • Generation of solid waste • Emissions, discharges and wastes from capping operations	• Use of BOPs rated for maximum reservoir pressure • Shut in other wells • Training simulation exercises • Routine pressure testing of BOPs • Oil spill contingency plan • Stand-by vessels equipped with oil booms and response equipment • Rapid mobilisation of response equipment from onshore bases	• The impact will depend on a number of factors including time of year, weather conditions and the effectiveness of the Oil Spill Contingency Plan. Risk is Medium because of low probability of occurrence. **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.4.2)**

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
Cuttings Injection Well		
C14. Loss of integrity allows oily mixture to access seabed.	**Predicted frequency: <<<1**	**Environmental Risk: Low**
• Marine oil spill	• Fracture analysis of receiving horizon	• Possible gradual release of oil causing localised impacts on benthic fauna and localised impacts on water column organisms – similar to naturally occurring seeps.
Production		
C15. 27 hour water-injection downtime causes discharge of 65,250 m3 water with 29 mg/l oil into the sea.	**Predicted frequency: 1**	**Environmental Risk: Low**
• Discharge of treated produced water	• Routine inspection and maintenance of water injection equipment • Water injection system run by trained operatives • Discharge into Open Drains Caisson at 50 m below sea surface • Oil in Open Drains Caisson pumped out and recycled	• Rapid dilution and dispersion of the discharge will limit impacts to the immediate vicinity of the discharge without no significant impacts on populations of marine organisms. • ISSUE OF STAKEHOLDER CONCERN **ISSUE FOR FURTHER ASSESSMENT** **(Section 8.3.2)**
C16. 1m^3/hour leak from production equipment	**Predicted frequency: 1**	**Environmental Risk: Low**
• Oil spill to installation drains or waste management system	• Routine inspection of production equipment for leaks • Production equipment bunded • Routine site audits • Environmental Management System	• Oil leaks constitute safety hazard, but processed by drain system will not affect biota
C17. Emergency blowdown flaring volume of separator train.	**Predicted frequency: <1**	**Environmental Risk: Low**
• Emissions from flaring	• Routine inspection and maintenance of production equipment	• Local air quality affected by additional flaring • Additional emissions may contribute to regional air quality issues

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
Utilities		
C18. Diesel bunkering spill of 1 tonne	**Predicted frequency: <1**	**Environmental Risk: Low**
• Marine oil spill	• Follow written procedures for bunkering • Bunkering operations during daytime only • Use ISO certified hoses • Transfer pumps stand within bunds • Pressure test hoses before use • Bunkering included in permit to work system	• Diesel will rapidly evaporate and disperse without reaching land. Transient localised contamination of the water column with localised toxic impacts on planktonic organisms • Sea surface sheen may result in oiling of birds although populations offshore are low • Evaporating oil contributes to air quality issues.
C19. Diesel tank rupture spilling 42 tonnes	**Predicted frequency: <<<1**	**Environmental Risk: Low**
• Marine oil spill	• Diesel tank stands in bunded area • Routinely monitor tank levels • Clean up to closed drain system	• Leak contained by bunding and does not impact on biota.
C20. Sewage treatment failure discharging 1 day's untreated waste water (90m^3)	**Predicted frequency: <1**	**Environmental Risk: Low**
• Contaminated water discharge	• Routine inspection and maintenance of sewage treatment unit • Routine monitoring of waste water discharge quality • Routine environmental audit	• Discharge will rapidly be diluted and dispersed. Local impact on planktonic organisms in the immediate vicinity of the discharge but no impacts at the population level.

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
Supply		
C21. 1 tonne Pallet of chemical dropped into sea from crane	**Predicted frequency: <<1**	**Environmental Risk: Low**
• Chemical spill • Seabed disturbance	• Routine inspection and maintenance of cranes and slings • Written procedures for onloading and backloading materials • Preferentially use plastic sacks and packaging for benign chemicals, and drums for most toxic products. • Avoidance of toxic chemicals in mud • Transfers to be scheduled for daytime only	• Seabed will be disturbed with minimal physical impact on benthic communities • Impact from chemical released into water column is likely to be gradual and localised. • Small scale of release is unlikely to result in impacts on populations of organisms,
C22. Radio active source lost overboard from supply vessel	**Predicted frequency: <<<1**	**Environmental Risk: Low**
• Increased emissions, waste and waste waters during salvage operations	• Radio active sources transported in protective containers • All materials to be secured with deck straps for transit • Recovery of source	• Increased emissions from vessels during salvage operations will contribute to regional air quality issues
Export		
C23. Nearshore pipeline rupture releasing oil at the rate of 692 m3/hour for 26 hours	**Predicted frequency: <<1**	**Environmental Risk: Medium** ◆
• Marine oil spill • Increased emissions, waste and waste waters during repair/replacement operations • Generation of waste	• Close block valves to limit scale of spill • Corrosion pigging • Routine pipeline inspection	**ISSUE FOR FURTHER ASSESSMENT** **(Section 8.4.2)**
C24. Nearshore pipeline leak releasing oil at the rate of 1 m3/hour for 720 hours	**Predicted frequency: <<1**	**Environmental Risk: Medium** ◆
• Marine oil spill	• Monitor pipeline pressures to detect leak • Corrosion pigging • Routine pipeline inspection	**ISSUE FOR FURTHER ASSESSMENT** **(Section 8.4.2)**

ACCIDENTAL EVENTS Scenario Potential Source of Impact	Likelihood Mitigation and Control Measures	Environmental Risk Ecological Impact
C25. Onshore pipeline leak releasing 400 tonnes of oil	**Predicted frequency: <<<1**	**Environmental Risk: Medium** ◆
• Terrestrial oil spill • Coastal oil spill	• Corrosion pigging • Routine pipeline inspection	**ISSUE FOR FURTHER ASSESSMENT** **(Section 8.4.3)**
Terminal		
C26. Emergency blowdown of one production train with flaring	**Predicted frequency: <1**	**Environmental Risk: Low** ■
• Emissions from flare at Sangachal • Noise	• Routine inspection and maintenance of production equipment	• Local air quality may be affected by additional flaring • Additional emissions may contribute to regional air quality issues • Disturbance of wildlife from noise
C27. Ruptured oil storage tank spills 10% of capacity of crude oil tank (890 tonnes) onto site	**Predicted frequency: <<<1**	**Environmental Risk: Low** ■
• Oil spill to bunded area • Emissions from repair activities	• Crude oil tanks stand inside bunds to contain spill volume of largest tank.	• No impact on biota • Additional emissions may contribute to regional air quality issues
Waste Management		
C28 Truck carrying 40 tonnes hazardous waste spills load	**Predicted frequency: <1**	**Environmental Risk: Low** ■
• Chemical spill	• Speed limit imposed on waste trucks • Check driver qualifications and health • Maintain trucks to high standard • Mobilize appropriate clean up response	• Localised ecological damage possible, depending on location of incident. After clean-up impacts are unlikely to be significant or long term.
Natural Disasters		
C29. Earthquake damage to installations	**Predicted frequency: <<<1**	**Environmental Risk: Low** ■
• Oil spill • Oily water discharge	• Pipelines and platforms designed to sustain 500 year return earthquake without rupture • Design will be checked against the 3,000 year return period where some damage can occur but the integrity of structures is retained • Regular inspection of pipeline condition	• The probability of damage to installations by a seismic event resulting in discharges to the environment is extremely low

SUMMARY OF KEY ISSUES		
ISSUE	**SCENARIO REFERENCE**	**TYPE OF ISSUE** **REFERENCE TO FURTHER DISCUSSION**
Large scale oil blow-out	**C13**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.4.2**
Discharge of treated produced water	**C15**	**ISSUE OF STAKEHOLDER CONCERN** **ISSUE FOR FURTHER ASSESSMENT** **Section 8.3.2**
Nearshore pipeline rupture	**C23**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.4.2**
Nearshore pipeline leak	**C24**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.4.2**
Onshore pipeline leak	**C25**	**ISSUE FOR FURTHER ASSESSMENT** **Section 8.4.3**

8.3 Further Assessment of Key Issues Related to Normal Operations

In this section the key issues related to Normal Operations that have been identified through the assessment process are discussed in further detail. The aspects that are discussed are;

- Nearshore Construction Activities;
- Discharge of WBM drill cuttings and drilling mud offshore;
- Intake and discharge of cooling water offshore;
- Other offshore operational discharges; and,
- Radioactivity.

Figure 8.1 shows schematically these aspects and installations comprising the ACG Phase 2 Project (also included are accidental events as described in **Section 7.4**). The emissions and discharges to the environment to be the focus of the impact assessment are indicated together with the associated environmental receptors.

Model simulations have been carried out for air emissions both onshore and offshore and noise at the Sangachal Terminal. The discussion of the air emission and noise modelling is presented in **Chapter 10:** Cumulative Impacts, since it is most relevant to take into consideration all phases of the ACG FFD in this context.

During the assessment process a number of issues have been noted where options are still under evaluation at the time of writing (as indicated in **Table 8.12**). This is discussed further in **Section 8.3.6**.

8.3.1 Nearshore Construction Activities

Introduction

Nearshore and coastal engineering in connection with the ACG Phase 2 pipeline construction has been identified as an activity that has the potential to cause environmental impacts of Medium Significance upon VECs in Sangachal Bay (see **Table 8.4**).

The environmental aspects related to construction activities are as follows:

- Construction (and subsequent removal or relocation) of the finger pier used to provide access for the trench excavator;
- Construction of the trench in the nearshore zone; and,
- Pipelay activity.

The base case for these activities is for the Phase 2 beach pull to take place over a 14 day period in August 2005 whilst the Phase 2 30” oil pipelay will take place over 284 day period from December 2004 to September 2005. In addition to Phase 2 there will also be pipeline construction operations in connection with Phase 1 and 3 and the Shah Deniz development. There is therefore potential for cumulative impacts in relation to this type of activity. These are discussed further in **Chapter 10**.

The main impacts identified related to these construction activities will be caused by:

- Physical destruction of habitat by smothering with the finger pier material and the excavation of the trench;
- Increased turbidity in the water column caused by sediment resuspension;
- Smothering of benthic flora and fauna by redistribution and resettlement of sediments; and,
- Longer term coastal erosion processes caused by the presence of the finger pier.

For the EOP a finger pier construction was used and left in-situ following completion of installation. Localised erosion/accretion has been identified on either side of the structure and a similar pattern of seabed mobility could be expected for further piers left in the bay. The base case for construction in Sangachal Bay is therefore removal of finger piers after use in a manner designed to minimise sediment resuspension.

The impacts of nearshore pipeline construction on sensitive receptors (VECs) are discussed in the following sections.

General Sensitivities in Sangachal Bay

The habitats in Sangachal Bay have been mapped and are described in **Chapter 6** and illustrated in **Figure 6.10**. **Figure 8.3**, first presented in the Phase 1 ESIA (URS, 2001) illustrates spatial variations in the seabed sensitivity. This has been developed using information on the distribution of seagrass and algae as well as sediment types and their mobility. Those areas which support seagrass and red algae have been considered most sensitive, as well as fine grained sediments composed of silt, which are highly mobile. Disturbance of highly mobile sediments will lead to increased water turbidity as well as increased sedimentation as the sediment settles.

Areas that supported sparse communities of seagrass and red algae, or are sandy sediments which could support seagrass mats, were classified as medium. Those areas where seagrass or red algae were not found during the survey, and areas composed of silty sand, were assigned the lowest sensitivity.

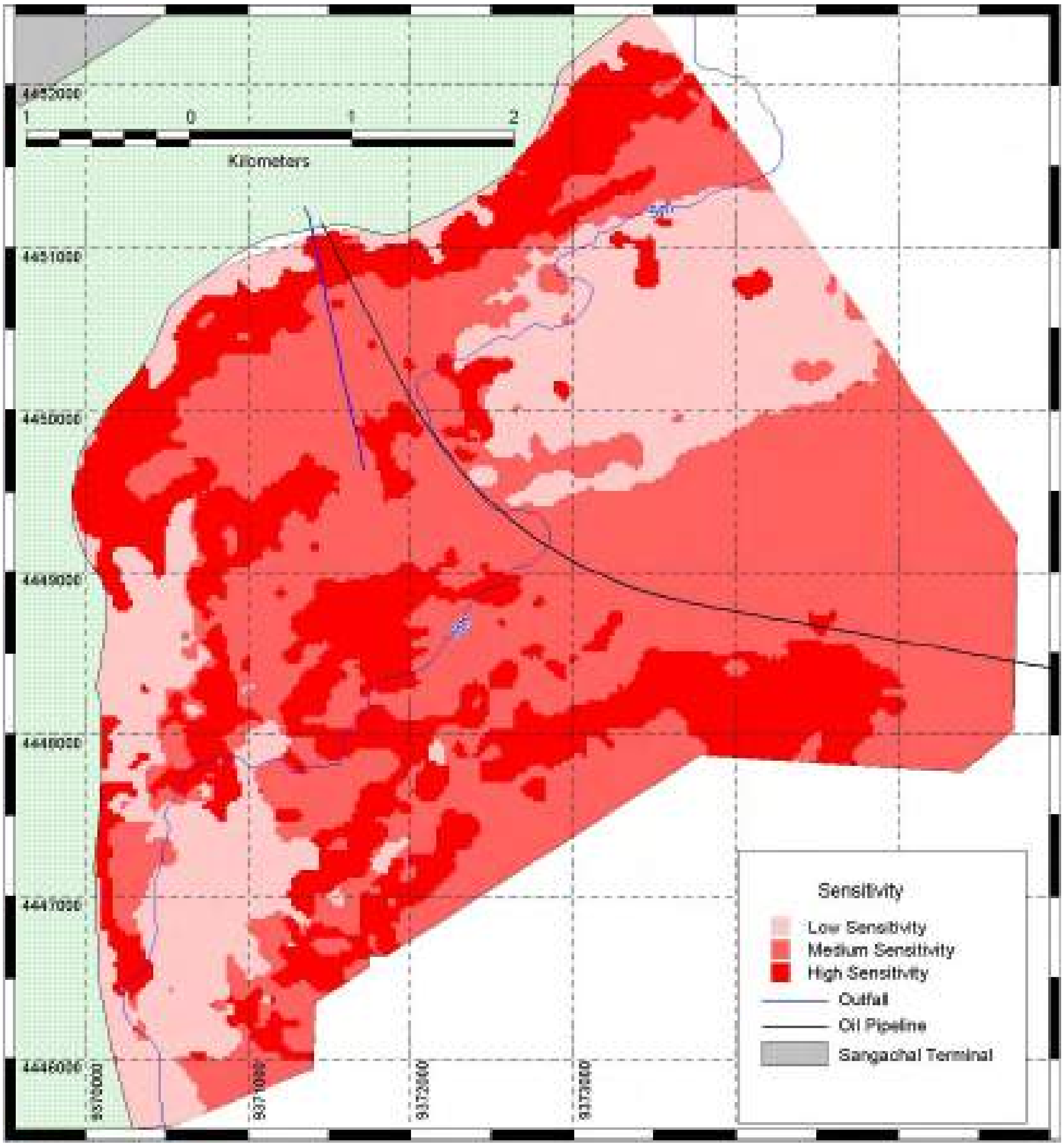


Figure 8.3: Sensitivities in Sangachal Bay

Impacts on Benthic Fauna

Benthic communities will be smothered by the material utilised to construct the finger piers (estimated area 1500m^2 assuming a finger pier of 300m length and 5m width). The trenching activity will also impact on benthic communities directly. However, the area impacted will be localised and limited in extent and will have no significant impact on the overall populations of the benthic communities that are widespread in the nearshore areas.

The construction activities including the presence of the finger piers will result in increased water turbidity and redistribution of sediments. This will impact on benthic communities over a wider area in the Bay. However, it is important to note that the nearshore environment is naturally dynamic with storm surges and wind driven waves resulting in increased turbidity and sediment redistribution such that the changes in benthic communities discussed below will also occur as the result of the natural climatic conditions.

The spatial distribution of macroinvertebrate fauna is, in part, mediated by sediment particle size characteristics. This has been noted in **Section 6.4.3,** where certain species were noted to be preferentially found either in, or absent from sediment with high mud content. Indeed the faunal community as a whole responds in such a way that the number of species present is greatest when the sediment consists of a wide range of sediment types (and is said to be heterogeneous, **Section 6.4.3**). Consequently, if the sediments of a particular location were changed, such as through suspension and resettlement of the finest particle components, then it would be anticipated that a faunal response would occur in the shape of a restructuring of the species composition. Species more characteristic of coarse sediments (e.g. bivalve molluscs) would become less frequent (or even absent) whilst those preferentially occurring in fine sediments (e.g. *Schizorhynchus euderolloides*) would become more abundant.

An indication of such a change can been seen when comparing the two surveys carried out in Sangachal Bay (ERT 1996 and 2001). This shows that where the silt/clay content has increased, the faunal diversity has shown a tendency to decline. **Figure 8.4** shows the silt/clay content and **Figure 8.5** shows the diversity of species at each station.

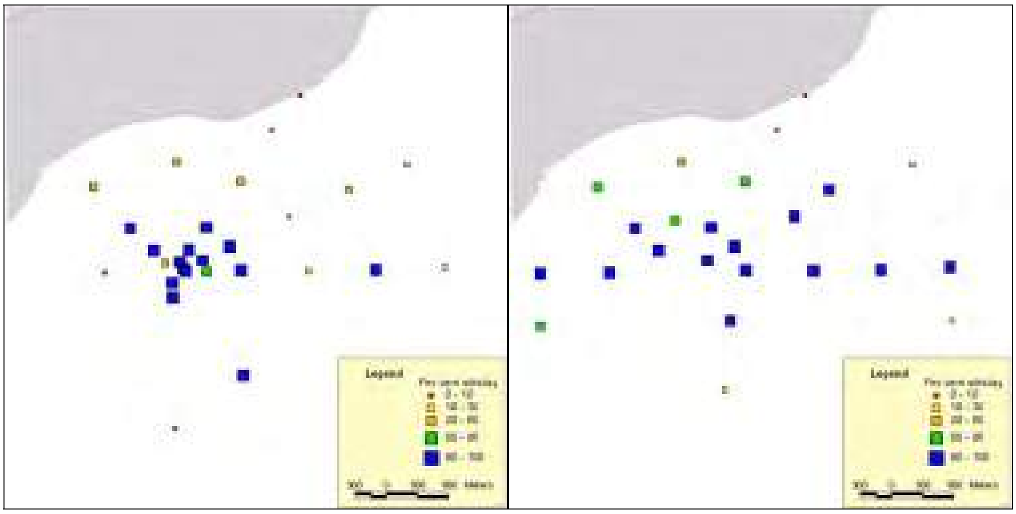


Figure 8.4: The silt/clay content at stations sampled in 1996 (left) and 2000 (right) in Sangachal Bay.

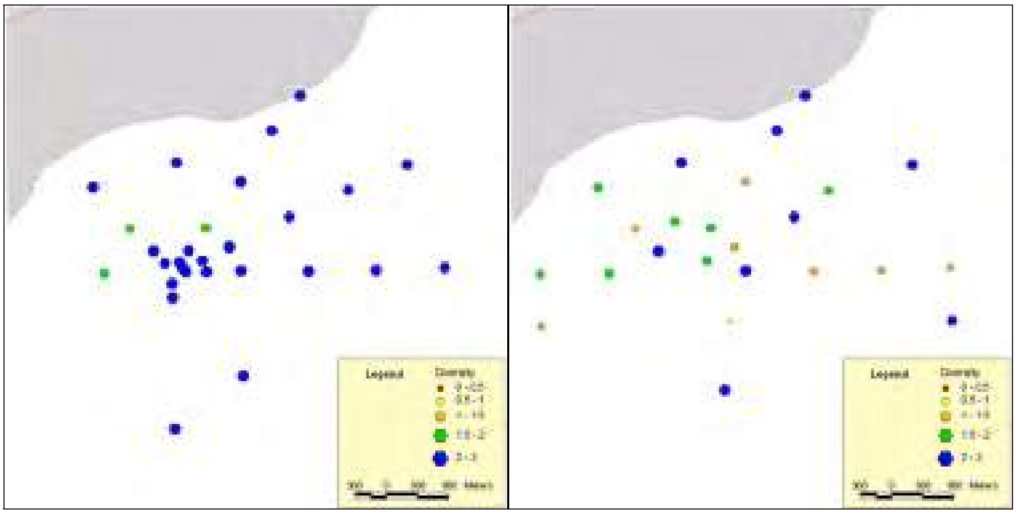


Figure 8.5: The species diversity at stations sampled in 1996 (left) and 2000 (right) in Sangachal Bay.

In summary the assessment indicates that benthic fauna in Sangachal Bay will be impacted by direct habitat loss caused by the finger pier construction and the trenching activities. Indirect impacts will be caused by resuspension and redistribution of sediments that will influence the particle size distribution on the seabed and the associated benthic community composition. It should be noted that the nearshore area in Sangachal Bay is a dynamic environment where increased turbidity would occur naturally as a result of storm conditions. The construction activities are temporary, and no long term impacts at the population level on benthic communities are anticipated. Longer term habitat alterations could be caused by the presence of the finger piers but this will be mitigated by the fact that the finger piers will be removed after use.

Impacts on Benthic Flora

Impacts on benthic flora related to construction activities will be caused by the same processes as described for benthic flora, i.e. direct habitat destruction and turbidity and sediment redistribution.

Seagrasses

A sizeable body of research exists concerning the environmental impacts to seagrasses (Rasmussen, 1977, Shepherd *et al* 1989, Giesen *et al* 1990, Holt *et al* 1996). From this it has been noted that they are sensitive to the following impacts:

- Physical disturbance including damage to roots
- Increased turbidity and associated light attenuation
- Loss of sediment stability and sediment erosion
- Eutrophication
- Blanketing by epiphytes
- Sediment accretion

It also appears in contrast, that seagrasses are generally insensitive to either metal or hydrocarbon contamination in both the water column and sediments. Oiling from spills is also considered to have minimal effect on *Zostera spp*., but use of dispersant chemicals can typically have an appreciable negative impact on seagrass stands (Hiscock 1987, Shepherd *et al*, 1989).

In spite of this level of understanding there is little quantification of these sensitivities and insensitivities.

Physical damage from intrusive engineering operations such as finger pier construction or trenching understandably results in the mortality of seagrasses that are smothered or dug up. As vegetative growth, the primary growth mechanism, of *Z.noltii* is slow (thought to be at best 0.5m per year), recovery will inevitably also be slow. When considering the likelihood that the disturbed sediment may no longer be optimal for recolonisation, potentially due to it being of the wrong particle size structure or being less stable, then recovery will be slower still or even negligible. This will have ramifications for associated fauna (including fish), flora and sediment stability, all of which are enhanced by the presence of seagrass (Shepherd *et al* 1989, Holt *et al* 1996).

With respect to sediment accretion, studies of *Thalassia* and *Halodule* (Odum, 1963. McRoy and Helfferich, 1980) suggest that though they are tolerant of rapid sediment accretion of as much as 10-20cm depth, in excess of this then mortality occurs. It is thought likely that smaller species such as *Z.noltii* will be less resilient in this respect.

Increased turbidity and associated light attenuation will also bring about a decline in seagrass. Typically the occurrence of seagrass, particularly with respect to maximum water depth of occurrence, is limited by light availability. Consequently a persistent decline in light penetration will have a long-term detrimental effect on the plants and their ability to grow.

Conditions within Sangachal Bay with respect to eutrophication and increase in epiphytic growth, as a consequence of the phase 2 development are not considered significant and hence not discussed further.

A temporal dimension mediates the degree of sensitivity shown to increased turbidity and sediment accretion. During October through to February, *Z.noltii* will not be in a growth phase and consequently not sensitive to effects of increased turbidity. During periods of growth, seagrasses will tolerate increased turbidity that is relatively short in duration, such as caused by seasonal phytoplankton blooms and stormy conditions. Even periods of several weeks are unlikely to precipitate dieback of leaves even if active growth ceases. Even periods of low light intensity that are of sufficient length to result in some dieback of leaves, recovery is feasible from the stored energy reserves retained in the roots and rhizomes (C.Maggs, *pers. comm.*).

Sediment accretion during winter months will not result in mortality through smothering unless the build up of new layers of sediment are of sufficient thickness to prevent new growth from rootstock reaching the sediment surface. The thickness at which point growth is prevented is uncertain though it is likely to be several centimetres. During periods of growth, sediment accretion is accommodated by vegetative growth. Seagrasses are adapted to this scenario as they are themselves increase the rate of accretion by their presence, which reduces the velocity of near-bed currents and hence increase particle settlement. Again, the rate at which such settlement exceeds the ability of seagrass to grow through accreting sediment is uncertain.

Red Algae

Either light penetration or substratum availability may influence the lower depth limits of the red algae. The upper depth limit of c. 5m is apparently determined by the small particle size of the sediments present at this depth. The lower limit of distribution, probably controlled by light penetration, was no more than 11m.

Changes in sediment and light penetration are the principal sensitivities of the red algae. As in the case of seagrasses, red algae will show some temporal tolerance of reduced light levels and increased sedimentation. The life history strategy of ephemeral species found in the nearshore environment (*Callithamnion spp*., *Ceramium* cf. *tenuicorne, Polysiphonia denudata* and *Acrochaetium spp*.) are based on the opportunistic colonisation of suitable substrata where and when available. This strategy means that they are, at least at a population level and assuming some suitable habitat persists, insensitive to temporary perturbations. Consequently impacts on these flora are considered to be negligible. The perennial species (including *Osmundea caspica* and *Polysiphonia stricta*) grow from a winter dormant base during spring. This base, like the rhizomes of *Z.noltii* acts as an energy store and means that the plant is able to survive sub-optimum light conditions for a lengthy period of time, perhaps up to several months.

Conclusions: Impacts on Nearshore Communities

The construction activities in Sangachal Bay will result in a number of impacts on the communities present:

- Smothering and physical removal caused by the finger pier construction and trenching. This will only impact a limited area in relation to the overall distribution of the communities concerned;
- Increased turbidity and sediment redistribution resulting in changes in benthic fauna community composition and possibly influencing seagrass and red algae growth and survival.

As regards these latter potential impacts it should be noted that the nearshore environment is naturally dynamic with regular increases in turbidity generated by wind and waves. Longer-term impacts will be mitigated by the removal of the finger piers after the construction activity is completed. It is anticipated that the habitats in Sangachal Bay will recover over time after the cessation of construction activities. However, this recovery may become prolonged by subsequent construction activities associated with the other Phases of the ACG FFD and the Shah Deniz development. This is discussed in **Chapter 10**: Cumulative Impacts.

The impacts on benthic communities, seagrass and red algae will be monitored on a regular basis to ascertain how rapidly and effectively the habitat is becoming recolonised (see **Chapter 12**).

8.3.2 Discharge of Drilling Mud and Cuttings

Introduction

Drill cuttings produced from the 26" hole section will be discharged to the marine environment. The base case drilling fluid is seawater with added viscous sweeps (natural organic cellulose or gum substances). The sweeps are non-toxic and biodegradable. The discussion below is however centred on a more complex Water Based Mud (WBM) system that may be used as a contingency. There are a number of additional environmental issues associated with WBM compared to the seawater system, e.g. discharge limitations on chloride content and standards for heavy metal content in barite.

During pre-drilling using the *Dada Gorgud* semi-submersible rig, the top hole section will be drilled using seawater with added viscous sweeps and the cuttings will be discharged directly to the seafloor in the immediate vicinity of the well. This may also be the case if there are operational difficulties during platform drilling. However here the base case is to drive the 30" conductor into the seabed using a hydraulic hammer such that there will normally be no discharge of mud or cuttings

During pre-drilling, mud and cuttings from the 26" section will be discharged via the cuttings caisson on the *Dada Gorgud* that ends 11 m below the sea surface (6 and 10 wells at the East and West Azeri locations respectively). During platform drilling drill cuttings and associated WBM will be discharged through the discharge caisson 97 m below the surface of the sea (42 and 32 wells at the East and West Azeri locations respectively). Whole WBM will also be discharged.

Since the water depths at the East and West location are 120 m and 155 m respectively the cuttings plume from the platform drilling will only impact a limited section of the water column that is well below the productive photic zone of the upper water layers. The cuttings discharged during pre-drilling will however pass through more of the water column since they will be discharged from 11 m below the sea surface. There will therefore be a degree of interaction with plankton organisms and this is discussed in the following sections.

The dispersion and fate of the drill cuttings has been investigated by using a simulation model and also by taking in account simulations carried out for the Phase 1 ESIA. The results of the modelling and a discussion of impacts on benthic communities based on these results are also discussed below.

Physical Impacts of WBM and WBM Cuttings Discharge in the Water Column

The mud and cuttings plume will increase the turbidity in the water column. However as indicated above the extent is limited since the discharge point is 97 m below the surface for the majority of the wells and the plume will be rapidly dispersed and diluted. The pre-drilling discharges will pass through more productive upper layers of the water column but will also be rapidly dispersed and diluted. There may be some mortality of planktonic organisms entrained in the plumes as a result of physical clogging of gills or filtering mechanisms and turbidity may temporarily reduce productivity over a limited area. However, the overall impact on populations of planktonic organisms will be negligible.

Ecotoxicity of WBM

The WBM system to be used for ACG Phase 2 drilling activities has been selected to ensure low toxicity to organisms in the water column and on the seabed.

As shown in **Chapter 5**, **Table 5.32** the component chemicals of the WBM system are classified as HOCNF category E/D. They are therefore generally considered to pose little or no risk to the organisms in the receiving water. The chemicals are typically of low toxicity with low bioaccumulation potential and are not persistent.

Barite makes up approximately 80% of the WBM, in terms of weight. The barite to be used by AIOC has been tested for heavy metals to ensure that concentrations are well below international barite heavy metal guideline limit values of <3 mg kg^{-1} for cadmium and <1 mg kg^{-1} for mercury.

Barite is the sulphate salt of the metal barium. The barium within the barite is therefore in the form of finely grained barium sulphate, which is a highly insoluble inert material of very low toxicity (classified as HOCNF E). Any impacts related to barite will be associated with smothering effects on the seafloor rather than toxicity effects on the seafloor or in the water column. Because of its inert nature, barium sulphate is an effective tracer for assessing the potential area covered by drilling discharges during post drilling surveys (UKOOA/DTI, 1996).

The low-toxicity of the WBM to be used for the ACG Phase 2 Project is confirmed by a series of tests carried out on a similar mud used for drilling of the first Oguz Contract Area exploration well (OOC, 2002, unpublished report). Toxicity tests of WBM with and without potassium chloride (KCl) and glycol were carried out on three Caspian test species (*Chaetoceros tenuissimus*, *Calanipeda aquae dulcis* and *Pontogammarus maeoticus*) using a pre-spud mud formulation. The results confirmed OOC's assessment of the low toxicity of these muds, which were reported in the Oguz Contract Area Exploration Drilling Environmental Impact Assessment (OOC, 2001). In the natural environment exposure times to the discharges would be brief because of the rapid dispersion and dilution of mud and cuttings and dilution of WBM prior to overboard disposal. No toxic effects are therefore anticipated. Samples of actual WBM muds from the different hole sections were also tested on Caspian species during the course of Oguz and Nakhchivan drilling operations. These tests also confirmed the low toxicity of WBM.

Any impacts related to a high chloride content in a WBM mud discharge will be mitigated by dilution prior to discharge. The AIOC PSA sets a chloride limit of four times the ambient chloride concentration at the point of discharge for cuttings and drilling muds.

Discharge Modelling - Introduction

The fate of WBM drill cuttings discharged to the Caspian at the East and West Azeri PDUQ locations was modelled using MUDMAP. This is a personal computer-based model developed by Applied Science Associates (ASA) to predict the near and far field transport and dispersion of drill muds and cuttings and produced water (Spaulding *et al*, 1994; Spaulding 1994). Hydrodynamic simulations were conducted for the Caspian Sea using HYDROMAP. HYDROMAP is a globally re-locatable hydrodynamic model capable of simulating complex circulation patterns due to tidal forcing and wind stress quickly and efficiently anywhere on the globe. The simulations were conducted during the summer and winter seasons of the year 2000, June through August and December through January, respectively. The computational grid covered the entire Caspian Sea with coarse resolution in the northern Caspian on the order of 20 km and finer resolution in the southern Caspian with resolutions on the order of 5 and 2.5 km in the Baku region. The hydrodynamic model was validated using current meter data collected by AIOC along a pipeline route between Chirag and Sangachal Bay during the winter season from 01 February to 01 April 2000. The validation consisted of both qualitative and quantitative measures. The validation showed the model to reproduce the major current trends within the region very well with the model being more energetic than the data at offshore data collection stations and slightly less energetic at near shore data collection stations. The difference between the energetic state of the model and data was within commonly accepted modelling guidelines except for one station offshore Kala (Absheron Peninsula) that can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid. Full details of the modelling can be found in **Technical Appendix B**.

Figure 8.6 shows the platforms connected with the ACG FFD in relation to each other.

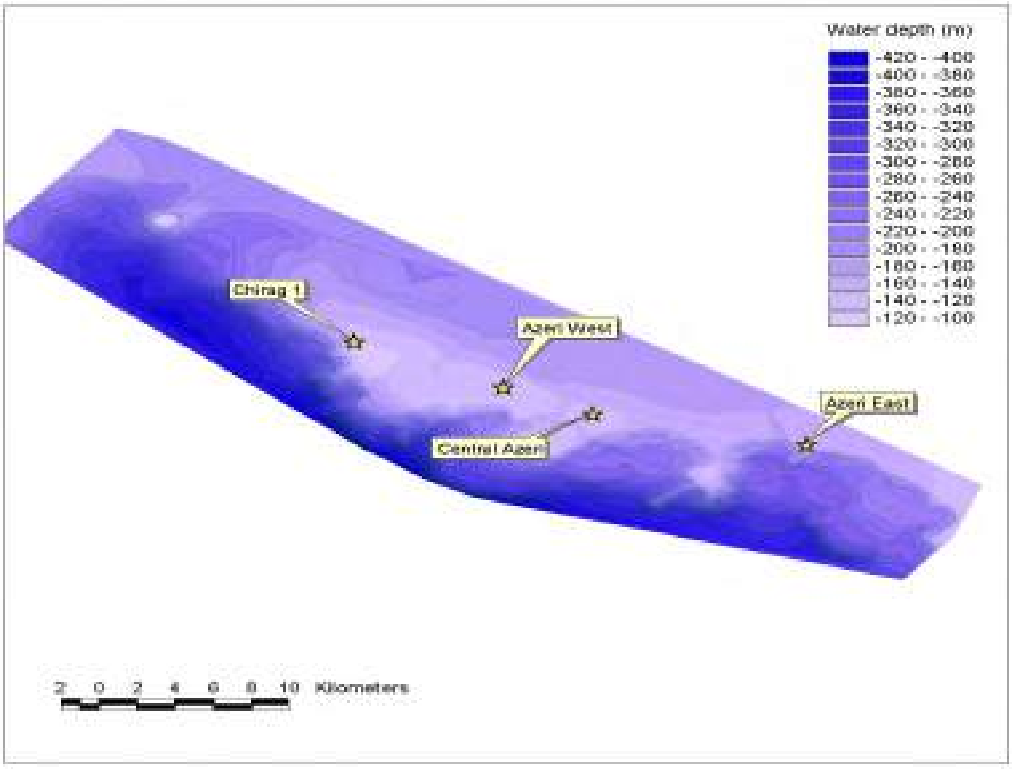


Figure 8.6: Existing and planned platforms in the ACG Contract Area

Scenario Specification

The simulations carried out for the Phase 1 ESIA (URS, 2002) at the Central Azeri location (water depth 128m) indicated that releases to the seafloor from the 36" top hole section would be deposited within tens of metres of the well location. As mentioned earlier the base case is however for no discharge of mud and cuttings from this section from the platform drilling.

The simulations also indicated the deposition pattern resulting from template drilling and platform drilling was similar.

For the Phase 2 modelling a conservative approach was taken by assuming that a maximum of 48 wells can be drilled at the East and West PDUQ locations, respectively, (based on available well slots). Mud and drill cuttings discharge from the 26-inch hole section was modelled, with the discharge taking place at 97 m below the sea surface. This resulted in a total discharge volume of 17,885 m^3, at each location, with the drill operations estimated to last 8 hours per well. This volume includes a contingency volume of approximately 34% in addition to the volumes calculated for this hole section as shown in **Chapter 5**, **Table 5.30**. The modelling is therefore likely to give an overestimate of actual extent of cuttings deposition from operations. **Table 8.7** summarises the release scenario specifications.

Table 8.7: 26 inch Drill Hole Specifications

Release coordinates East PDUQ:	51° 27' 6.8068 E, 40° 1' 11.0458" N
Release coordinates West PDUQ:	51° 18' 33.1424" E, 40° 3' 20.6350" N
Release depth:	97 m
Water Depth	120m (West Azeri), 155m (East Azeri)
Total volume of 26" cuttings:	17,885 m^3
Total drilling time per well:	8 hrs
Specific gravity of cuttings:	2.2

Since only the average specific gravity of the mud and drill cuttings to be released was available, a typical grain size distribution and associated fall velocity based upon ASA's experience was utilised for the simulations.

In order to bind the trajectory and the eventual bottom thickness contours of the mud and drill cutting releases, simulations were conducted during average and maximum flow events during the summer and winter periods based on the wind climatology. The currents present during the winter are on average twice as energetic as those present during the summer. This is attributed to the presence of stronger coherent winds fields during the winter season. The currents at the West PDUQ are generally more energetic than those present at the East PDUQ during both the summer and winter seasons due to the greater depth of the eastern location.

Simulation Results

Table 8.8 summarises the percentage of total mass deposited on the bottom versus time for the 48 wells at both the east and west Azeri PDUQ. The maximum deposition of the 48 wells at each location occurred within 50 m of the release location. The depth range of these depositions and the approximate radius of the deposition surrounding the well site are summarised in **Table 8.9**.

Table 8.8: Sediment Deposition Times

	East Azeri PDUQ (hrs)	**West Azeri PDUQ (hrs)**
Time for 90% of particles to reach the seabed	8	8
Time for remaining 10% to reach the seabed:		
Average winter current conditions	24	28
Maximum winter current conditions	35	39
Average summer current conditions	25	29
Maximum summer current conditions	28	31

Table 8.9: Summary of Deposition Characteristics Related to Seasonal Current variation

	East PDUQ		West PDUQ	
Seasonal Current Condition	Deposition Range (cm)	Radius of Deposition (m)	Deposition Range (cm)	Radius of Deposition (m)
Winter Average	3.5 - 208	170	5.5 - 203	180
Winter Maximum	15 - 89	190	5 - 144	260
Summer Average	4 - 211	198	1 - 210	208
Summer Maximum	8 - 208	213	5 - 177	211

The deposition patterns for the various scenarios were similar for both the East and West Azeri locations. **Figures 8.7–8.10** illustrate the results obtained for the East Azeri location. Full results are included in **Technical Appendix B**.

The Figures indicate that generally the deposition pattern surrounds the well site. An exception is during winter under maximum current conditions (**Figure 8.10**). Here the pattern is bimodal with an offset to the southwest, although the region of highest deposition is still surrounds the well site.

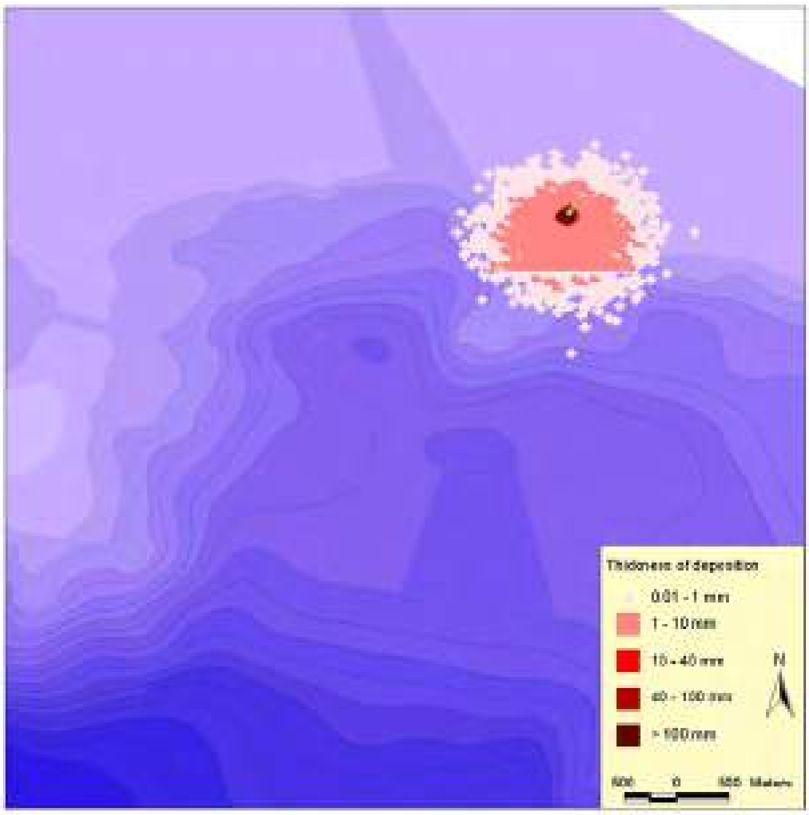


Figure 8.7: Deposition pattern for the discharge of mud and drill cuttings at the East PDUQ Location during the summer under average current conditions.

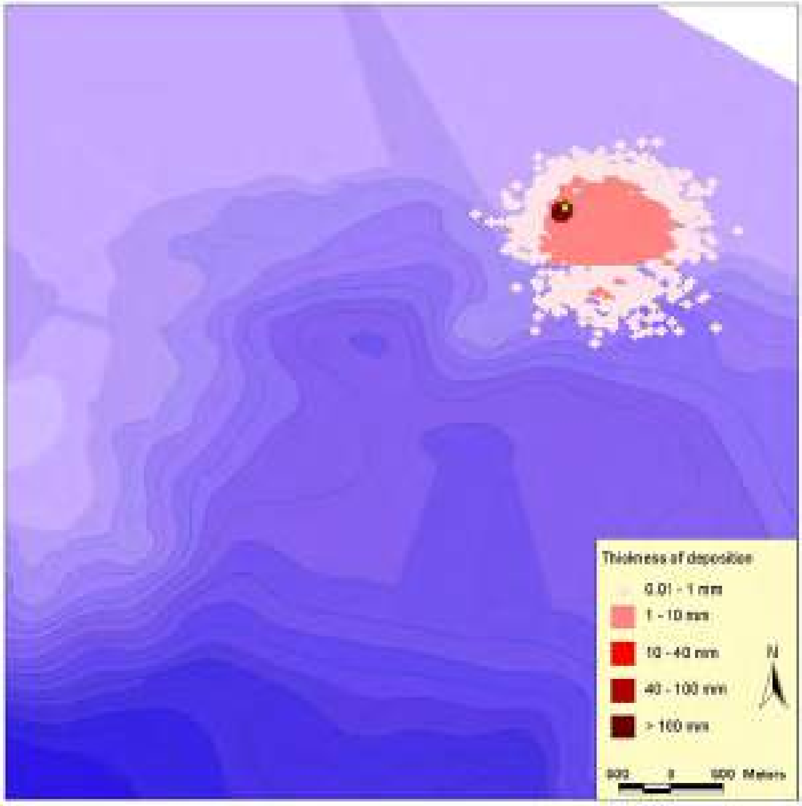


Figure 8.8: Deposition pattern for the discharge of mud and drill cuttings at the East PDUQ location during the summer under maximum current conditions

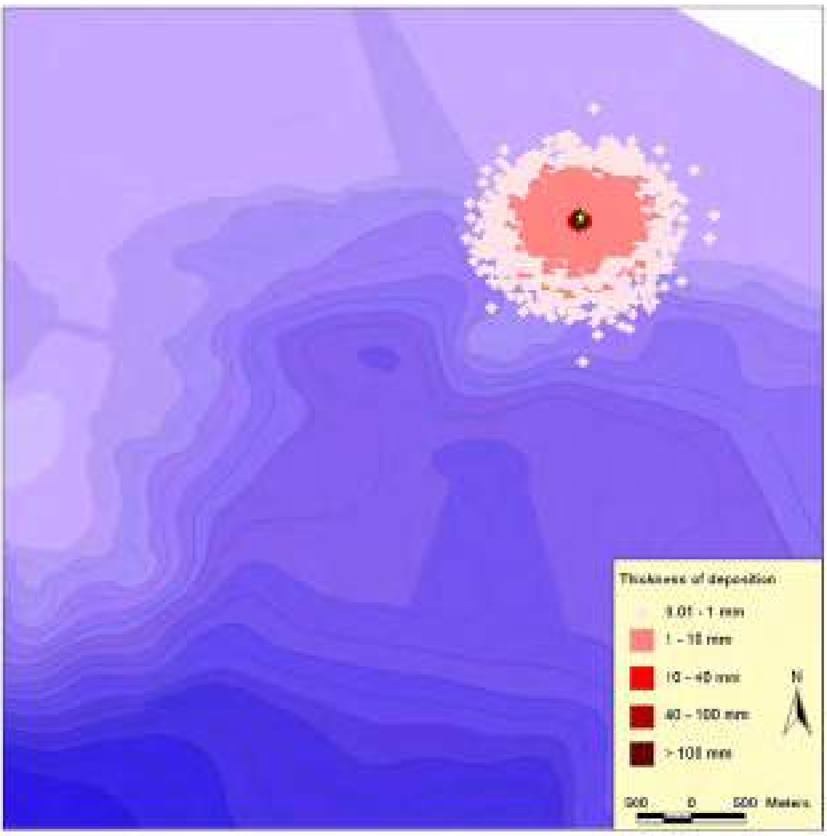


Figure 8.9: Deposition pattern for the discharge of mud and drill cuttings at the East PDUQ location during the winter under average current conditions.

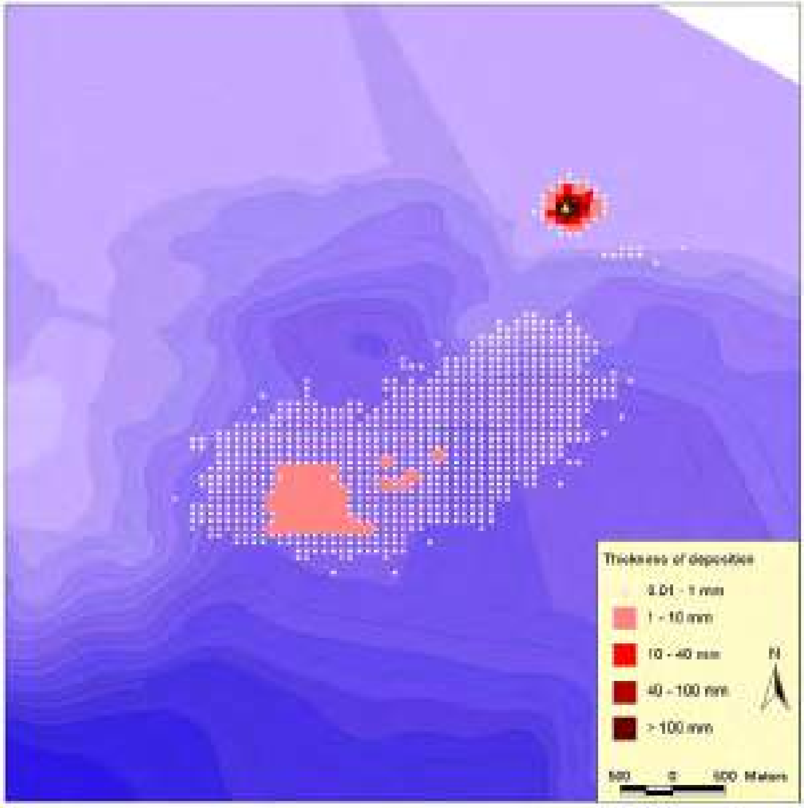


Figure 8.10: Deposition pattern for the discharge of mud and drill cuttings at the East PDUQ location during the winter under maximum current conditions

Physical Effects of WBM Cuttings on Benthic Fauna

As discussed above there will no toxic effects of any signficance related to the WBM discharge. The impact of localised smothering effects on the benthic fauna associated with settlement of the particles on the seabed, as predicted by the discharge model, will be dependent on the sensitivity and resilience of the benthic community. The macrofaunal communities present in the vicinity of the two platform locations consist of a combination of actively motile species, such as the amphipod and cumacean crustaceans, less mobile but otherwise unattached species such as polychaete and oligochaete worms and sessile epifauna such as bivalve molluscs, for example *Dreissena*. Given these different ecological strategies, their collective response to smothering by discharged cuttings will vary. Species attached to hard substrate, such as *Dreissena* will not be able to respond in the same way as other more mobile species.

Although results from the North Sea indicate that areas that are covered with more than 0.01 mm sediment show temporary changes in benthic communities (Statoil 1994), in general, alterations in benthic communities are confined to areas in the immediate vicinity of the discharge site. In the ACG contract area where WBMs have been utilised (Appraisal well 1, GCA 3 and GCA 4), the zone of detectable impact on the benthic fauna has been suggested to be no more than 50 to 100m (URS, 2001). In the UK sector of the North Sea, monitoring results from wells drilled with WBM only indicated infaunal effects within a radius of 200 m from the well. Recovery of benthic communities where WBM have been used normally occurs within one year in the North Sea (OLF, 1993).

Consequently it is considered unlikely that a significant degradation in the macrobenthic faunal community will occur as a consequence of smothering of the seabed except within a distance of approximately 200 m from the well site as indicated by the modelling results.

Although sustained recovery of the macrobenthic fauna is unlikely until cessation of the main drilling activity, which is anticipated to last approximately 7/8 years, the area of seabed that will be impacted will be minor in comparison with the overall area of the similar water depths and habitats in the South Caspian Basin. The baseline information (**Chapter 6**) indicates that the benthic communities found at the East and West Azeri locations are widespread and typical of those that would be expected in similar habitats.

Effects on Fish

The Phase 2 locations are at a water depth of around 150m. Consequently demersal fish such as sturgeon will have minimal contact with the cuttings piles being primarily feeders in shallower water (typically less than 50m). Other than deep water gobies, no other fish are likely to routinely be in contact with the seabed at these depths and hence cuttings depositions and WBM discharges do not represent a significant impact on this component of the fauna.

Conclusion

Table 8.10 summarises the fate and effect of the components of the WBM system. In conclusion, the impacts of the discharges of WBM cuttings will be confined to a limited area around the East and West Azeri platforms, which will be caused by physical smothering of benthic communities that are widespread in the area rather than any toxicity to marine organisms. Recolonisation and recovery of impacted areas would be expected after cessation of drilling, although differences in particle size distribution may result in differences in faunal composition compared to those present before the start of drilling operations. The recovery of the seabed will be monitored during the planned post-drilling benthic survey (see **Chapter 10**).

8.3.3 Intake and Discharge of Cooling Water

Introduction

The potential environmental effects of cooling water uptake and discharge are related to;

- Entrainment of plankton in intake water;
- Discharge of thermal plume with temperature above ambient; and,
- Antifouling additives in the discharged cooling water.

These issues are addressed in the following sections. Discharge modelling has been carried out to ensure that the thermal effluent complies with the International Finance Corporation (IFC) water quality criteria (see below). Maximum volumes of cooling water intake and discharge are anticipated at the CW&P platform with a worst case discharge volume of approximately 10,000 m^3/hour, compared to 1,700 m^3/hour for the East and West Azeri platforms.

Entrainment of Plankton

The intake pipe will have bars that will prevent the ingress of larger fish, which would in any case be expected to avoid the area. The intake depth of the water is at 101 m below the sea surface and therefore well below the productive surface layers of the water column. Mortality will occur of zooplankton, possibly including fish eggs and larvae that are entrained in the intake water. However, the loss of biomass will be negligible when compared to the overall plankton biomass of the Middle Caspian and there will a negligible impact on plankton populations.

Table 8.10: Composition and Environmental Fate of WBM Additives

Chemical	Composition	Fate	Comment
Barite.	Barium sulphate.	Deposit on seabed.	Inert and dense, primary seabed effect will be due to physical smothering.
Bentonite.	Clay.	Eventual deposit, but will remain suspended in water column for some time.	Inert material. May cause limited physical effects (light attenuation, clogging) in main part of plume, but will rapidly disperse to background turbidity levels.
KOH	Potassium hydroxide.	Dissolve in water column.	Inorganic material. Will cause toxicity at high concentrations, but components are not harmful once diluted and will not have persistent or far-field effects.
KCl.	Potassium chloride.	Dissolve in water column.	Inorganic. Components are of negligible toxicity, and significant effects only at very high salt concentrations. No effect outside plume.
Soda ash.	Sodium carbonate.	Dissolve in water column.	Inorganic, dissolves readily and components of negligible toxicity.
Guar gum.	Non-ionic polymer.	Dissolve in water column.	Simple, degradable natural polymer of very low toxicity.
Polypac R Polysal.	Poly anionic cellulose based polymer (PACP). Partially hydrolysed polyacrylamide.	Significant fraction may remain adsorbed to clay.	Adsorptive organic material. Anionic nature can cause some toxicity due to surface interactions. Significant fraction likely to remain associated with settled solids, and adsorption will reduce toxicity. Degradable, with no persistent components.
XCD.	Bio-polymer made from bacteria and long chain PACPs	Dissolve in water column.	Simple, degradable natural polymer of very low toxicity.
Glydrill.	Alkyl glycol.	Dissolve in water column.	Simple, degradable organic material of low to moderate acute toxicity. No persistent effects outside plume.

Thermal Discharge Modelling

Introduction

As the issue of thermal effluent discharge has been shown to be an issue of stakeholder concern thermal dispersion simulations have been carried. The results are summarised in this section.

The dispersion simulations were conducted for the release of cooling water at the East Azeri, West Azeri, CWP and PDQ locations using the Visual Plumes near field dispersion modelling system. Visual Plumes is a mixing zone modelling application developed by the United States Environmental Protection Agency.

Scenario Specification

Thermal dispersion simulations were conducted at all locations under stagnant conditions during the summer and winter seasons. These conditions were chosen in order to determine the worst-case dispersion of the thermal effluent relative to the water quality criteria for cooling water effluent specified by the International Finance Corporation Environmental Health and Safety Guidelines, **Table 8.11** lists the thermal effluent release parameters. Due to the depth of the water column, in excess of 150 m, and the stagnant flow condition to be used in the simulations it was possible to combine the East Azeri, West Azeri and PDQ simulations into one hereafter referred to as Azeri.

Table 8.11: Thermal Effluent Release Parameters

	East Azeri	**West Azeri**	**CWP**	**PDQ**
Longitude	51° 27’ 6”	51° 18’ 32”	51° 21’ 40”	51° 21’ 40”
Latitude	40° 01’ 11”	40° 03’ 20”	40° 01’ 53”	40° 01’ 53”
Intake Depth (m)	101	101	101	74
Discharge Depth (m)	67	67	40	67
Caisson Diameter (mm)	800	800	1500	800
Discharge Rate (m^3/hr)	1700	1700	10161	1700
Discharge Temperature (°C)	25	25	25	25

The vertical structure of temperature for each season was developed from data provided during the Phase 1 ESIA (URS, 2002), and characteristic temperature profiles of the entire southern Caspian Sea as presented in Kosarev (1994). The summer season is characterised as having two dominant thermal layers with surface and bottom temperatures of approximately 25°C and 7°C, respectively, with the major thermocline at approximately 40m depth. The winter season is characterised as being thermally well mixed with surface to bottom gradients no greater than 1°C.

Simulation Results

The results of the thermal discharge simulations are presented below in **Figure 8.11** and **Figure 8.12**. The water quality criteria for the cooling water effluent, as listed in the International Finance Corporation (IFC) Environmental, Health and Safety Guidelines, states that “the resulting temperature increases should be no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge”. Since no mixing zone is specified for the study region 100 meters will be used as the distance threshold.

The output from the model indicated that at no time was the water quality standard violated. The temperatures presented in the figures are at the centre of the plume. Temperatures away from the centre of the plume will be much cooler. An important feature to note in the results below is the downward travel of the plume, this is due to the discharge being directed straight down. This configuration will cause the plume pass through two primary phases balancing the momentum of the jet against the buoyancy of the plume. The first phase will be downward travel due to the momentum effects of the discharge jet being greater than the buoyant forces. Once the energy from the jet has diminished the effects of buoyancy will dominate causing the plume to travel upwards.

Figure 8.11 presents the results of the thermal dispersion simulation at the CWP location during the winter season. The thermal effluent is released at a depth of 40 m and travels downward, due to the momentum of the discharge, to a depth of 60 m. At this depth the plume has cooled to within 3°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend to the surface. As the plume approaches the surface it further cools to within 1°C of the ambient temperature. This entire process takes slightly more than seven minutes to complete with the plume cooling to within 3°C of ambient within two minutes at a depth of 60 m

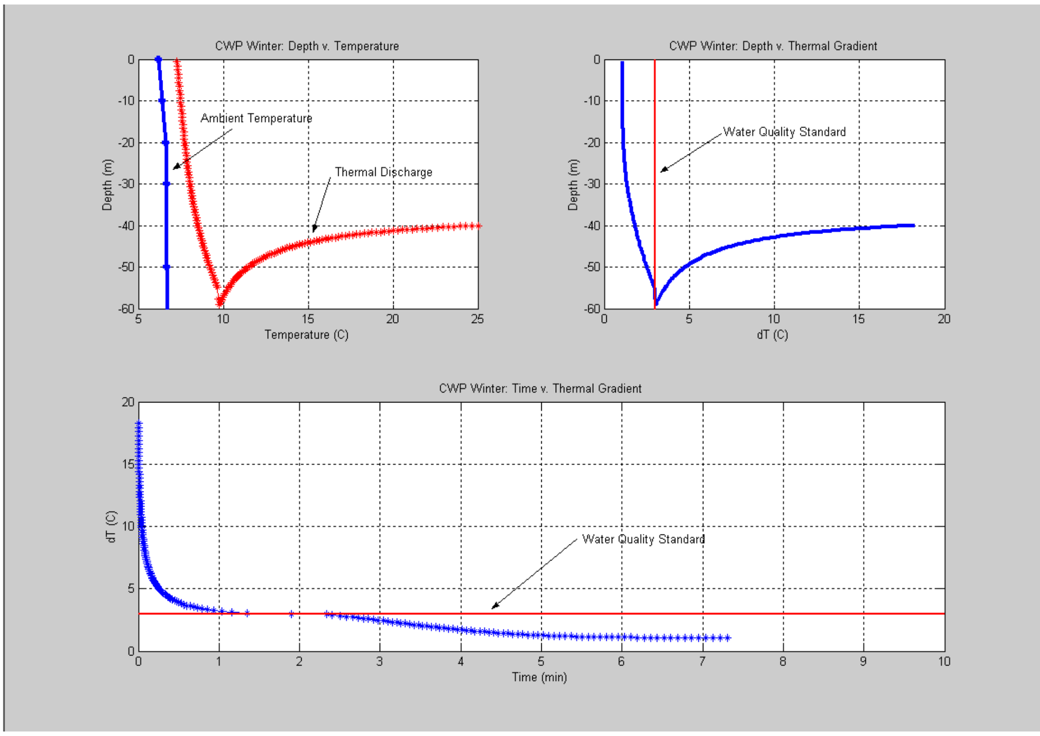


Figure 8.11: **Thermal dispersion results at the CWP location during the winter.**

Figure 8.12 presents the results of the thermal dispersion simulation at the CWP location during the summer season. The thermal effluent is released at a depth of 40 m and travels downward, due to the momentum of the discharge, to a depth of 50 m. At this depth the plume has cooled to within 6°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend towards the surface. However, the presence of the summer thermocline causes the plume to become trapped, where ambient conditions are reached, at a depth of approximately 42 m. This entire process takes slightly more than 1.6 minutes to complete with the plume cooling to with 3°C of ambient within 1.4 minutes at a depth of 48 m.

Although the volumes discharged from the Azeri location are much lower than for the CWP location (see **Table 8.11**) the results show the same pattern with the plume reaching the surface in the winter and being trapped and reaching ambient temperature below the thermocline in the summer.

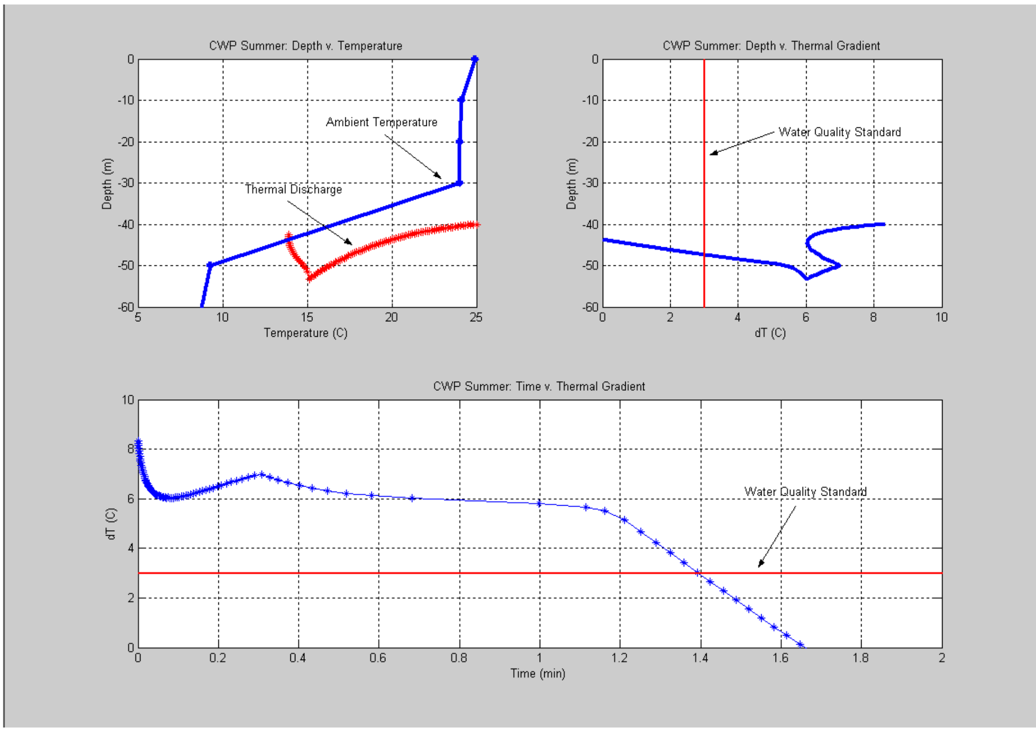


Figure 8.12: Thermal dispersion results at the CWP location during the summer.

Prevention of Biofouling in the Cooling Water System

Prevention of biofouling in the Cooling Water System is achieved by the use of the Biofouling and Corrosion Control (BFCC) System, a patented system that has been in existence since 1987. The system uses chlorine and copper that work synergistically at low concentrations (Knox-Holmes, 1992). The levels of copper and chlorine in the water in the seawater intake caisson will be in the order of 1 ppb and 10 ppb respectively assuming perfect mixing. This indicates the maximum possible levels in the seawater discharge although in practice the levels at discharge will be lower. Even at maximum possible levels copper is below the Maximum Allowable Concentration of 5 ppb (Azerbaijan Standards) and chlorine level can be compared with the maximum level allowed in sewage discharge in accordance with PSA of 2000 ppb. These low levels in the cooling water discharge that will be further diluted on release to the marine environment are not anticipated to cause any measurable impact on marine organisms.

Conclusion – Impacts of Cooling Water Intake and Discharge

The water intakes for the cooling systems on the CW&P and East and West Azeri platforms are situated at a depth of 101 m below the sea surface, well away from the productive water column surface layers. The mortality of any organisms, which are present in the intake water, will have a negligible impact on populations of planktonic organisms.

The thermal discharge modelling indicates that even at the CWP platform where the largest cooling water discharge occurs the IFC water quality standard is not violated. It is likely that there will be some mortality of planktonic organisms entrapped in the thermal plume. However, exposure times to temperatures greater than 3°C above ambient will be around 2 minutes in winter and less in the summer. The highest temperatures will occur below the discharge depths of 40 m at the CW&P and 67 m at East and West Azeri. These will generally be areas of relatively low plankton abundance as described above, since the highest biomass will be in the photic zone of the upper water layers. In summer it is predicted that the thermal plume will reach ambient temperatures below the thermocline and have no impact on the photic zone. Based on this information the thermal discharge is assessed as having a negligible impact on populations of planktonic communities.

As a result of the technology adopted, the levels of chlorine and copper in the thermal discharge will be low and will in turn be rapidly dispersed and diluted such that there will be a negligible impact on marine organisms.

8.3.4 Other Offshore Operational Discharges

Introduction

Other discharges to the offshore environment resulting from ACG Phase 2 operations are;

- Sanitary and domestic waste water; and,
- Produced water during periods of down time for the water reinjection system.

These have been assessed in **Table 8.4** and as part of the ACG Phase 1 ESIA (URS, 2002) and have been categorised as having a low environmental significance. However, these issues have been of concern to stakeholders and are therefore readdressed briefly here.

Sanitary and Domestic Waste

Sewage

It is estimated that approximately 18,250m^3 per year of sewage water (black water) would be generated at and discharged from the each of the East and West Azeri Phase 2 offshore facilities (based on the capacity of the system of 50m^3 per day).

Discharge of sewage effluent can result in localised organic enrichment in the vicinity of the discharge point that in turn, can result in potential oxygen depletion in the discharge plume resulting in some minor disturbance to the marine ecosystem close to the point of discharge.

Sewage discharges from the PDUQ would be from a US Coast Guard Marine Sanitation Device (MSD) or certified equivalent. Residual chlorine content in discharges would be of less than 1.0 mg/l. All vessels used for installation and commissioning and for supply and support would be required to comply with MARPOL, which stipulates no discharges of sewage waters in nearshore waters and treatment of sewage waters in a marine sanitation unit prior to discharge offshore.

It is expected that the anaerobic digestion of the effluent carried out on the offshore facility marine sanitation units would rapidly reduce the Biochemical Oxygen Demand (BOD) at and near to the sewage discharge point to levels that are insignificant. Water currents would also assist the dilution and dispersion of discharged material and would eventually restore oxygen and nutrient levels to background conditions. Impacts on marine water quality and marine organisms are therefore, considered to be of low significance.

Food wastes

Food waste would be generated on board all operational vessels and offshore facilities. Such wastes would be macerated and discharged directly to the water column. Large-scale discharges of organic material can result in increased biological productivity in the vicinity of the discharge point with a resultant reduction in dissolved oxygen in the receiving waters. Given the limited number of personnel that would be onboard offshore installations (i.e. normally 180 on each PDUQ) combined with the anticipated level of dispersion and mixing of wastes in the water column, it is considered that impacts on marine water quality from the discharge of galley wastes would be negligible.

Produced Water

The base case design for the Phase 2 development includes no overboard discharge of offshore produced water under normal operating conditions. All generated offshore produced water would be co-mingled with treated seawater and re-injected for reservoir pressure maintenance. There remains the possibility however, that if the water injection facilities are taken off-line for maintenance or if they fail, then treated produced water would need to be disposed of to sea.

Produced water consists of formation water from the reservoir as well as other components as a result of contact with the produced hydrocarbons and the offshore production process. The composition of produced water varies between wells and the mixture of chemicals is always complex. Typically, produced water contains dispersed and dissolved hydrocarbons, trace metals, dissolved inorganic salts and organic components such as fatty acids. In addition, some proportion of the process chemicals used in the production process such as corrosion inhibitor, scale inhibitor, demulsifier and methanol may also remain in the water phase.

The produced water treatment package on the PDQ has been designed to comply with the IFC Environmental, Health and Safety Guidelines: Oil and Gas Development (Offshore) (IFC, 2000). These Guidelines require oil-in-water concentrations to be a daily maximum of 42 mg/l and a monthly average of 29 mg/l. The PSA requirements are less stringent at 72 mg/l on a daily basis and 48 mg/l as a monthly average.

Figure 8.13 presents the predicted volumes of produced water that would be discharged to the water column over the life of the Phase 2 project assuming the produced water re-injection facilities are unavailable for 5% of the time.

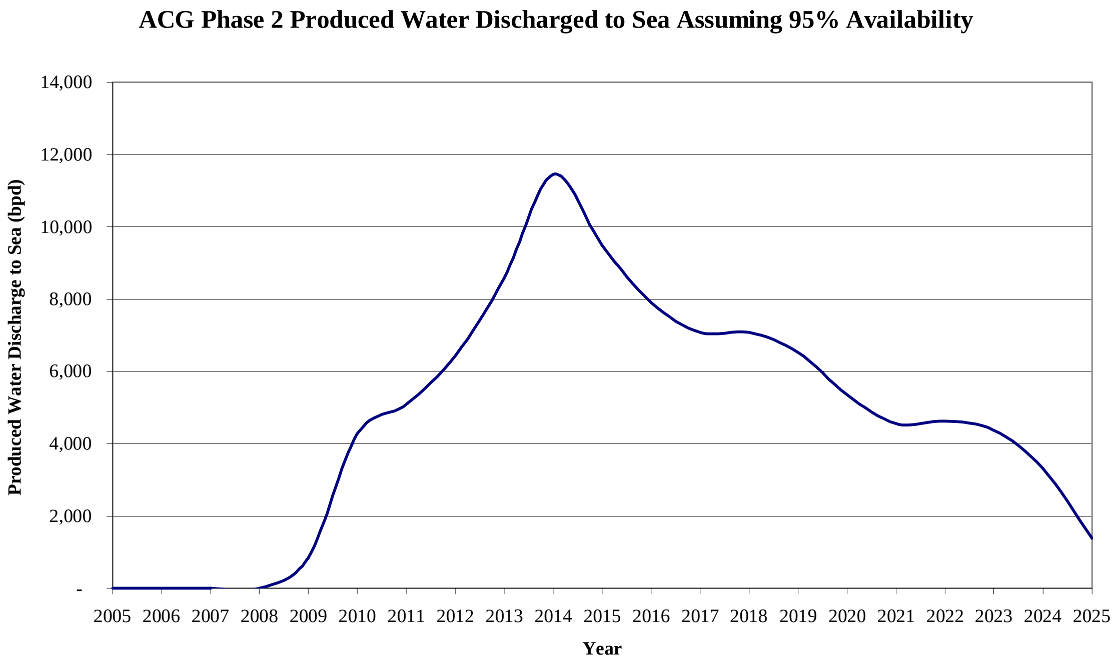


Figure 8.13: ACG Phase 2 predicted volume of produced water discharged to sea assuming injection facilities are available 95% of the time (bpd).

Impact significance

Discharge of offshore produced water to the sea is common practice in international oil and gas operations offshore and is considered Best Available Control Technology

(BACT) for this waste stream in the absence of re-injection facilities.

Studies of produced water discharges have shown that any effects on marine fauna are limited to the immediate vicinity of the discharge point and that dilution of the effluent reduces the concentration of the components present to negligible levels within tens of metres of the discharge point (Somerville *et al*., 1987). A study in the North Sea (Davies *et al*., 1987) found slightly depressed zooplankton populations in the vicinity of a continuous produced water discharge although no direct effects were evident on phytoplankton or on the larvae of the native cod and herring. Planktonic species would however be the most vulnerable to the discharge, as they would come into direct contact with the plume. Any reduction to primary production rates of plankton in the vicinity of the produced water discharges would nevertheless be expected to be insignificant in terms of the overall populations in the area.

As discharges would occur only as a contingency in the event of any down-time on the water injection facilities and treatment prior to discharge would be to standards that exceed the requirements of the PSA resulting in only very low concentrations of oil in the discharge stream, the effects on marine organisms in the mixing zone are expected to be insignificant. Overall, impacts associated with produced water discharges are considered to be of low significance.

8.3.5 Radioactivity

Despite stakeholder concerns, there is no evidence that AIOC operations have increased the level of exposure to radioactivity for flora, fauna or humans either offshore or onshore. As part of the EOP regular measurements are made of radioactivity in produced sand and the crude oil stream from the Chirag-1 Platform. No raised levels of radioactivity have been found. It is anticipated that similar measurements will also be taken as part of ACG Phase 1 and 2 operations.

8.3.6 Issues Under Evaluation

In **Table 8.4** a number of issues have been identified where the options for disposal are still under evaluation. AIOC have commissioned a number of studies and reports to enable the best possible solutions from an environmental, technical and economic point of view to be selected. **Table 8.12** summarises the ongoing initiatives. Once final solutions have been selected for these issues, the environmental implications will be the subject for separate assessments and appropriate documentation will be provided to the MENR and other stakeholders as applicable.

Table 8.12: Issues under Evaluation with Associated Options

Issue	Options being evaluated
Hydrotest of Phase 2 Pipeline: disposal of 500,000 bbls of hydrotest saline water containing biocide and oxygen scavenger	• Disposal to a dedicated injection well at the Lokbatan onshore oilfield; • Transfer to the Garadagh Cement Plant north of the terminal site for use in the cement manufacture process (limited volumes only); • Treatment and use as irrigation water; • Treatment and disposal to the marine environment at a suitable distance offshore.
Hydrotest of onshore equipment: disposal of up to 800,000 bbls of hydrotest fresh water containing biocide and oxygen scavenger	• Disposal to a dedicated injection well at the Lokbatan onshore oilfield; • Transfer to the Garadagh Cement Plant north of the terminal site for use in the cement manufacture process (limited volumes only); • Storage in an evaporation pond followed by export to the Cement Plant; • Treatment and use as irrigation water; • Treatment and disposal to the marine environment at a suitable distance offshore via a Phase 2 nearshore pipeline section.
Sangachal Terminal produced water storage and disposal. Disposal volumes over the life of ACG may reach 200 million barrels at a maximum rate of 60 mbwpd. (20 mbwpd for Phase 2)	• Disposal to a dedicated injection well at the Lokbatan onshore oilfield; • Transfer to the Garadagh Cement Plant north of the terminal site for use in the cement manufacture process (limited volumes only); • Treatment and use as irrigation water; • Treatment and disposal to the marine environment at a suitable distance offshore.
Disposal of sulphur as a result removal of H_2S from oil at Sangachal Terminal	• Levels of H_2S may be such that there is no need for sulphur disposal. If, however, a disposal requirement is identified then a specific waste management strategy will be developed.

8.4 Further Assessment of Key Issues Related to Accidental Events

8.4.1 Introduction

This section addresses impacts related to the following:

- Hydrocarbon spills in the marine environment resulting from a well blow-out, pipeline rupture or other accidental event (Marine Oil Spill Risk Assessment – **Section 8.4.2**); and,
- Hydrocarbon spills onshore resulting from a pipeline rupture or loss of storage containment (**Section 8.4.3**).

Figure 8.1 gives an overview and shows schematically environmental interactions of the ACG Phase Project in relation to these accidental events as well as for normal operations.

8.4.2 Marine Oil Spill Risk Assessment

Introduction

The Marine Oil Spill Risk Assessment evaluates the likelihood of occurrence of a large scale oil spill event and the environmental consequences should such an event occur. Since there is no specific Caspian documentation of such events it has been necessary to resort to information and case histories from other regions to illustrate important concepts such as:

- The low probability of occurrence for a large scale oil spill resulting from exploration and production activities; and,
- The lack of correlation between the size of the release and the environmental impact - the vulnerability and presence of VEC within an area impacted by a spill are shown to be more important factors.

Oil spill modelling has been carried out to predict the dispersion and fate of oil spills from selected scenarios. The results of the model provide probabilities for oil reaching any particular area and used as input data to the risk assessment.

Assessment of risk

The term “*Risk*” may be defined by the combination of likelihood (probability) for an event to happen, and the consequence (impact category), should the event actually happen. Risks are usually addressed and evaluated in the form of a risk matrix, where likelihood is plotted against impact. In general, events resulting in a low environmental impact may have a relatively high probability, while events resulting in a high environmental impact must have a very low probability for the risk to be deemed acceptable (see **Section 8.2.2**, **Figure 8.2**).

Risk assessments may be qualitative, semi-quantitative or quantitative, depending on the quality of the available data. An oil spill risk assessment will usually be qualitative or semi-quantitative, due to the inherent large variability in the quality of the data required for the analysis.

The main input data required for an oil spill risk assessment are outlined below:

Event probability; which is the probability for an event leading to release of oil to occur. This is established on the basis of historical data, and adjusted based on specific information on the planned activity. Selection and development of technology are factors applied in adjusting event frequencies.

Rate and duration; which is the expected release rate of oil for a given event, as well as the expected duration. With respect to duration, the operator may either select to use the anticipated duration (available from the historical data base), or the time needed to drill a relief well, based on site specific evaluations.

Oil distribution; which is calculated by the use of mathematical models, taking into account the properties of oil and the local climatic and oceanographic conditions. Normally, a number of simulations are carried out, using different wind conditions as input data. The aim of these *stochastic* simulations is to indicate the *probabilities* for any given area of being affected by oil, the *mass of oil* that may reach an area, as well as the *minimum drift time* from start of a release to oil may reach the area.

Resource distribution; as an overlap between a vulnerable resource (or a Valued Ecosystem Component – VEC) is a prerequisite for an impact to occur. As biological resources and VECs are characterised by a patchy distribution and large variations in time (temporal) and in space (spatial), such information is essential.

Overlap/exposure; which takes into account the geographical overlap (e.g. fraction of a population), the degree of exposure (e.g. hydrocarbon concentrations), and, where applicable, the duration of exposure.

Vulnerability; where the vulnerability for the individual VEC is included in the assessment. While some species may be only lightly affected by exposure to oil, other may be significantly affected by only small amounts.

Fate of Oil Spills

When oil is released to the sea, the oil spreads on the water surface due to gravity. The speed of the spreading may vary widely and depends mainly on the physical properties of the oil under the given hydrometeorological conditions. Depending on the amount of oil, this process may continue for several minutes, several hours or even days in the case of especially large-scale spills. Subsequent spreading of oil on the surface may be attributed to the effects of surface tension and turbulent diffusion, or more specifically the turbulent character of the tangential tensions on the oil-water and oil-air boundaries. Deformation and transport of the surface tension field is determined by the combined action of the wind and mesoscale currents in the area of the oil slick.

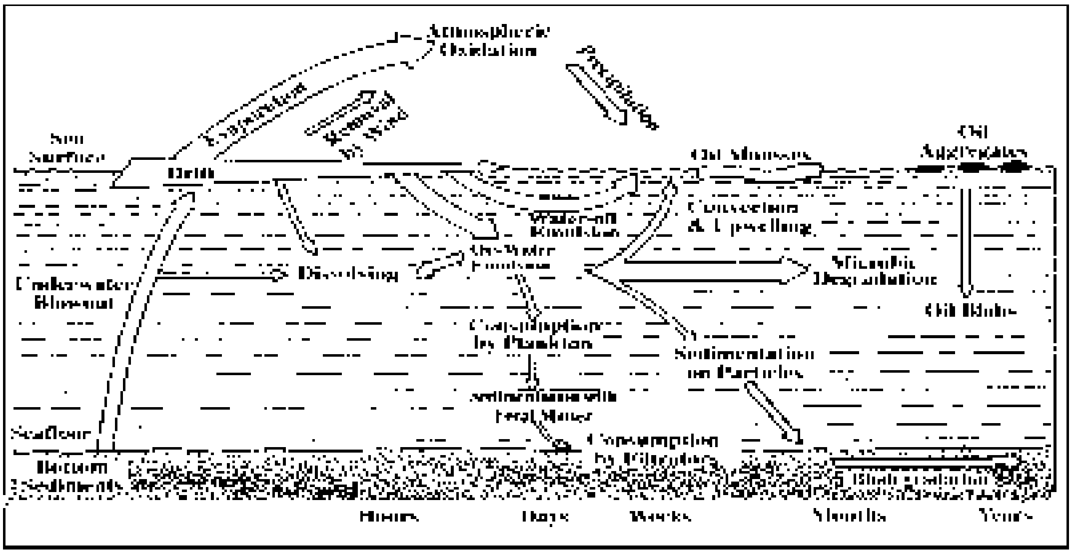
The characteristics and behaviour of oil change as a result of physical factors as well as the inherent properties of the oil. The most important changes from an environmental point of view include:

Evaporation; where the “lightest” hydrocarbon fraction evaporates first. As these also are the most toxic, the toxicity of the remaining fraction decreases. In addition, the total oil mass decreases, and the viscosity of the remaining oil increases.

Dispersion; where wind and waves result in a mixing of oil droplets in the water. This decreases the mass of oil on the sea surface, but results on the other hand in an increased potential for dissolution of toxic hydrocarbons in the water.

Emulsification; where the oil absorbs water and form emulsions. This process increases the viscosity of the oil, and also increases the volume by up to fivefold. After emulsification, the oil is more stable, and less amenable to natural and chemical dispersion.

There are also other factors involved, as illustrated in **Figure 8.14** (Patin, 1997) that schematically summarises the behaviour of oil on water.



Source: Patin,S.A., *Environmental Aspects of Offshore Oil and Gas Development,* VNIRO, 350 pp., 1997.

Figure 8.14: Biological and geochemical processes of oil transformation and transportation into the sea

Oil Spills and the Environment

The possible impact of an oil spill is a function of a number of important factors such as;

- The temporal and spatial distribution of the resources "at risk";
- The corresponding distribution of the oil and its derivates; and,
- The biological characteristics of organisms exposed; both regarding their sensitivity to oil pollution (i.e. tolerance) in the short term and the dynamics of the population in the longer term.

The significance of these factors is clearly demonstrated in reviews of historical accidental events (e.g. Teal & Hearth 1984; Spies 1987; Moe *et al*. 1993); each individual spill tends to have its own unique characteristics. Simple correlations between volume of oil and impact significance cannot be made; even small spills can on occasion result in large impacts while only limited damage is reported from some of the largest spills recorded. This is illustrated by the following examples;

- Discharges of a limited amount of crude oil from the tanker *Stylis* in the Skagerrak (between Norway and Denmark) in the winter of 1980-81 caused the heaviest mortality of sea birds in Europe to date. The time of the incident corresponded to the winter aggregation period, and in total 45,000 dead individuals, mainly auks, were observed. The estimated bird mortality was above 100,000 individuals;
- The grounding of the *Braer* in January 1993 on the coast of the Shetland Isles resulted in an oil spill with an unusual and initially unexpected outcome (The Scottish Office 1993). Although 85,000 tones of crude oil were released into the sea, the environmental impact appears to have been relatively limited. The combination of a light crude oil together with the high wind and wave energy conditions that prevailed for the first ten days caused the majority of the oil to be dissipated into the sea rather than be washed up on the shore; and.
- About 72,000 tonnes of oil were released from the *Sea Empress* at the entrance to

Milford Haven, South Wales in February 1996. Except for some local, heavily affected shoreline communities, no large-scale mortalities of commercial finfish, crustaceans or molluscs were observed (Edwards & White 1997). About 7,000 dead seabirds were recorded, in addition to an unknown number dying at sea. The area is considered one of the most important UK locations for birds. However, many of the migrants had not returned to their nests at the time of the spill and so a major environmental impact was avoided.

A qualitative risk assessment of the effects of an accidental oil release in connection with the ACG Phase 2 Project has been performed, and the input data and results are presented in the following sections.

Historical Data on Exploration and Production Oil Spills

Well Control and Blowout Events

It is understood that uncontrolled influx of formation fluids into a well (kicks and blowouts) is a potential drilling hazard that may cause pollution if not managed through the design of the drilling programme and competent drilling operation practices. Continental shelf exploration and production account for only a small percentage of the total amount of oil entering the sea, even in areas such as the North Sea, the Arabian Gulf, and the Gulf of Mexico where there is extensive offshore exploration and production drilling. According to official statistics, loss of oil during drilling operations is no greater than 10^{-4} to 10^{-5} percent (0.0001% to 0.00001%) of the total volume of oil produced in continental shelf areas (Gachter, 1997).

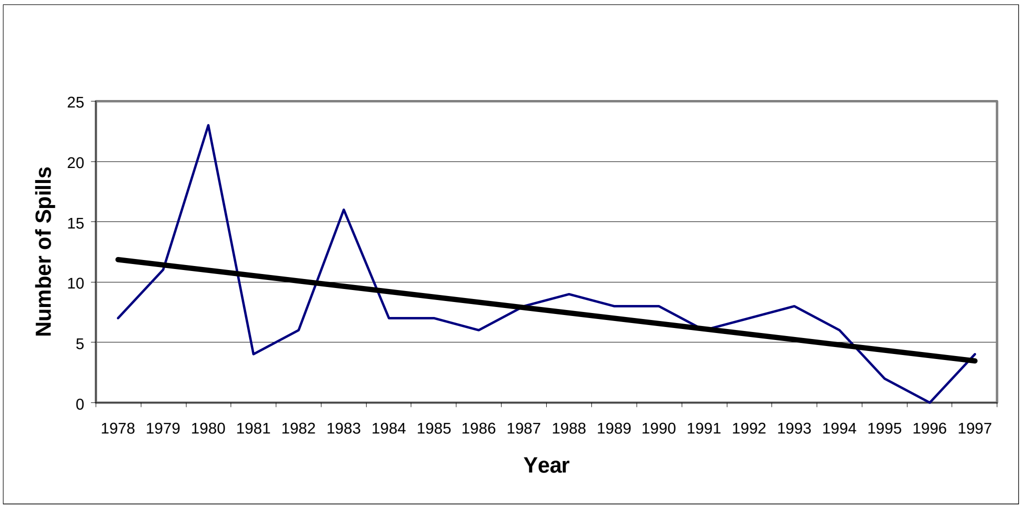
According to Government statistics on the US offshore oil and gas industry from 1971 through to 1995, there were 24237 wells drilled (exploration and production) and 151 blowout events were registered with a total (cumulative) environmental release volume of 140 tonnes (Gachter, 1997). Of these 151 blowout events, 49 were from exploration drilling and accounted for 100 of the 140 tonnes of oil released into the environment (Gachter, 1997). Production from these wells exceeded 1.2 billion tonnes.

Spills from Rigs, Platforms and Production Wells

From 1978 through 1997 there were a total of 153 spills in excess of 10,000 gallons (34 tonnes) from rigs, platforms and production wells worldwide (Etkin, 1998). **Figure 8.15** shows the historical trend in the frequency of these types of spills. The data includes spills from all causes related to exploration and production including blowouts, equipment malfunction and oil/fuel transfers and indicates improved performance over time.

Out of the 65 largest spills (i.e. greater than 3400 tonnes) only five are attributable to oil exploration and production activities (Etkin, 1997). **Table 8.13** lists the five spills and their corresponding volumes released (ranked in order of volume spilled).

One of the most recent events is the sinking of the P-36 rig offshore Brazil on March 20th, 2001. 80,000 gallons of heavy oil was released during this incident.



Source: Etkin, D.S., *International Oil Spill Statistics: 1997*, Cutter Information Corp., 1998

Figure 8.15: Spills greater than 34 tonnes from rigs, platforms, and production wells worldwide (1978-1997)

Spills from Pipelines

Spills from pipelines are dependent on a range of different factors, including pipeline volume, hydrocarbon type, pipeline slope and pipeline monitoring and shutdown systems.

The most recent major pipeline spill occurred in January 2000, when 2 600 tonnes of petroleum product was released to Guanabara Bay in Rio de Janeiro, Brazil.

Table 8.13: Rank order of Exploration and Production Related Spills Greater than 3400 tonnes (1978-1997)

Rank Order (of 65 largest oil spills world-wide)	Oil Spilled (tonnes)	Description of Spill	Date of Spill
2	486000	Exploratory well Ixtoc; Gulf of Mexico	March 1979
3	300000	Oil well Uzbekistan; Fergana Valley	March 1992
4	272000	Platform No. 3 well (Nowruz); Iran, Persian Gulf	February 1983
9	143000	Production well; Tripoli, Libya	August 1980
62	34000	Production well; Abkatun; Gulf of Mexico	October 1986
Source: Etkin, D.S., *International Oil Spill Statistics: 1997*, Cutter Information Corp., 1998.			

Event frequency – ACG Phase 2

There are no consistent or comprehensive data sets on accidents or events leading to release of oil to the Caspian. Within the Azerbaijani sector of the Caspian, there are a significant number of existing production installations (see **Figure 8.6**) and the contribution of Phase 2 activities to the overall risk for accidental pollution should be seen in the light of this.

The probability (frequency) for offshore blowouts and major pipeline spills were addressed in the ACG Phase 1 report (URS, 2002). As the technology applied is similar for the two phases of the project, these data are considered applicable also for ACG Phase 2. Adjusted for the number of wells, to be drilled, the annual probability for an offshore blowout and a major pipeline spill, respectively, are:

- Offshore blowout > 300 tonnes: 0.00372 (corresponding to 1 in 100-1000 years or <<1 – Table 7.4)
- Pipeline spills > 300 tonnes: 0.00288 (corresponding to 1 in 100-1000 years or <<1 – Table 7.4)

The higher probability for a blowout compared to ACG Phase 1 reflects the greater number of wells in Phase 2 (96 vs. 48).

With regards to the probability for offshore blowouts, the numbers correspond well with data reported for production areas on the Norwegian continental shelf, as given in Scandpower, 2001.

Oil Spill Modelling

Since each oil spill is unique, the exact prediction of a spill's fate cannot be made in advance due to the impossibility of foreseeing numerous specific parameters that influence the oil movement and thus potential impacts (i.e. volume of oil spilled, the wind speed and direction). However, prediction of the potential development of a spill is possible through the use of computer modelling of specific spill scenarios and hydrometeorological conditions.

For ACG Phase 2, oil spill modelling has been undertaken by BMT, using the OSIS model. This model was selected to allow comparability with the oil spill modelling undertaken in connection with ACG Phase 1 ESIA, where OSIS was also utilised.

The modelling for ACG Phase 1 was made using Iranian crude as the oil type. After discussions with BP (Parviz Salimanov) the modelling for Phase 2 was carried out using the characteristics of Chirag crude. Reliable data on Azeri crude was not available at the time.

An extract from the results of the oil spill modelling are given in this oil spill risk assessment. See BMT, 2002 for the complete oil spill modelling report.

In should be noted that the modelling was carried out without taking into consideration any effect of oil spill response on the oil dispersion.

Model Scenarios

A total of nine different events were identified as the basis for oil spill modelling. The first three scenarios were modelled to identify whether transboundary impacts could be an issue, and if so, what the minimum drift time would be to the nearest landfall in Azerbaijan, Turkmenistan and Iran respectively. These are all deterministic scenarios, i.e. with a constant wind speed and direction throughout the simulation period. The spill location for the Azerbaijan and Iranian modelling was taken as the West Azeri platform location and for Turkmenistan the East Azeri platform. These were chosen as being the platforms closest to the countries in question.

To give a basis for assessing the risk from an offshore blowout, stochastic oil spill modelling was carried out for a blowout during summer and winter conditions, respectively. A release rate of 198.7 m^3/hour, and duration of 42 days was used as input to the modelling. For the stochastic modelling of the blowout scenarios a location equidistant between the East and West Azeri platform locations was chosen. The distance between the two platforms is approximately 14 km. As oil travels several hundred kilometres during the modelling and the currents are generally low and uniform between the two platforms the results can be assumed to be applicable to a release from either platform.

In addition, oil spill modelling was carried out for a nearshore pipeline rupture and a nearshore pipeline leak, respectively. These were also carried out for a summer and a winter situation. The chosen location was on the pipeline route at a distance of approximately 5 km from the shoreline in Sangachal Bay and a water depth of approximately 12 m. As the pipeline is likely to be trenched out to 3.5 km, the chosen area is one where the pipeline will be laid directly on the seabed and could be vulnerable to damage from, e.g. vessel anchors. However, the probability of this occurrence is low.

A summary of all scenarios modelled is given in **Table 8.14.**

Table 8.14: Summary of Modelled Spill Scenarios

Scenario	**Location (Lat/ Long)**	**Event type**	**Start date**	**Sea Temp (°C)**	**Air Temp (°C)**	**Spill Characteristics**		
						Release Depth (m)	**Release Rate (m^3/hr)**	**Release Duration (hrs)**
1	40°03’20”N 51°18’32”E	Blowout	01\04\02	10	5	0	198.7	1008
2	40°01’11”N 51°28’00”E	Blowout	01\04\02	10	5	0	198.7	1008
3	40°03’20”N 51°18’32”E	Blowout	01\04\02	10	5	0	198.7	1008
4	40°02’15.4”N 51°22’48.9”E	Blowout	01\07\02	25	35	0	198.7	1008
5	40°02’15.4”N 51°22’48.9”E	Blowout	01\01\02	10	5	0	198.7	1008
6	40°8.53’N 49°32.42’E	Nearshore pipeline leak	01\07\02	25	35	0	1	720
7	40°8.53’N 49°32.42’E	Nearshore pipeline leak	01\01\02	10	5	0	1	720
8	40°8.53’N 49°32.42’E	Nearshore pipeline rupture	01\07\02	25	35	0	692	26
9	40°8.53’N 49°32.42’E	Nearshore pipeline rupture	01\01\02	10	5	0	692	26

Model Results

The three deterministic simulations were run under a constant wind speed of 20 m/sec, with a direction towards the parts of the coastline of the three nations Azerbaijan, Iran and Turkmenistan that were closest to the point of discharge. The modelling also took into consideration the effect of wind induced currents.

The minimum drift time (time from the start of the release until the first oil particle reached the coastline) were;

- *Azerbaijan*, 28 hours for oil reaching the tip of the Absheron peninsula;
- *Turkmenistan*, 34 hours to reach the coastline west of the Krasnovodskiy bay; and,
- *Iran*, 96 hours for oil to reach the coast near the mouth of the Sefid Rud river

The areas are indicated in **Figure 8.16**.

Scenario 1 – Azerbaijan   Scenario 2 – Turkmenistan   Scenario 3 – Iran

Figure 8.16: Areas where the deterministic modelling showed minimum drift time for oil to reach the shore.

The results from the stochastic modelling of an oil drift from an offshore blowout is given in **Figure 8.17.**

In summer, the area of influence (> 5 % probability) does not include the coastline of Azerbaijan. However, the 5 – 10 % probability area includes a section of the Iranian coastline in the vicinity of the Sefid Rud River, and also the Ogurchinsky Island and a section of the coastline southeast of this island in Turkmenistan.

In winter, the area of influence includes the Azerbaijan coastline from Bandovan Cape south to the mouth of the Kura River. In Iran, the area of influence includes a section of coastline to the east of the Sefid River, and also a section in the extreme south of the Caspian, from 51.3 to 52.4 Longitude. In Turkmenistan, the coastline within the influence area is the same as for summer simulations.

The times from the start of the blowout to initial beaching are given in **Table 8.15**. Locations of the sites for beaching are given in **Figure 8.18**.

Table 8.15: Maximum and Minimum Drift time for Azerbaijan, Turkmenistan and Iran, respectively, from the Stochastic Modelling.

Nation	Summer		Winter	
	Maximum (days)	Minimum (days)	Maximum (days)	Minimum (days)
Azerbaijan	39	17	25	7
Turkmenistan	31	14	16	6
Iran	28	14	42	6

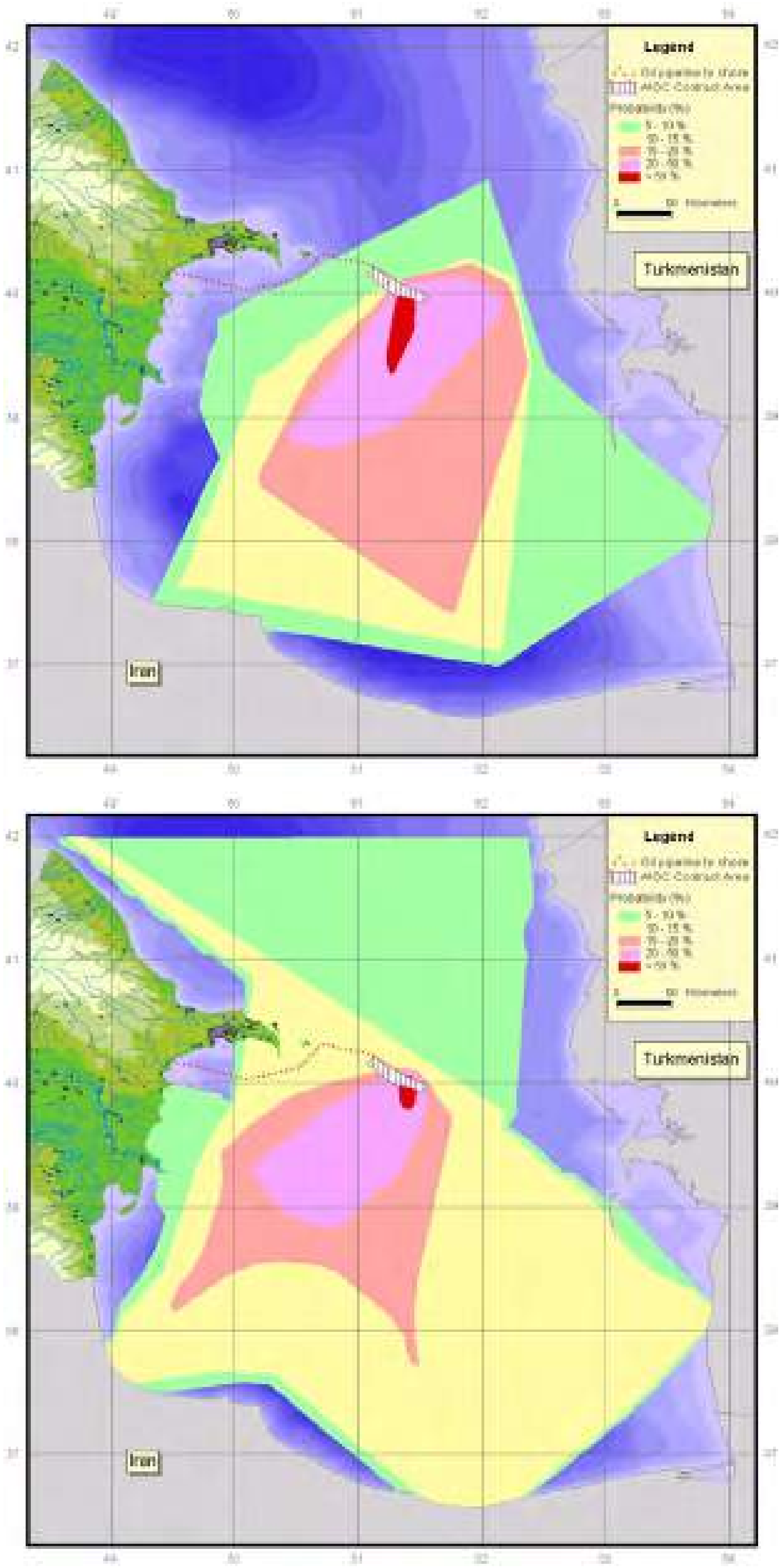


Figure 8.17: Probability of oil on the sea surface from an offshore blowout, in the summer (top) and winter (bottom) season. Only probabilities exceeding 5 % are shown.

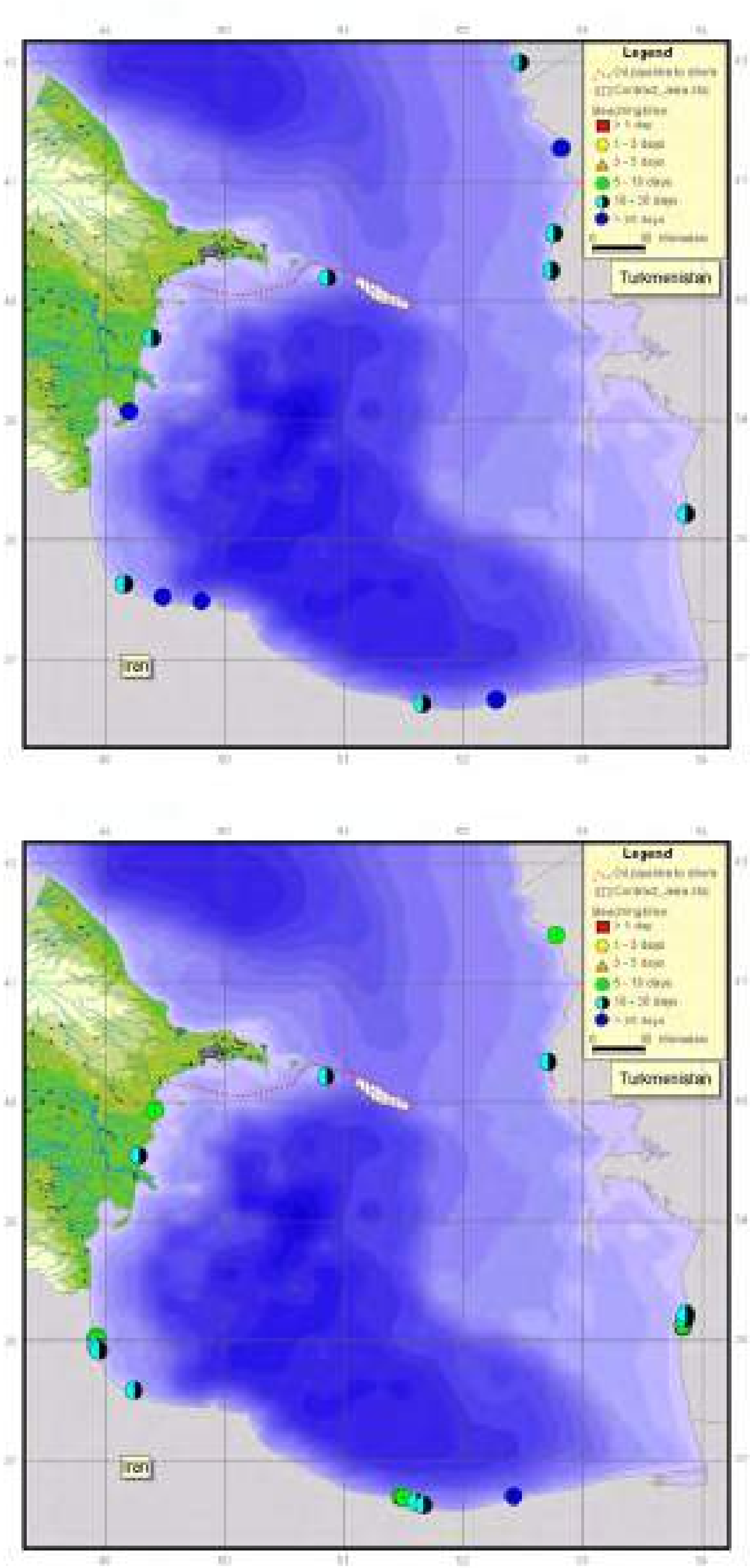


Figure 8.18: Time for initial beaching from an offshore blowout, in the summer (top) and winter (bottom) season. Only sites with probabilities exceeding 5 % are shown.

Results from the stochastic modelling of a nearshore pipeline leak are presented in **Figure 8.19**. In summer, the area of influence extends some 100 km to the east/southeast of the point of discharge. In winter, this area extends further in this same direction. In both summer and winter, the area of highest probability (> 50 %) extends some 3 to 4 km from the point of discharge.

Results from the stochastic modelling of a nearshore pipeline rupture are presented in **Figure 8.20**. The influence area is noticeably smaller than for a pipeline leak, at most extending some 30 km from the point of discharge.

Summary and Discussion of the Model Results

In the unlikely event of an offshore blowout, the area of high probability for oil pollution is restricted to the open sea, towards the South-Southeast. There is however a 5 to 10 % probability of oil reaching the coastline of the Caspian, with the highest probability in the winter season.

In the unlikely event of a pipeline leak or a pipeline rupture, this may occur at any point along the pipeline route. As the major part of the pipeline is located in nearshore waters south of the Absheron peninsula, this is also the area most likely affected by a nearshore pipeline leak or rupture.

In the ACG Phase 1 ESIA, an offshore pipeline rupture was modelled, and the model results were comparable with the results from an offshore blowout.

Combining the event probabilities and the oil spill modelling results, the areas of highest probability for accidental pollution from ACG Phase 2 include the offshore areas of the southern Caspian basin, and also the nearshore waters of Azerbaijan south to the mouth of the Kura River.

With regards to the potential for accidental events to impact the coastline of other Caspian nations, this is a matter of notification according to international agreements. See also **Chapter 11** (Transboundary Impacts).

It should be noted that the modelling results are conservative in as much as that do not take into account any effects of the implementation of the Oil Spill Response Plan.

A number of different models have been applied in various studies and assessments carried out for Azerbaijani offshore operations (e.g. OSIS, OILMAP and the Norwegian DNV model). The characteristics of these models differ such that results obtained are not immediately comparable. While use of the OSIS model enables comparison between the Phase 1 and Phase 2 ESIAs, there are issues related to the amounts of beached oil predicted by the model. This particular data has therefore not been included as part of the present assessment. In addition, results from OSIS oil spill modelling carried out for the Faeroe Islands and the Mediterranean (Ceyhan) also indicate that the area of influence is exaggerated, compared to other models. A detailed discussion on this issue is however not within the scope of the ESIA.

It is BP's intention to carry out further oil spill modelling as soon as the weathering characteristics of a fresh sample Azeri crude are available. At this time BP will also assess the suitability of a number of oil spill models and their applicability to BP's requirements.

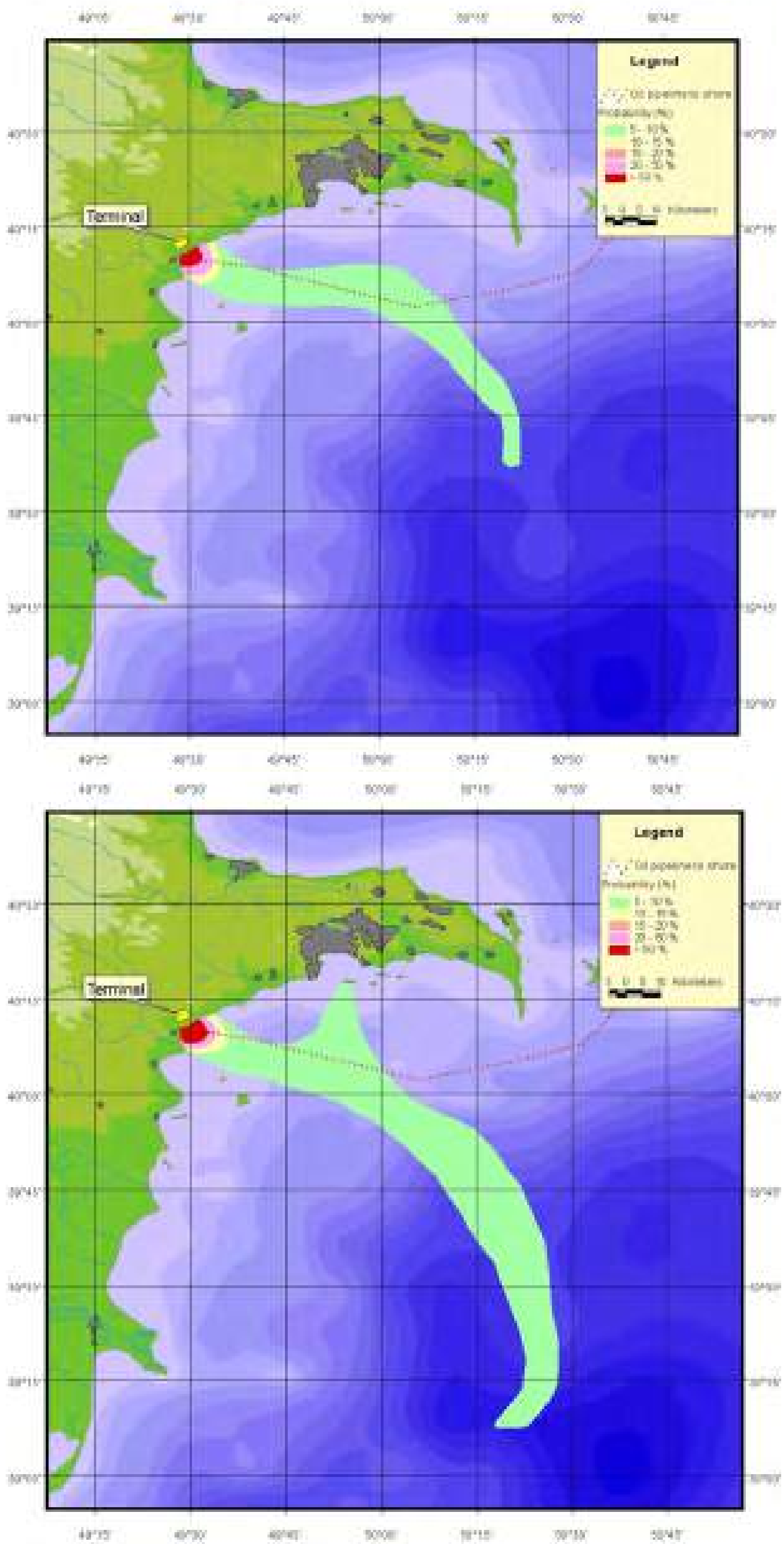


Figure 8.19: Probability of oil on the sea surface from a nearshore pipeline leak, in the summer (top) and winter (bottom) season. Only probabilities exceeding 5 % are shown.

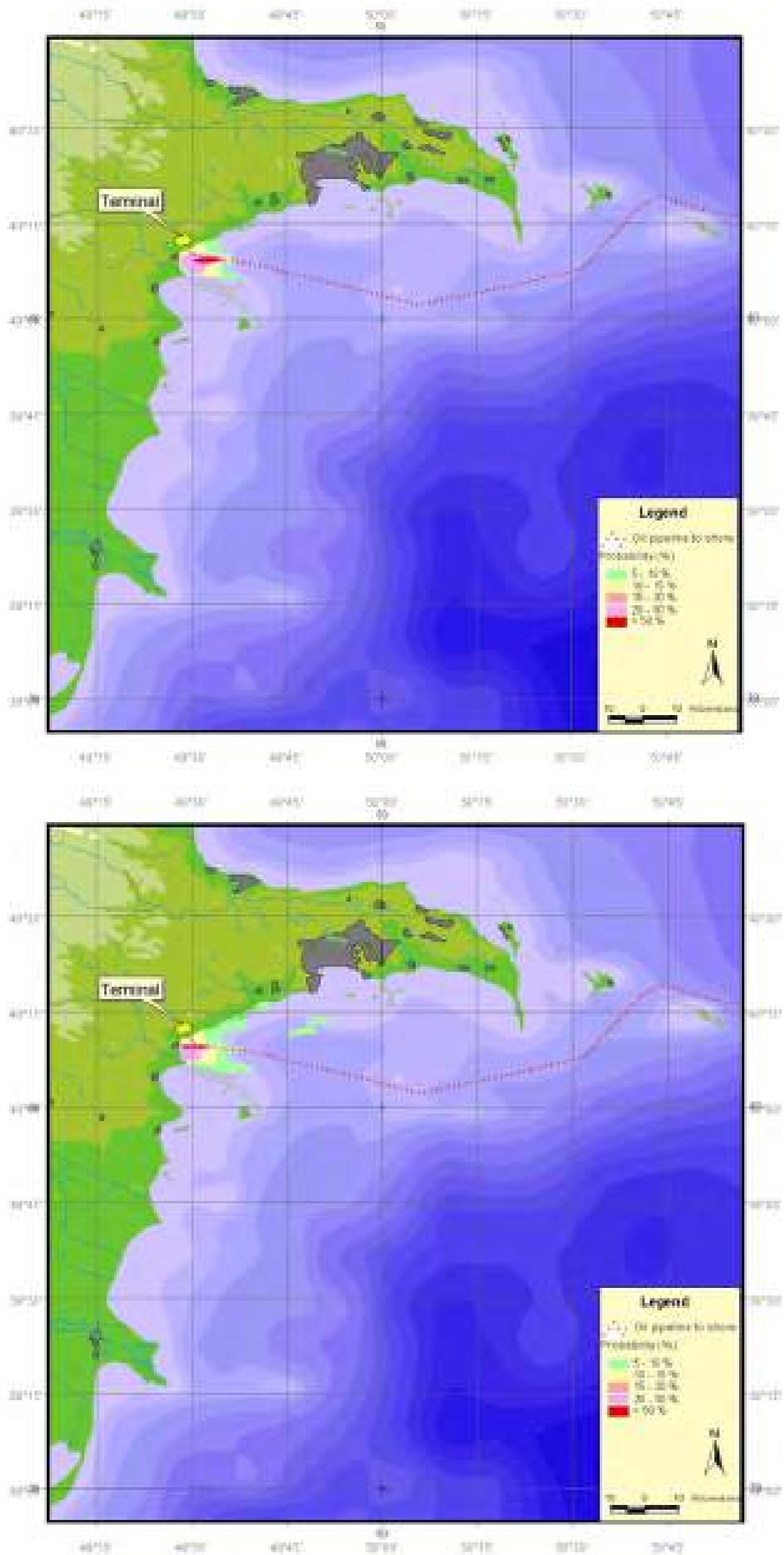


Figure 8.20: Probability of oil on the sea surface from a nearshore pipeline rupture, in the summer (top) and winter (bottom) season. Only probabilities exceeding 5 % are shown.

Potential Environmental Impacts on Caspian Ecosystem Components

In this section, detailed assessments of potential impacts on Caspian ecosystem components (VECs) are presented (see **Section 8.2**). These include;

- Shoreline Habitats;
- Nearshore Habitats and Communities;
- Fish (and Fisheries);
- Plankton communities;
- Benthic Communities;
- Birds; and,
- Caspian seals.

Impacts on Shoreline Habitats

If a situation arises where oil does reach the coast, then the vulnerability to oil spill damage will depend on the type of shoreline and the resources exposed. **Table 8.16** below indicates a classification of shoreline relative vulnerability. The classification in **Table 8.16** takes account of coastal morphology together with sediment grain size and wave energy when determining how oil will behave if it reaches the shoreline. In **Figure 8.21**, a map of the coastal sensitivity of Azerbaijan is presented, based on the classification in **Table 8.16** and the Azerbaijan specific coastal morphological characteristics shown in **Figure 6.4**, **Section 6.2.2**.

Table 8.16: Summary of Proposed Environmental Classification in Order of Increasing Vulnerability to Oil Spill Damage (after Gundlach and Hayes, 1978)

Vulner-ability index	Shoreline Type	Comments
1	Exposed rocky headland	Wave reflection keeps most of the oil offshore.
2	Eroded wave-cut platforms	Wave swept. Most oil removed by natural processes within weeks.
3	Fine-grained sand beaches	Oil with limited penetration into the sediments, facilitating mechanical removal. Otherwise oil may persist for several months.
4	Coarse-grained sand beaches	Oil may sink and/or be buried rapidly making clean up difficult. Under moderate to high energy conditions, oil will be removed naturally within months.
5	Mixed sand and gravel beaches	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years.
6	Gravel beaches	As above.
7	Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for years.
8	Sheltered inundated flats	Areas of great biological activity and low wave activity. Oil may persist for years.
9	Salt marshes	Highly productive aquatic environments. Oil may persist for years.

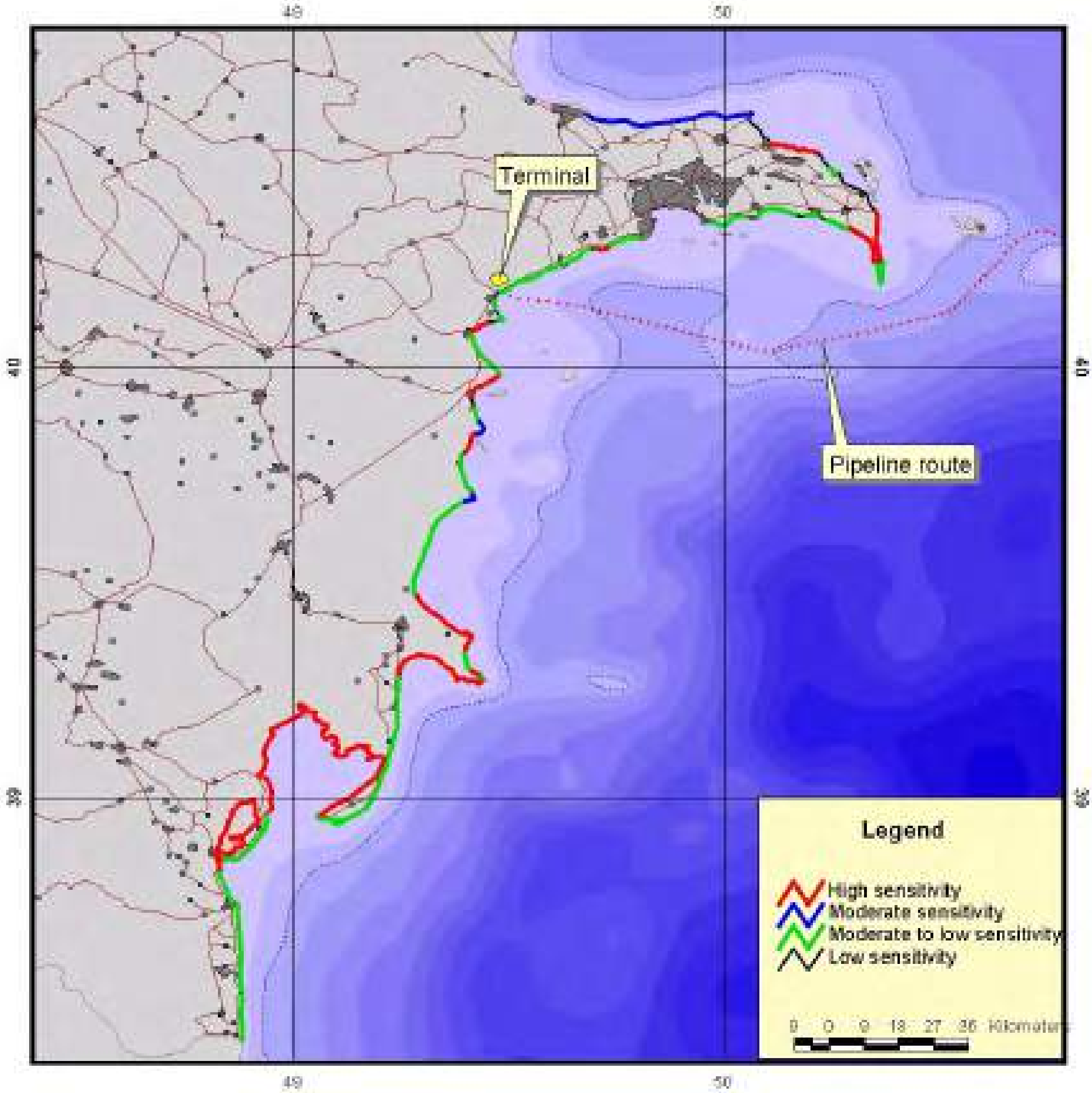


Figure 8.21: Coastal vulnerability (after AIOC, 1997a and subsequent studies, sensitivity adapted from indices shown in Table 8.16).

South of the Azerbaijan border with Iran, the shore is almost entirely a narrow hard, sand beach (Mansoori, 1995) of relatively low vulnerability to oil. There is however a wetland complex associated with the mouth of the Sefid Rud River, which is close to the extreme southern and eastern boundary of the defined area of influence. The Sefid Rud is the second largest river in Iran.

Based on the assessments carried out, the areas of shoreline within the area of influence most vulnerable to oil spills are located in the region of the Kura Delta, and possibly also in the vicinity of the mouth of the Sefid Rud River. Depending on the amount and state of oil (i.e. oil-in-water emulsion, oil aggregates (tar balls)) reaching the shore there is a possibility that oil could persist in these environments for a number of years.

Impacts on Nearshore Habitats and Communities

In general, the vulnerability of the benthic flora and fauna in the nearshore, shallow waters, gradually decreases with depth. Under normal weather conditions, worldwide experience with surface oil spills has shown that shoreline regions are most at risk.

Oil may adhere to particles on the shore, and by vertical transport (sinking and/or mixing by wave action) subsequently contaminate sublittoral sediments. Oil buried in sediments can be a chronic stress factor. If areas with unstable sediments are contaminated, secondary transport may result in contamination of adjacent areas. However, impacts on the nearshore benthos of the Caspian are, generally speaking, likely to be less than in other environments where the tidal rise and fall redistributes the oil. Once the direct physical and toxic effects of the oil are sufficiently reduced, the natural processes of the marine environment ensure that community recovery will occur. This usually takes 1 to 5 years (Baker *et al.*, 1990). However, the duration of the recovery will be influenced by many factors including extent of initial damage, type of oil, and time of year of the spill.

Seagrass beds are a prominent feature of the Caspian nearshore (see **Section 6.4.3**). Incidents in other parts of the world indicate that seagrass beds themselves are relatively robust and tolerate exposure to surface oil slicks, while the association communities are more sensitive. Damage to the seagrass *Zostera marina* was caused by the spill of 230,000 tonnes of light oil from the grounding of the tanker *Amoco Cadiz* in 1978 near the coast of northern France. The effects on the seagrass were only local (Jacobs, 1980) and recovery was rapid. However, the fauna associated with the seagrass was greatly reduced and organisms such as crustaceans and fish larvae are clearly more vulnerable than the plants themselves. Similar impacts are possible in the Caspian.

While mapping of seagrass communities have been made in the nearshore areas of the landfall at Sangachal terminal, there have been no extensive mapping of seagrass distribution in the nearshore waters of the Caspian. However, the nearshore waters of the Azerbaijan coast south of the Absheron are very shallow, the 10 m isobath is located between 6 and 40 km from the shoreline. It is reasonable to assume that seagrass communities are distributed within this area.

Impacts on Fish

The youngest stages of organisms (e.g. the fish eggs and larvae) are generally accepted as being the most susceptible to oil pollution (GESAMP 1993). Later developmental stages, i.e. juvenile and adult fish, tend to be more resistant and less vulnerable. Adult fish are able to detect and may escape from oil contaminated water even at very low oil concentrations (Boehle 1986).

A significant number of fish species have been tested in laboratory toxicity studies, and the results show large variations in sensitivity for different species and types of oil (Malins & Hodgins 1983; Capuzzo 1987). A series of experiments have shown that mortality of eggs and larvae can be caused by oil at concentrations of 30-50 micrograms per litre WSF. Sublethal effects, including depressed metabolic activity are observed at the time of hatching (FOH 1984; Ellingsen *et al*. 1992).

However, because of dilution processes, the water volume with concentrations high enough to cause acute lethal effects would be limited. Significant mortality affecting fish, either as egg and/or larvae at population level is not likely as a result of oil pollution in open water systems. Populations could, however, be adversely effected if elevated oil concentrations occur in areas of concentrated, extensive spawning or high concentrations of larvae.

Eggs and larvae of kilka species (see **Section 6.5.2**) can be found in the open waters of the southern Caspian and some mortality is possible from an oil spill arising in the Contract Area if exposure occurs. However, kilka spawn over a wide area and only a limited proportion of the population would be at risk to exposure to oil at any one time. It can be concluded that no significant impacts on kilka populations would be expected as a result of an accidental oil spill originating from the Contract Area.

Impacts on Plankton communities

A realistic study of the effects of oil on other components of the plankton is extremely difficult since the planktonic ecosystem is generally complex and dynamic with seasonal changes in abundance and species composition. In addition, many of the zooplankton undertake diurnal migration and the plankton in general has an extremely patchy distribution. Actual experience from oil spills has so far shown small or no effects of oil on phytoplankton or zooplankton.

Experimental studies have shown that oil pollution may change the composition of plankton communities directly as a result of the differences in sensitivity to oil of the individual species, or indirectly by effects on groups of particular planktonic organisms, which may subsequently affect other parts of the ecosystem. Some species have shown increased growth when exposed to oil, while other species are able to migrate and avoid contaminated areas (Spies 1987; Skjoldal & Thingstad 1987; Dale 1988; Thingstad 1990).

Significant impacts on plankton communities from an accidental oil spill are not expected, due to the wide distribution of planktonic species compared to the distribution of oil from a spill.

Impact on Benthic Communities

Oil spills in deep water are unlikely to have any immediate effect on benthic communities. Oil will, however, eventually reach the seabed through various processes (see **Figure 8.14**) such as sedimentation on particles or sedimentation of faecal matter from planktonic organisms. Although this oil may be detectable by sampling and analysis of benthic sediments, the concentrations are unlikely to be high enough to cause any significant changes in benthic community structure or on their availability as food to adult bottom feeding fish such as the stellate sturgeon.

Impacts of oil on benthic communities in shallow waters and on communities associated with seagrass beds can be more significant and persistent (see discussion above). This could also impact on juvenile fish populations that are dependent on these communities as a food source. This applies particularly to the shallow areas in the vicinity of the Kura River. These nearshore areas are nursery and feeding areas for sturgeon. Populations of one or other of the sturgeon species are present throughout the year. In addition, this area is a focus for a new initiative to revive the farming and release of juvenile sturgeon to the wild (see **Section 6.4.4**). The Kura River is therefore a particularly important area for fish and their food organisms and should be considered vulnerable to a large scale oil spill. All these issues indicate clearly the benefit of responding to the oil whilst it is offshore in order to reduce the likelihood of coastal contamination.

Fisheries

An accidental oil spill may disrupt fishing activity that is in the near vicinity of a spreading slick and may result in fouling of gear with oil. The only significant offshore fishery at present is the harvesting of kilka using pumps and lights. These boats may have to relocate their fishing activities away from the area if a spill were to occur. These impacts will only be temporary. Fixed installations near the shore may be fouled with oil causing economic consequences for the individuals involved.

Impact on Birds

Each oil spill has its own unique characteristics and the consequences for bird populations are not necessarily related to the size of the spill. Birds’ vulnerability to oiling depends on their feeding and roosting behaviour.

High risk species roost, by day or night depending on species, on the sea surface and feed by diving. They include divers, grebes, cormorants, diving ducks and coot. All these species may form aggregations in any season, but in general divers, grebes and great cormorant are present at low density, whereas pygmy cormorants, diving ducks and coot form large, dense flocks so that a single, small spill has the potential to involve a large number of individuals.

Intermediate risk species roost on the sea surface and feed from the surface or from non-marine habitats. They include swans, geese, dabbling ducks and gulls. Swans may be more vulnerable than dabbling ducks because they are more likely to attempt to swim through oil. Gulls are infrequently oiled when feeding but, like the other species in this group, may be overtaken by oil when roosting on the water at night.

Low risk species include terns, which rarely alight on water, and waders that feed on shore or in the shallow margins to depths of at most about 15 cm. These species will usually see oil and avoid it.

Oiling affects birds in several ways. It reduces plumage insulation and may cause death through hypothermia - the probability of mortality increasing with the extent of the body surface that is contaminated and in colder air and lower sea temperatures. Severe oiling also affects mobility so that birds may be unable to feed efficiently, avoid adverse weather conditions, or escape predators. In attempting to clean their plumage by preening, birds may ingest oil. Birds that survive are likely to lose weight and condition so that they are less well equipped to undertake migration or to breed successfully.

The significance of bird mortality depends on their population status (numbers and population trends) and on their reproductive strategy - species which have high recruitment rates (and are usually short-lived) recover from mortality incidents more quickly than those with low recruitment and high adult longevity. Small-scale mortality may be relatively unimportant to most duck species because they are numerous and have high recruitment rates but the same event could be seriously detrimental to the conservation status of birds whose populations are small, which are declining rapidly due to other factors, or whose recruitment rates are low.

With these factors in mind, some of the seabird populations in the influence area should be considered as highly vulnerable. Aggregated in dense flocks over small areas, even minor oil slicks may affect a large number of birds within relatively short periods. The numbers of birds present on the coast of Azerbaijan from the south side of the Absheron Peninsula south to Kyzyl-Agach may top the million mark in some years. The wetland area in the vicinity of the Sefid Rud River, in Iran, is also an important area. There is clearly the potential for mortalities due to oil spillage during the autumn passage, wintering and spring passage periods which extend from late August to May, with the greatest numbers likely to be present in November to March. If a very large spill occurs during these periods and large quantities of oil reach the coast despite the implementation of the Oil Spill Contingency Plan, impact at the population level is possible. By taking into account the vulnerability of different species groups, the conservation status of the populations in the area and their recovery potential following major mortality, it is possible to derive a ranking of priority for protection (see **Table 8.17**). However, as stated above, each oil spill is unique and assessment during any event will be used to confirm or update the situation as regards resource vulnerability in order to make the best possible response.

As described in **Section 6.3.3**, the coastal zone of the Caspian is one of international ornithological importance. Although the whole coastline can at one time or another have significant bird populations, areas of particular importance within the area of influence are the Kura River delta and the Sefid Rud region. Kyzyl Agach is shown to be outside the area of influence by the oil spill modelling but is still included because of its relative importance (see discussion below).

Table 8.17: The Protection Priority for Various Species Groups

Species group	Vulnerability	Conservation status in area	Potential for recovery	Overall protection priority
Diving ducks	High	High	High	High
Divers	High	Unknown	Low	High
Grebes	High	Unknown	Low	High
Pelicans	Low/moderate	High	Low	High
Pygmy cormorant	High	High	Unknown	High
Great cormorant	Moderate	Moderate	Moderate	Medium
Coot	High	Moderate	High	Medium
Dabbling ducks	Moderate	Moderate	High	Medium
Geese	Low/moderate	High	Moderate	Medium
Swans	Low/moderate	Moderate	Moderate	Medium
Raptors	Low	High	Moderate	Medium
Herons	Low	High	Moderate	Low
Gulls and terns	V. low	High	Moderate	Low
Waders	V. low	Low	Moderate	Low

Impacts on the Caspian Seal

Seals can be affected by a large scale accidental spill of oil in the following ways;

- direct fouling by oil;
- contamination of haul-out sites;
- inhalation of toxic volatile aromatic hydrocarbons;
- ingestion of oil; and,
- indirect effects on prey species or habitat important to these species.

The Caspian seal is already faced with a number of threats in the Caspian. These can be summarised as;

- reduction in the availability of terrestrial haul-out sites due to:

  -a) a general rise in sea level; and

  -b) industrial and urban development on or close to established haul-out sites.
- fishery related interactions; as a direct cause of mortality through net entanglement and indirectly through depletion of food availability;
- the unknown, but cumulative, effects of pollution from industrial and municipal developments which have been discharging effluent into the Caspian. Contaminated water can either have a direct effect on seals or an indirect effect, through ingestion of contaminated prey species or disruption to prey availability due to degradation of habitat essential to prey species.

In the unlikely event of a large oil spill in seals on their summer feeding grounds in the immediate vicinity of the spill location could be at risk because of the presence of hydrocarbons. In this area individual mortalities are possible if extensive contact with unweathered oil occurs. Long term exposure to the most toxic volatile hydrocarbons (which may form up to 20% of the hydrocarbons in crude oil) can have a deleterious effect on seals (Frost *et al.*, 1994), however, the seals in the Caspian will have the ability to avoid the worst areas of contamination in the open sea. Apart from this, the effects of direct fouling with oil on Caspian seals are not thought to be of great significance (see Geraci and St. Aubin, 1990; St. Aubin, 1990 for discussion, Conroy *et al.*, 1997). There may be some irritation of the skin and the mucous membranes of the eyes, nose and mouth (Hall *et al.*, 1996). Very young or weak animals, if very heavily contaminated, may die from exhaustion. The most susceptible category of seal, newly born pups, are least likely to encounter situations where they become fouled as most breeding takes place on ice in the northern Caspian. The small breeding colony off the Turkmenistan coast is also outside the area of influence. Haul-out sites closer to the Contract Area may become contaminated with oil, requiring seals to find temporary alternative sites.

Ingestion of oil by seals could occur, resulting in accumulation of hydrocarbons in fatty tissues such as blubber, brain and liver. In extreme cases acute mortality could occur. However, this is not considered to be a significant factor in the open sea where the seals can avoid any slicks. The cumulative effect of existing pollution loads (Kajiwara *et al*, 2002), canine distemper virus (CDV) and sublethal accumulation of hydrocarbons from oil spills in general, may in the long term increase mortality rates of Caspian seals although the ACG Phase 2 Development adds little, if any, to the existing risk.

The indirect effects of oil discharges on seals are very poorly understood. No effects are predicted on the kilka, which are the most important prey species for the seals. However, the seal population along the coastline is already exposed to the chronic pollution, which is evident along the coast, such that their vulnerability to acute oil pollution incidents may be increased.

Summary of Impacts from an Accidental Oil Spill

The probability of a large scale oil spill occurring in connection with the ACG Phase 2 activities is very low. The oil spill modelling that has been carried for an offshore blowout indicates that, if such a spill were to occur, the coastal area that could be contaminated with oil (the area of influence) stretches from south of Baku to the Kura River delta. The areas of influence also include sections of the Iranian and Turkmenistan coastline.

The time that it would take for the oil to reach the coast is estimated as being from 3 to 17 days.

Spatial Distribution of VEC

Based on the baseline information presented in **Chapter 6** and the impact assessments given in previous sections of this report, the following geographical areas are identified as sensitive:

Shallow water communities along the Azerbaijan coast

- high but patchy distribution of seabirds
- assumed occurrence of seagrass communities
- feeding and nursery areas for juvenile fish
- important fisheries

Kura Delta

- shoreline of high sensitivity
- sturgeon species spawning in the Kura River
- the shallow water areas east of the Kura Delta, contain sturgeon populations throughout the year and are important nursery and feeding grounds for sturgeon and other fish; and
- bird populations along the open coast.

Eastern Absheron Peninsula and islands

- Caspian Seal haul-out sites
- Migrating Waterfowl
- Breeding birds

Kyzyl-Agach Region

- Kyzyl Agach Bay is the most important area for birds in Azerbaijan. Containing species of global importance as well as large numbers of other birds;
- also important feeding and nursery areas for juvenile fish

Sefid Rud River (Iran)

- the shallow sea bay, associated freshwater marshes and the nearby riverine marshes at the mouth of the Sefid Rud River are important as spawning and nursery grounds for fish; and
- the area is also important for breeding, staging and wintering for a wide variety of water fowl.

Seasonal distribution of VECs

As may be seen from **Table 8.18**, the seasonal distribution of VEC varies from component to component. Seals mainly are found in the summer, birds in coastal areas are found throughout the year, with the highest vulnerability in autumn, winter and spring.

Table 8.18: Seasonal Variations in Vulnerability for Key Environmental Resources

Resource	Main Period of Vulnerability	Comments
Nursery areas for fish nearshore	Whole year	Populations of sturgeon present throughout the year
Fishing Activity	Whole year for kilka fishery	Month of May is a close season to allow spawning
Seals	Summer	Main population breeds in northern Caspian in winter
Birds - Offshore	Winter	Small numbers of divers may be present
Birds - Coastal	September-March	Significant bird populations throughout the year
Birds –Kyzyl Agach	Whole year	Significant bird populations throughout the year

Risk Areas and Seasons

Based on the probability for presence of oil from accidental events, the spatial and the temporal distribution of Valued Ecosystem Components, risk areas have been identified as presented in **Figure 8.22**.

Area A is the area in the vicinity of the landfall at Sangachal. The area has a high probability of contamination from a pipeline leak and rupture. The entire area has water depths less than 10 m, and seagrass communities are observed within the area. In addition, seabirds are distributed in these nearshore waters throughout the year. Area A also includes the Pirsagat Islands, which are important for birds.

Area B includes the eastern part of the Absheron peninsula, Shakdilli Spit and islands. This area has a high probability of oil contamination from a pipeline leak or rupture. It also has a high probability of oil from an offshore blowout in the winter season. Caspian seals are frequent in this area in summer. The area also contains shoreline of high sensitivity.

Area C includes the Kura River delta. This area is within the area of influence from an offshore blowout in the winter season. The area is important for fisheries, are nursing grounds for juvenile sturgeons, and also has high densities of seabirds throughout the year. A significant part of the shoreline in this area is of high sensitivity.

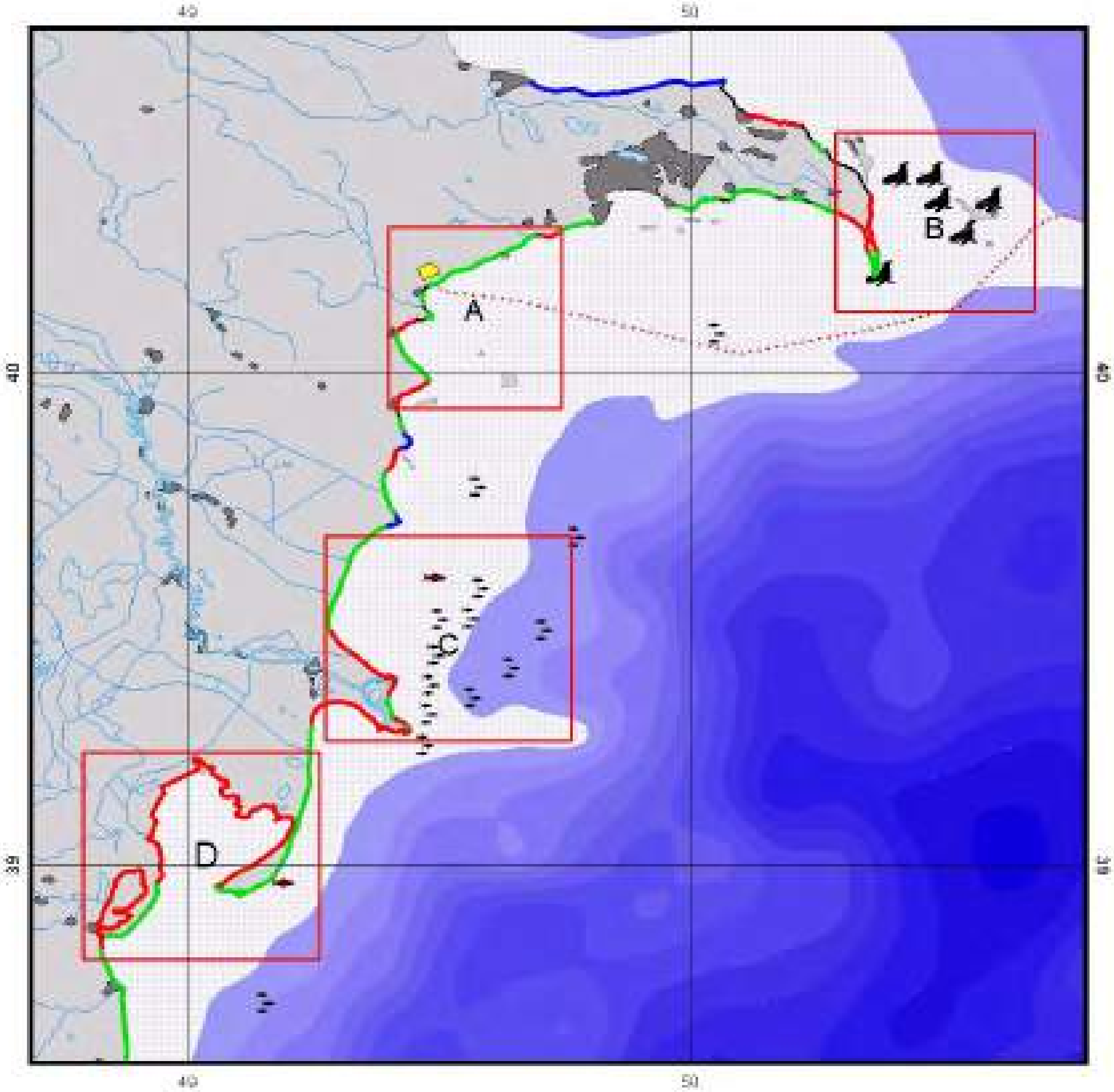


Figure 8.22: Key areas of environmental risk from an accidental oil spill.

Area D includes the Kyzyl-Agach Bay. Although this area is outside the area of influence, it is designated a risk area since it is a Ramsar site, containing bird populations of global significance. This, combined with a high sensitivity shoreline ranks this area as extremely vulnerable.

Risk reducing measures

BP has incorporated many features into the engineering design of the ACG Phase 2

Project to ensure that the risk of accidental oil spills is reduced to a minimum. These include site selection for drilling operations to avoid shallow gas and other hazards and the use of Best Available Technology (BAT) for platforms and pipelines. If despite all these measures a spill should occur, then the risk of impact to VECs (particularly shoreline and coastal) will be reduced by implementation of the Oil Spill Contingency Plan that would have the key aim of protecting sensitive nearshore and shoreline areas.

8.4.3 Hydrocarbon Spills Onshore

General considerations

In the event of an on-shore oil spill, its area of influence would be determined by;

- volume of oil spilled and its exit velocity;
- permeability and porosity of the ground;
- topography of the land; and,
- availability of water to act as a transport mechanism.

The larger the volume of oil that is spilled the greater will be its area of influence. If the spill happens where the oil is under pressure the velocity may cause the oil to travel some tens of metres through the air before landing on the ground. In the vicinity of the terminal site the surface layer is hard, baked and generally impermeable. Soils are not developed and the upper layers consist of bentonite clay, which is underlain by calcareous silty clays to a depth of at least 25m. As a consequence any oil spill will form a pool on the surface and flow in the direction of the slope. The lighter the viscosity of the oil the greater will be the surface area and the rate of volatilisation.

The availability of water to act as a transport mechanism is clearly important. If the oil reaches a watercourse it will flow in the direction of the water, and in the case of the terminal site this is a short distance from the Caspian. Another source of water would be drainage ditches on the terminal site however, given the very low rainfall in this area the probability of there being any water in these ditches is very low. In the unlikely event of such an incident occurring, containment of oil to prevent it reaching the Caspian will be part of the onshore Oil Spill Response Plan.

Spills at the terminal site

Small spills during routine operations are likely to occur. They will happen during maintenance activities, changing valves and at pig traps. These spills will happen where they have been anticipated and in areas where the ground surface has been paved and is impermeable. These spills will go into the sites open drainage system and through the water treatment system to remove hydrocarbons.

If a tank fails, its contents will collect in a bund that surrounds each tank. If pipework fails within the terminal site but out with a paved area the oil will spread on the surface, volumes are likely to be small and its containment straightforward.

As a consequence, any spills within the terminal area are unlikely to affect an area beyond the boundary of the terminal site.

Spills between the landfall and the terminal

A spill between the pipeline landfall and the terminal could result from a failure in the pipeline resulting from corrosion or third-party interference. The volume of the oil spill would depend on the size of hole, the pressure of the pipeline and the duration of the leak before it is detected. The volume of oil likely to be discharged to the environment would depend on the damage scenario, but a typical corrosion leak could produce a spill in the order of 400 tonnes (estimated using BP software). The probability damage to this section of the pipeline is low. The pipeline is buried to a depth of 1 m below the surface and management plans will be in place to avoid damage to existing pipelines when new construction activities take place. Leakages as a result of corrosion will be mitigated by the use of an intelligent pig that will be used on a regular basis to assess the internal condition of the pipeline.

If a pipeline failure as described above should occur it has the potential to contaminate the semi-desert habitats and the limited areas of wetland that are found in the vicinity of the pipeline corridor (see **Figure 6.10**) and possible reach the shoreline and the sea.

Each of the habitats has a different sensitivity to oil pollution. The effect of an oil spill would be greater if it occurred in the wetland areas than if it occurred in the semi-desert environment. Oil can very quickly disperse over the surface of a wetland, covering any fixed surfaces with an oily film. In the semi-desert areas any oil pollution will be rapidly degraded by physicochemical and biological processes. The high summer temperatures of the region will enhance this degradation.

Impacts on Flora

Crude oil has a high smothering effect on vegetation. Oil affects plants in a number of ways, largely through a disruption to cellular biochemistry and physiology, cell membrane damage and cell leaking with accompanying reduced biochemical performance, reduced photosynthesis, increased respiration rates, and reduced translocation of materials due in part to blocked stoma and intercellular spaces. Thinner fractions penetrate the stoma, disrupting cellular activity, while heavier fractions block out the light needed for photosynthesis.

Other effects on vegetation associated with oil pollution include a reduction of the number of seedlings and annual species, varied susceptibilities and recovery rates of perennials, a competitive advantage to some species and growth stimulation possibly associated with the nutrients released as oil degrades (Baker, 1970). The stimulation may also be indirect, resulting from favourable bacteria, changing soil condition or, as suggested by Baker (1971), due to suppression of flowering and seed formation making more nutrients available for shoot and leaf production. Severe oil pollution can completely destroy vegetation, but some plants have been shown to be able to withstand moderate to minor oil coverage causing only temporary effects (Baker 1970, 1971).

In addition there is the possibility that more toxic substances may be produced on release of crude oil to the environment, especially if it has been stored for long periods. Some oils increase in toxicity with storage, due to the formation of acids (Johnson and Hoskins, 1952). For example, naphthalenic acids found in crude oil are known to be toxic to salt marsh grasses (Baker, 1969).

The time of year that the pollution occurs also affects the level of impact. Perennial species are more sensitive in the pre-seeding period as compared to the autumn period of seed maturation.

The level of impact will also depend on the individual species. Some species are more resistant to oil than others. This resistance may be epidermal as seen in Sedum and other xerophytes (Knight *et al*, 1929, Minshall and Helson, 1949) suggesting that some of the xerophytically and halophytically adapted species found on the site may be less impacted in the case of an oil spill.

Impacts on Fauna

Mammals, Reptiles and Amphibians

The main impact upon terrestrial animals will be to those actually engulfed by the spill. Many desert animals rely on burrows and natural cavities for protection from the elements and so there is also potential for animals to be drowned underground in oil, or to become coated in oil as they pass up and down tunnels. Other potential problems lie in the assimilation of the oil into the ecosystem and the resultant effects to biota through biological and chemical pathways.

Birds

Birds may be impacted by a terrestrial oil spill, particularly if they are present in the wetlands areas. Oiling affects birds in several ways. It reduces plumage insulation and may cause death through hypothermia, the probability of mortality increasing with the extent to which the bird is oiled and with cold weather. Severe oiling also affects mobility and such birds may be unable to fly so increasing vulnerability to predation. In attempting to clean their plumage by preening, birds may ingest oil and be affected by toxins. Occasionally, secondary oiling may affect predators feeding on oiled carcasses but is unlikely to result in mortality.

Conclusion

An oil spill between the terminal and the coastline could result in habitat contamination and impacts on flora and fauna. Impacts would be greater in the small wetland areas than in the semi-desert areas. Generally the amount of habitat that could be affected is likely to be limited in extent compared to the overall habitat distribution and in addition any impacts could be mitigated by the rapid implementation of the Oil Spill Response Plan.

9. SOCIO-ECONOMIC IMPACT ASSESSMENT

This Chapter presents the findings of the Socio-Economic Impact Assessment for the ACG Phase 2 Project. The chapter describes the methodology utilised and identifies key areas where both beneficial and negative impacts may occur. For each issue addressed, remaining residual impacts after mitigation are highlighted and these are brought together and summarised in a concluding Table.

9.1 Methodology

The assessment methodology focuses on socio-economic impacts (including health) in terms of their significance to local and regional communities and Azeri society as a whole. It assesses the significance of socio-economic consequences both before and after implementation of mitigation measures.

The methodology used reflects good international practice, as illustrated by guidance issued by agencies such as the World Bank group, adapted to the local Azeri context (see World Bank, 1991 Environmental Assessment Sourcebook, Vols 1-3,Technical Paper 139, Washington DC; World Bank and subsequent EA Sourcebook Updates).

The understanding of impacts to specific stakeholders is based on a range of sources and approaches including;

- Baseline description and trends (**Chapter 7**);
- The Resettlement Action Plan and other reports on specific issues;
- Projections of employment resulting from the project;
- Environmental assessment and modelling;
- Consultation with stakeholders; and,
- Experience from similar projects.

The secondary data has been used to describe the communities affected in terms of population size, location and livelihood. Information from consultations has been used to assess vulnerabilities, expectations and concerns. The key stakeholders include;

- The Baku population (including Sumgait);
- Sahil settlement;
- Sangachal settlement (including a herder population);
- Umid Settlement;
- Commercial fishery operators; and,
- Other businesses operating in the area (such as the Café/Garage).

The assessment focuses on the groups that are most vulnerable and are most at risk from the project. They include groups with lower income levels, those who are unemployed, and people who have a reduced ability to adapt their livelihood as a result of their age, disability, low levels of education, or skills.

For the assessment of socio-economic impacts, the allocation of significance depends on two separate, but linked approaches. First, a predetermined list of criteria is used to determine if a predicted impact is significantly adverse or beneficial. Any impact that meets these criteria is automatically considered to be significantly adverse, and requiring mitigation, unless consultations with stakeholders indicate otherwise,

- Contravention of stated government policies or plans;
- Contravention of government or accepted international environmental standards;
- Breach of a multi-lateral environmental agreement to which the government is a

signatory and which is in force;

- Infrastructure capacity being exceeded;
- Increase in morbidity and/or mortality rates;
- Involuntary resettlement; and,
- Threats to food and water security.

Similarly, significant beneficial impacts are those which result in;

- Creation of more than 150 construction jobs over a 5-year period;
- Creation of more that 50 jobs in the operational phase over a 10-year period;
- Increased training provision; and,
- Local sourcing of goods and services with a value of more than 25% of total spend.

The second approach applies to impacts not included in the above lists. This allocates significance based on the views obtained from consultees, the predicted change from the socio-economic baseline in terms of:

- Extent (area affected);
- Magnitude (number of people affected);
- Probability of occurrence (high, medium, low);
- Duration (time period over which impact occurs); and,
- Reversibility (reinstatement of previous conditions either naturally or through human intervention).

The judgement of the ESIA team members is applied to this information to assign significance.

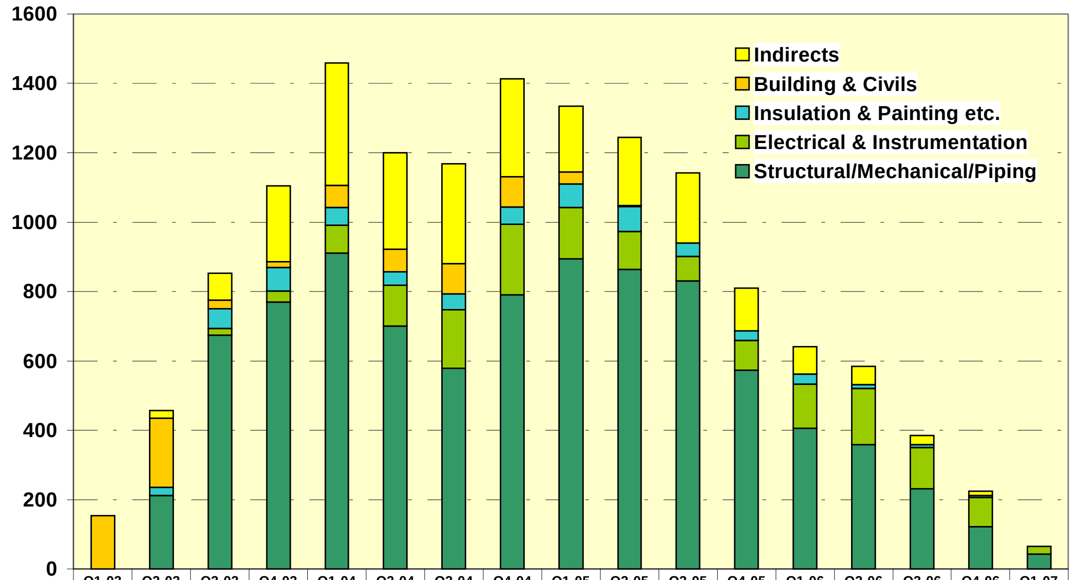
The discussion of impacts is based around a number of key themes that have been identified from the assessment such as employment generation, livelihoods, economic development, social infrastructure and health. First, the sources of impacts from the project and how they affect specific stakeholders are identified and discussed. Secondly, information is presented on how beneficial impacts will be enhanced and significantly adverse impacts mitigated. Finally, those residual impacts that remain following mitigation of significant adverse impacts are discussed at the end of each section. Emphasis is placed on those likely to remain significant. Impacts after enhancement are not presented in this manner, as attention of most stakeholders will be focused on significant adverse impacts and the extent to which they can be avoided and/or reduced to an acceptable level.

9.2 Impacts on Employment Generation

As discussed below the distribution of employment opportunities is a significant positive benefit of the project. These opportunities come with a potential downside: there is a risk of a boom and bust cycle with rapid mobilisation and demobilisation of staff. In addition, local expectation for employment is likely to be greater than the availability of jobs.

During Phase 2, it is estimated that there will be a total of 10,000,000 in-country man-hours required for construction. As illustrated in **Figure 9.1**, construction for Phase 2 will start during the first quarter 2003 and be completed by the first quarter 2007. The number of jobs will reach a peak (the peak is defined as the period when more than 1000 jobs are available) during the period between the fourth quarter 2003 and the third quarter 2005.

Using an average of 1260 jobs during this almost two year period, it is estimated that there will be 76 expatriate managerial workers (6%), 176 foreign skilled workers (14%) and approximately 1,010 (80%) workers sourced from Azerbaijan who will be evenly divided between skilled and unskilled.



	Q1-03	Q2-03	Q3-03	Q4-03	Q1-04	Q2-04	Q3-04	Q4-04	Q1-05	Q2-05	Q3-05	Q4-05	Q1-06	Q2-06	Q3-06	Q4-06	Q1-07
Indirects	0	22	77	218	354	278	287	282	189	196	202	124	78	52	27	12	0
Building & Civils	154	200	25	17	63	64	86	86	35	3	0	0	0	0	0	0	0
Insulation & Painting etc.	0	22	57	68	52	40	46	50	68	71	39	27	29	11	8	6	0
Electrical & Instrumentation	0	0	19	32	80	117	168	203	147	110	71	86	127	162	119	84	22
Structural/Mechanical/Piping	0	213	674	769	911	701	580	791	895	864	830	573	407	359	232	123	44

Figure 9.1: In-country employment from construction of the ACG Phase 2

Note: This data does not include employment from operations

On top of the in-country construction jobs, there will be employment out-of-country. In Phase 1, this included work in Italy, Sweden, Dubai, and France. 17.5 % of the total manpower was required out of country (3.1 million out-of-country man-hours out of a total of 17.7 million). No details of out-of country employment for Phase 2 will be available until contracts are awarded.

During operations, the estimates for Phase 1 included 300 offshore employees and 35 onshore employees. It is estimated that the two Phase 2 platforms will provide 200 jobs/people giving a total of 400 jobs/people. As with Phase 1, it is anticipated that Azeri nationals will occupy 50% of in-country jobs during operations. This will increase to 75% and 95% over five and ten years respectively.

Through the life of the project, the requirement of workers of different trades/skills will vary. **Figure 9.1** also gives an indication of the requirements for different skills required during the full life of the ACG project. The percentage of local content in each of these positions will vary. It should be noted that;

- Most employment is contained within the “structural, mechanical and piping” category and 85% of these positions are expected to be Azeri;
- Given the prior experience and long period for training required, employees in “electrical and instrumentation” category are likely to be foreign skilled employees. However some workers with appropriate skills may exist in Sumgait; and,
- ‘Indirects’: such employees include supervisors, crane operators etc. This

category will include expatriates, foreign skilled workers and Azeri skilled workers.

The injection of additional income into Azerbaijan through the wages of directly employed workers and the purchase of local goods and services will create indirect employment through the multiplier effect[1]. Basically, the amount of money in the economy will increase and it will circulate faster. This creates extra job opportunities in businesses and other organizations within the economy. The extent of the additional jobs and their location depends on many complex factors amongst which the most important are the degree and timing of money leaving the local economy ('leakage'), the availability of workers and the skill base. The number of indirect jobs, their location and their longevity, will vary between the construction and operational phases because of the different expenditure patterns of each phase. In a country such as Azerbaijan leakage will be high. Leakage of extra income into the economy of Baku will be less than would be the case for the settlements near the terminal because the size and diversity of the former economy enables the money to stay in local circulation longer. The economic data of Azerbaijan only allows an estimate of the likely multiplier to be made for the country as a whole. Here the multiplier is presented as a range between a 'best' and a 'worst' case with the expected falling somewhere between the two boundary values. It is not possible to estimate the multipliers for Baku or Garadagh district.

The Phase 1 ESIA estimated a 'global' multiplier of 1.43. This was based on a calculation by the European Bank for Reconstruction and Development that 70% of the total expenditure on supply of goods and services would leak from the national economy[2]. This figure is a best 'guess' estimate based on incomplete data on economic linkages in the Azeri economy and in the oil and gas sector. If a range of 1.25 – 1.5 for the multiplier is used, then the assessment can consider the possible 'worst case' situation where the number of indirect jobs is low. Applying the multiplier to the construction phase results in an additional 315 – 630 indirect jobs over the construction period (based on a notional peak labour force of 1260 over a two-year period, see **Figure 9.1**). These jobs will be short-lived because of the two-year duration of the peak period. The number of indirect jobs will follow the general trend of direct employment.

During the operational phase the number of additional indirect jobs is between 108 and 217 (based on an estimated operational workforce of 200 jobs/platform plus 35 at the terminal). Although this represents a small number of employees the jobs will be long-lived.

Even with the low multiplier value the number of new indirect jobs remains a significant positive impact of the Phase 2 ACG project. The potential benefits from indirect and induced jobs will be enhanced through the social investment programme: activities such as provision of microcredit, training and improvement of infrastructure can build the capacity of local small and medium enterprises to provide direct and indirect services to the project.

9.2.1 Availability of Employment Opportunities for Local Communities

Consultation with communities surrounding the project (Sangachal, Umid and Sahil) indicates that their main concern is related to their opportunity to secure employment. This is linked to earlier expectations for employment during the Early Oil Project. This concern is also supported by the numbers of people registering at the information

[1] The multiplier can calculate additional income (or employment) provided to a local economy through indirect and induced effects.
[2] The figure of 1.43 was derived from the simple calculation 100 divided by 70 = 1.43

centres indicating their interest in employment (5,000 people as of 20/4/02). In addition, as local communities will be disproportionably affected by negative impacts, it is important to assess the employment benefits they will receive.

As stated above, the overall expected local employment content in the work is approximately 80%. However, the proportion of this depends on the skills and experience available in local communities. It is estimated that within Sahil, Sangachal and Umid, approximately 16%, 9%, and 28% respectively stated they were not trained in a technical or professional field (Azerbaijan-Holland Friendship Society, 2001). This limits the opportunities for many local people to become skilled staff unless training is provided. In previous phases of the project such as preliminary civils, the project only sourced 19%, 11% and 3% of the total required workforce from Sahil, Sangachal and Umid respectively.

In the Phase 1 ESIA, it was estimated that 40% of the Azeri workforce would be drawn from the Garadagh and Baku local government areas. It is difficult to estimate how many will be sourced from the settlements of Sahil, Sangachal and Umid, but it may be between 500-850 during the two-year peak. There will continue to be local jobs available on either side of the peak; estimated to include between 30-120 jobs. Any figure within these ranges represents a significant beneficial impact for these settlements.

There is a possibility that fabrication work may be carried out at either the Fels or Zykh yards in Baku. If this were to occur then there would be fewer jobs available for the settlements of Sahil, Sangachal and Umid as Baku based workers would be employed. It is not possible at this stage to be precise about the relative distribution of jobs by settlement or Baku districts.

The project will work to ensure that internal AIOC targets for local employment are achieved and, in particular, to increase employment opportunities for the inhabitants of Sahil, Sangachal and Umid, beyond the figures achieved during earlier project phases, through an ongoing training programme. However, given the timing of the programme, the most likely source of employment is in the area of structural, mechanical and piping work. **Figure 9.2** below illustrates the training programme to enable local and wider populations to acquire necessary skills.

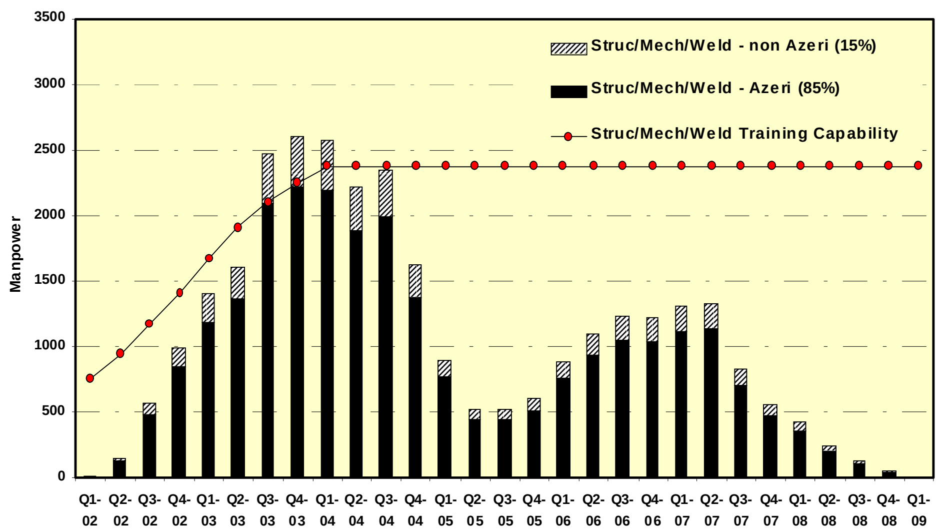


Figure 9.2: Illustration of training programme for ACG Phase 2 project.

AIOC has established information centres in Umid, Sangachal and Sahil for ongoing consultation and information dissemination on issues such as training and employment opportunities. Through clear and consistent messages, the extent, type and longevity of employment opportunities are becoming understood by local communities immediately adjacent to the project and regionally

The number of individuals to be trained will exceed Phase 2 requirements. The training is considered to be a ‘benefit’ by AIOC even for those who do not obtain employment during Phase 2 activities. Trained individuals will have skills that they may be able to use to set up their own businesses or seek employment elsewhere. This will enable the Azeri content of future oil and gas related employment to be achieved more easily. However, it might lead to a ‘pool’ of discontented individuals whose expectations of employment had not been met. Also, trained people might be more likely to leave the local area thus reducing the population of skilled and economically active individuals. This might be a ‘brake’ on future economic growth. Finally, it may act to depress local wage levels.

On the other hand the Garadagh district is the likely focus of continuing oil and gas-related development thus such out-migration may be limited because of likely future job opportunities. Also, any ‘adverse’ effect on wage levels will be minimal because of the existing significant wage differential in favour of the oil and gas sector compared to all other sectors is unlikely to be affected.

In addition to providing vocational skills AIOC will provide, from the start, training programmes focusing on transferable skills. This includes basic language and technology training, and management of personal finances. In addition, through the social investment programme, there will be actions taken to assist capacity building for small and medium business development and to develop other opportunities for sustainable economic development in the Sangachal vicinity.

On balance, the impacts of training (despite the over-provision of certain skills) are considered to be beneficial at both local and national levels. The local benefits may be offset to some extent by some adverse impacts but the overall effect is considered to be positive. Generally the impacts of training are not significant *per se* but training plays an important role in ensuring that the local employment opportunities are maximised and contributes to the overall positive benefit of the employment created by the Project.

9.2.2 Impacts of Demobilisation

As **Figure 9.1** illustrates, there is a rapid demobilisation starting in the 3rd quarter of 2004. A few of the jobs lost during this period may be regained during Phase 3. However there is a requirement to address potential unemployment of up to 2,000 workers. Those most adversely affected include the vulnerable households where a whole family’s livelihood is based on employment by AIOC. As discussed in **Chapter 10**, there is also a cumulative impact as it occurs along with the demobilisation of workers from other projects.

The project will ensure that all workers are clearly aware of the length of their employment from the start of their work. Workers who have been involved in Phase 2 will be informed of new employment opportunities within Phase 3 and other parts of the project.

However following demobilisation, there is likely to be a significant adverse impact on unemployment rates, *per capita* incomes and local business profitability in local communities. These can only be mitigated to a limited degree by training and consultation. The advent of Phase 3 will provide new jobs, but not all Phase 2 workers will be able to enjoy prolonged employment into the post-Phase 2 period (see

Chapter 10: Cumulative Impacts for a discussion of employment phasing).

9.2.3 Residual Impacts from Employment Generation

Significant residual impacts after mitigation are presented in **Table 9.1**

Table 9.1: Significant Residual Impacts from Employment

Significant Impact	Description and Rationale
Expectations of employment in Sangachal, Umid and Sahil that cannot be met	Negative impacts affecting large numbers of people within local communities and a major concern raised during consultation.
Demobilisation of up to 2,000 workers	High likelihood of negative impacts on the large number of people (affected workers and families), many of which may originate from neighbouring towns.

9.3 Impacts on Livelihoods

The livelihoods that could be directly affected by the project cover a range of activities and will impact several social groups. Potential impacts include;

- Impacts on two groups of transhumant herders based around the existing terminal in winter (including resettlement of one extended family group); impact on a garage/café owner and his family because landtake will require resettlement and business start up in a new location;
- Impacts on all fishery activities and yields as a result of a range of project related actions such as landtake, access prevention, accidental damage to nets, discharges or abnormal operations; and
- Disruption to sea users caused by the presence of the 500m exclusion zone surrounding offshore infrastructure, the 1 km exclusion zone along the pipeline route and increased vessel traffic.

As discussed below many of these impacts are either addressed in the Phase 1 ESIA or the Resettlement Action Plan (RAP) that considers all issues related to direct loss of livelihoods through landtake, resettlement or change in location of livelihood activities not requiring resettlement (BP, 2002). The RAP has been prepared according to current World Bank policies and guidelines.

9.3.1 Impacts on Herding Communities

The area around the Sangachal terminal is a grazing ground for both cattle and sheep. A local transhumant herding community, numbering 30 individuals, uses the grazing land around Sangachal during winter for their sheep and are likely to be resettled. As of June 2002, details of resettlement have not been fully agreed with the community in question. If there is resettlement, associated impacts and appropriate mitigation measures will be included in the RAP. If the community remains at its current location, an additional study will need to be conducted to assess impacts and appropriate mitigation measures and will serve as an update to this ESIA.

Another similar group also uses grazing near the terminal, but the loss of grazing and subsequent impacts on their livelihood is not considered significant and resettlement is not required. Any impacts associated with land use restrictions, and loss of access to land, that could potentially impact the livelihood of the herders is addressed in the RAP.

Surrounding the terminal will be a safety ‘no development’ zone and this area will be pegged off. Herders remaining in the terminal vicinity will be able to gain access and utilise the area for grazing during both terminal construction and operation. Therefore there will only be minor and insignificant impacts in the form of nuisance and disturbance including noise for both themselves and their animals, whilst they are using nearby grazing land.

9.3.2 Impact on Garage/Café Owner and Family

A new location for his premises needs to be found to enable him to continue trading. The resettlement of this businessman and family is dealt with in the RAP.

9.3.3 Impacts on Fisheries and Fishermen

The existing jetty (built as part of the Early Oil Project) and nearshore area are used for fishing and other activities by local residents. Fishing activities are both recreational and contribute to local livelihoods especially in Sangachal (see **Chapter 7**). Disruption to nearshore fishing will be limited to onshore installation of the pipelines and vessel traffic. It is estimated that the onshore and offshore installation of the Phase 2 pipeline will take place over approximately 12 months. During these periods the sections of the Bay and beach area will be unavailable to recreational and other users. There is a range of specific impacts to nearshore fishing activities including;

- The impacts associated with the removal of the fishing nets operated by approximately 30 fishermen currently working for the Ministry of Environment and Natural Resources (formerly employed by Azerbalyk) in the Sangachal Bay. These are addressed in detail in Phase 1 ESIA and the RAP; and,
- The impacts on an unknown number of unregistered and informal fishermen who have nets based in Sangachal Bay. Following accidental destruction of some of these nets by BP vessels, local people were advised to remove their nets from certain areas. There is a chance that some nets may remain in the area and be accidentally damaged/destroyed through vessel activities affecting the livelihood of the fishermen concerned.

The latter impacts are very difficult to quantify, as the activities are illegal. It is possible that as many as 150-200 individuals (see **Chapter 7**) either gain their main means of livelihood, or supplement it to an important extent, by fishing. There will have been some minor disruption to livelihoods due to the need to relocate nets and there may be further disruption to those with nets (whether moved or not). Such impacts are discussed in the RAP.

The nearest offshore fishing area to the ACG installations is the Makarov Bank (see **Figure 6.32**). The construction phase will result in the additional presence of project-related vessels and the physical occupation of an area of seabed and water column by the offshore facilities. During construction, operation and decommissioning there will be exclusion zones of 500m around offshore structures. There will also be a 1000 m exclusion zone within which all pipelines will be constructed. This zone will also remain during operations.

Up to 100 fishing boats operate 40-60km from shore and some are based at a harbour in Baku. Offshore exclusion zones and construction traffic may negatively impact these boats. However, the total area of exclusion is very small compared with the area available for fishing and transit. Basically, there will be an exclusion zone of 500m around each of the East and West Azeri offshore structures and a zone of 250m (on both sides) associated with 10km of in-field pipelines giving a total excluded area of ~10.8 square km. This area is additional to the exclusion zone of ~186 square km associated with the pipeline corridor from the structures to the coast at Sangachal Bay. Therefore, the impact on fishing is not considered to be significant. A potentially significant impact is the risk that an anchor from a fishing vessel could become snagged and possibly damage or rupture a pipeline, particularly as some vessel operators may not refer to navigational charts as required. This scenario is discussed in detail in

Section 8.4.2.

A major oil spill either from a pipeline rupture or an offshore blowout could have a significant and adverse impact on local fisheries. These impacts would, however, be relatively short-term in duration. Measures taken to prevent and manage such a spill will be effective in reducing the risk of harm to fishermen's livelihoods to an acceptable level.

9.3.4 Impact on Sea Users

The exclusion zones will restrict the movement of other sea users. However, the area of exclusion is small. The extra distance that may need to be travelled to avoid the zones is also small compared with total routing. The impact on operating costs is expected to be negligible and not significant for operators or their customers.

9.3.5 Residual Impacts to Livelihoods

The ACG project as a whole may result in significant residual impacts to a limited number of local livelihoods. Particular parties that may be affected include fishermen, herders, a garage/café owner and other sea users. However as discussed above, most of these impacts are discussed and mitigated through the Resettlement Action Plan. If this Plan is implemented successfully then these residual impacts should not be significant.

9.4 Impacts on Economic Development

9.4.1 National and Regional

The contribution of the project to the national, regional and local economies is based on employment generation (discussed in **Section 9.2.1**), direct procurement of goods and services, the multiplier effect and fiscal impacts (changes in public finances and expenditure patterns, for example as a result of alterations in tax revenues).

At the national level there will be benefits through increase in jobs and the indirect benefits gained via the multiplier. Almost all of these benefits will occur in the coastal area bounded by Sumgait in the north and Gobustan in the south. In addition, the national government will receive more tax revenues through the increase in oil and gas operations. Such additional monies may be used in a number of ways to benefit the national economy and the population and, perhaps, assist Azerbaijan move towards sustainability.

9.4.2 Garadagh District

At the Garadagh district level it is likely that direct procurement of goods and non-employment services will occur. There are a number of existing industrial and commercial operations (from major facilities such as the SPS yard and the Garadagh cement plant to the small shops in Sahil) that might be expected to benefit from increased business. For example, employees will spend a proportion of their wages locally on food, other retail goods and local transport services. However, the economies of Sangachal and Umid are not sufficiently diverse to be able to take a significant direct advantage of this increased demand for goods and services. Nevertheless, there will be an increased scope for small scale trading activities that can benefit the inhabitants of these settlements.

The Azeri tax regime does not allow local level governments to raise taxes from the types of activities being undertaken by AIOC in the Sangachal area. Since the provision of needed infrastructure to support the terminal is being provided by AIOC there is no need for increased local (or indeed national) government expenditures on infrastructure.

Thus, there is not likely to be any significant fiscal impacts at the local government level as the net inflows and outflow of money from local government entities will not be affected. Indeed, as AIOC are planning to provide assistance to Sangachal and Umid to improve wastewater treatment and disposal there may be a net saving to Garadagh Executive Power (if such projects were in its budget).

There is a potentially negative impact associated with the increased investment in the local economy; for example, the construction workforces may distort local markets and pricing mechanisms. The increased spending power of local residents employed by the project may have knock-on impacts on the local economy. Local suppliers and vendors may increase prices to take advantage of increased local incomes and cash flows. This may negatively impact those in the community such as the retired, female headed households not in receipt of remittances or the disabled. These groups may be on fixed incomes and may not be able to benefit from the project employment opportunities. Thus, greater inequalities within the local community may be created. The scale of such changes will depend on the size and nature of the local economies compared with the scale of the externally induced factors such as extra incomes. Based on the available data (number of unemployed, number of shops in Sahil, their low profitability and the likely number of residents obtaining work) it is considered that local sporadic instances of price inflation will occur, but the overall impact will not be significant. Nevertheless, the degree of uncertainty is such that monitoring should be carried out to identify any inflation and subsequent adverse impacts on vulnerable groups.

It is not expected that there will be induced development caused by the project in the form of in-migrants looking for jobs or seeking other economic opportunities. Garadagh district has enjoyed higher average incomes than Azerbaijan over the past 5 years and continues to be well placed to benefit from the oil and gas sector. Despite these comparative advantages there is no evidence of in-migration to the District apart from IDPs/refugees. This may be due to difficulties in purchasing and integrating into new communities. Thus, it is not expected that there will be either a sudden or gradual influx of people that will increase unemployment levels, competition for jobs and cause significant adverse impacts on the ability of the local social infrastructure to deliver services.

9.4.3 Regional Impacts of Transportation of Project Components

The road route local to the project area forms part of the main north-south road network and accounts for two thirds of all road freight transport within Azerbaijan. Project activities have the potential to create inconvenience and disruption to other road users. It is not envisaged however, that this disruption will be lengthy nor sustained and thus disruption is likely to be limited. The local road and rail networks have significant capacity to absorb additional traffic without significant impact on both the infrastructure and the logistics needs of other users. Once precise additional traffic loads, by mode, have been calculated for the construction phase of the project it will be possible to provide an accurate assessment of the impact on the current transport situation.

There may also be increased pressure placed on the road network as a result of extra delivery traffic for local suppliers who may be supplying goods and services to both the onshore construction facilities and camp and the offshore upgrade and assembly works. Contractors will be encouraged, via the tendering process, to use suppliers local to the project area wherever possible. It is not clear as yet however, exactly how many local suppliers will be used and for what purposes.

It is not envisaged that operations activities either onshore or offshore will result in significant increases in either road or rail traffic.

9.5 Impacts on Social Relations and Life-Style

Workers employed for the onshore terminal expansion and who do not live in Sangachal, Sahil or Umid will be 'bussed' to and from the site daily or housed in a self-contained construction camp adjacent to the terminal. The number of workers who will be housed in the self-contained workers camp will be a maximum of around 350. The construction camp for the onshore terminal construction will be an open camp with workers permitted to leave the camp at regulated times. It is not envisaged that any workers will bring family members with them.

For construction activities within the SPS yard, it is envisaged that there will be approximately 400 workers housed in a camp. Other construction yards such as Fels, and Zykh have existing self-contained workers camps and source many of their employees from the local area.

Given the skills required for Phase 2, however, it is anticipated that approximately 20% of the workforce will be drawn from outside Azerbaijan and 40% from outside the Garadagh District (**Section 9.2.1**). The influx of these workers may create a range of social impacts;

- There is a perception that local people could have supplied these skills and could have benefited from employment opportunities;
- An increase in workers from outside the local area may be perceived as a threat to resources used by locals;
- Some expatriate and non-local Azeri workers within the project workforce may perceive themselves as ‘protected’ and therefore ‘immune’ to local law, order and customs; and,
- The accommodation of a large number of single men in the worker’s camps may lead to problems of alcoholism, prostitution, drug abuse, conflict over competition for women and also to violence/crime.

Many expatriates will not live locally. They are likely to be housed in Baku where there is already a sizable expatriate community that has not been the source of communal tensions and friction. Baku is both large enough and sufficiently ethnically diverse to house more expatriates without causing significant negative social effects. Also, some of the expatriates will come from Turkey where there are important cultural similarities to Azerbaijan. This is likely to mean that local customs and traditions are respected.

The ethnic mix of Garadagh District is similar to that of Azerbaijan. The local population is accustomed to living and working in a multi-ethnic community. Again, the periodic presence of workers from the work camp(s) is unlikely to cause ethnic tension in the three settlements closest to the terminal and work camp(s) *per se.* Tension could occur if behaviour in specific social contexts, for example in cafes/bars and during community social and cultural events provokes local antagonism due to norms being breached.

Mitigation measures will be put in place to prevent such impacts. These include requiring tenderers to maximise the percentage of Azeri personnel drawn from the directly affected communities. In addition, consultation programmes will minimise inaccurate perceptions about employment in the areas local to the project. Worker and camp management plans, including housing and transport options for workers, as well as the provision of canteen and leisure facilities will reduce the extent to which workers spend their recreational time in local communities as opposed to in the camps/larger cities. Finally a workers code of conduct will be applied to guide workers on appropriate social behaviour inside and outside the workcamps. This deals with alcohol, drugs, and violence and can include other potential problems. A process will be developed to ensure that this code of conduct is enforced.

9.5.1 Residual Impacts Related to Social Relations and Life-Style

The consequence of significant impacts on social relations is sufficiently high (although the probability may be considered low) that the range of mitigation measures discussed above is essential. However, once implemented it is considered that the residual impacts are unlikely to be significant.

9.6 Nuisance and Disturbance

Nuisance and disturbance includes noise, odour, disruption to utilities and transportation, and impacts of severance to local communities.

9.6.1 Noise

The primary community noise objective for the project is to comply with the World Bank's General Environmental Guidelines[3] for noise, which state:

"Noise abatement measures should achieve either the levels given below (**Table 9.2**) or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB (A)]. Measurements are to be taken at noise receptors located outside the project property boundary."

Table 9.2: Community Noise Requirements from the World Bank Environmental Guidelines

MAXIMUM ALLOWABLE LOG EQUIVALENT (HOURLY MEASUREMENTS), dB (A)		
Receptor	Day (07:00 – 22:00)	Night (22:00 – 07:00)
Residential, Institutional, and Educational	55	45
Industrial, Commercial	70	70

Noise measurements and modelling described in Halliburton KBR (2002) state that the noise criteria to be met by Phase 2, therefore, depends on the measured background noise levels and time of the day. The criteria are summarised as below in **Table 9.3**.

Table 9.3: Noise Criteria at Nearest Sensitive Locations

CRITERIA dB (A)	**LOCATION**		
	Caravansari, Roadside Café (Commercial /Industrial)	Umid Settlement , Herding Settlement, Umbaki, Sangachal Town (Residential)	
	Day and Night	Day Time	Night Time
	=< 70	=< 55	=< 45

Table 9.4 shows the predicted noise levels for different ACG and Shah Deniz development scenarios. No predictions have been made for Phase 2 alone, instead predictions have been made for Phases 1 and 2 and Shah Deniz (see also Chapter 10: Cumulative Impacts). These predictions represent a 'worst case' scenario. Also, the predicted noise levels at all receptors are less than the measured background noise levels (see Chapter 6: Environment Baseline). As the herders are to be relocated in the near

[3] World Bank Group (1998) *Pollution Prevention and Abatement Handbook, General Environmental Guidelines.* Washington DC: World Bank Group

future the predicted community levels at normal operating conditions are in compliance with World Bank Group's Guidelines and will not constitute a significant impact on community receptors. It should be noted that these predictions do not include the construction period where the site is being prepared and structures and equipment installed.

The Phase 1 ESIA indicated that construction activities would cause short-term interference with receptors within 850m of the site. Apart from the Caravansari the other receptors will be resettled in the near future. The noise impacts of construction phase vehicle movements were not assessed, but are judged insignificant because of the marginal increase in traffic movements. The Caravansari will be affected, but only for a short-time period. Therefore, it is considered that Phase 2 construction-related noise impacts will not be significant as the noise–producing actions, and the intensity of operations, will be similar to Phase 1.

The policy for flaring of gas for the ACG full field development is not yet finalised. Certain assumptions have been made in terms of predicting the noise impacts from flaring. The model predicts that World Bank Guidelines will be exceeded at the receptors for the ACG FFD HP flare. This flare will only operate in emergencies and for very short periods (3 – 15 minutes). Although the Guidelines will be exceeded the impact of noise from flaring is not considered to be significant. Further, the likelihood of the impact occurring is very low, its duration is very short and the impact is reversible. There is no likelihood of an adverse impact on individual well-being or community well-being.

Table 9.4: Predicted Noise Levels at sensitive receptors under normal operating conditions

Location	Noise Level, dB (A)				
	EOP	ACG FFD Ph 1	ACG FFD Ph 1 & Shah Deniz	ACG FFD Ph 1, 2, & Shah Deniz	ACG FFD Ph 1, 2, 3, & Shah Deniz
Caravansari	26.5	36.1	38.5	39.5	40.1
Roadside Café	29.7	37.5	39.4	40.7	41.5
Umid Camp	27.7	33.3	34.2	35.7	36.6
Herding Settlement	26.7	40.5	41.6	44.7	46.9
Umbaki	21.3	31.6	35.1	36.1	36.8
Sangachal Town	20.1	30.0	33.2	34.2	34.9

Other areas that may experience increased noise include the yards where construction of jackets and topsides occur. From the assessment of noise during Phase 1 at the SPS yard, it was concluded that there is a potential for noise impacts on communities living within 600m of the yard. Similar activities will occur for Phase 2 and could affect adjacent communities to SPS, Fels and Zykh. It is likely that any activities at these yards will replace, in the main, existing work and that noise–producing activities will remain stable. Therefore, significant changes in noise levels at nearby communities are not expected.

9.6.2 Disruption to Utilities and Transportation Infrastructure

The laying of the onshore pipelines will involve delivering pipeline sections, welding and testing connections, trenching, pulling through casings below the road and railway and backfilling trench restore site. These operations will be short lived and will have a negligible impact on utility providers and users of the main Baku-Tbilisi-Iran highway and the railway.

9.7 Severance Impacts

Phase 1 activities have disrupted access routes to water and markets for the herders. As they will be resettled there will be no similar impact from Phase 2. No other communities will be affected by severance.

9.8 Impacts on Social Infrastructure

The capacity of local social infrastructure (clinics, schools, cultural and recreational facilities) provision will not be exceeded to the detriment of current users. Local employees will continue to use them as before. Workers in the camp will be provided with their own facilities. In-migration is not expected to occur to any significant extent. However following demobilisation, there is a risk that some workers from outside the local communities may remain in the area putting additional pressure on social infrastructure. This can be addressed through monitoring of employees following demobilisation and where possible, provide information of employment opportunities adjacent to their original homes. The potential impact on different types of social infrastructure varies and includes;

- The schools are at full capacity, but the children of expatriates are likely to attend schools in their own countries or to attend international schools in Baku, not the local schools;
- Transportation infrastructure will be used to move equipment, pipelines, and waste etc. It will also be used to transport construction workers to and from the terminal/construction yards and their homes. These impacts are unlikely to be lengthy or sustained. However workers commuting to the terminal or construction yards may cause localised congestion, especially in Baku itself. This will be managed through providing buses for workers, and implementing a transport management plan that chooses routes and times to minimise congestion; and,
- There is unlikely to be additional pressure on housing surrounding the terminal. Workers will either be housed within the workers camp or they are expected to live in Baku.

9.9 Impacts on Health

These include impacts from infectious and non-infectious diseases such as road-traffic accidents. As discussed below the most likely significant impacts are expected to occur in the construction phase and be linked to the size of the workforce and the proximity of many workers from outside Garadagh to the settlements of Sahil, Sangachal and Umid. The operational phase is not expected to result in any significant health impacts except for those that might arise from emissions of air pollutants or abnormal events at the terminal.

As shown in the baseline section (**Section 7.4**) the health status of many adults and children is poor. One of the main causes is poverty coupled with inadequate access to health care. The additional employment will enhance, significantly, the *per capita* income of many individuals and their families. This extra income will help families to purchase sufficient and better quality food. This will have significant health benefits albeit for a short time period. Also, there will be more disposable income to purchase health care if the publicly funded institutions are not able to deliver the requisite health care on time and to the requirements of the patients. There will be similar health benefits from the operational period. A much smaller number of people will be affected, but the benefits will be longer lasting.

9.9.1 Impacts from Infectious Diseases

During the peak employment period between 2003-2005, the numbers of Phase 2 non-local employees (outside Sahil, Sangachal and Umid settlements) may be between 260 (including Phase I, Shah Deniz and BTC projects, there may be 500-850 employees). Many of these will commute from Baku and other nearby major centres of population. The remainder will be housed in workcamps (the terminal work camp has a planned capacity of 350 individuals). As with any project of this size, involving incoming workers who are sharing facilities, there is a risk of increased infectious diseases. These risks include;

- Respiratory disease as a result of close proximity of workers and air pollutants;
- Vector borne diseases;
- Sexually Transmitted Diseases (STDs) through project employees; and,
- Water borne illnesses including gastrointestinal illnesses, and Hepatitis A.

Respiratory Illnesses

As discussed in **Section 7.4**, respiratory illness is prevalent in both the Sangachal area and Garadagh as a whole. In addition, respiratory disease is likely to be carried /occur in a number of the incoming workers. During the construction phase of the Project, workers living in shared accommodation are likely to be at particular risk of developing respiratory illnesses such as tuberculosis (TB) or influenza especially during the winter months. These diseases are spread via cough and body fluids including spit and require relatively close interactions between individuals to spread through a community. There would also be a small additional risk of the development of these diseases in the local community arising from the interaction of the local population with men living in the construction camps. TB requires a long and relatively complex programme of treatment (up to 1 year) and it may be difficult to ensure that affected individuals comply with their programme of medication.

Influenza spreads very easily and can have widespread short-term impacts in communities, but is a rarely a serious illness in healthy adults. Young children, the elderly and the chronically sick, however, are at risk of serious illness and death even when prompt care and treatment are available.

These diseases will be managed by providing most services within the camps. In addition, the design of the workers camps will ensure there is adequate space and ventilation in the workers' accommodation: There will be no more than 4 people per room, with no shared showers. In addition, all workers will undergo a chest X-ray during pre-employment health screening and will be educated about the symptoms of TB and other infectious illnesses, their prevention and given incentives to report illness promptly. It may be appropriate for a PPD skin test to be used to complement X-rays for TB screening. Extra vigilance is needed in the winter months. Incentives will be provided to encourage workers to complete their course of treatment and there will be penalties for those who refuse to accept appropriate medication or try to conceal illness. Other measures such as ensuring that fresh fruit and vegetables are readily available to workers at affordable prices would help to reduce the risks of infection. If these mitigation measures are adopted, respiratory diseases are unlikely to result in a significant impact on local communities.

Vector-Borne Diseases

Risks of mosquito and other insect-borne and other vermin-related diseases may substantially increase during the construction phase for both the local population and site workers. Infected workers can introduce mosquito-borne diseases such as the commoner form of malaria (*Plasmodium vivax*) that is occasionally reported in the

Garadagh area. This is the variant which is not life threatening, but which can be debilitating. As mentioned in **Section 7.4**, malaria generally occurs in the rural lowlands and is not common in Garadagh. Malaria is unlikely to have a significant impact as long as appropriate anti-mosquito controls are provided (avoiding standing water and providing screens in workers compounds) and incentives exist for reporting incidences of the disease among workers.

Waste from the site, including food waste, is likely to attract both insects and other pests including rats and dogs. Endemic animal-borne diseases include rabies, and leptospirosis (Weil's disease). Waste may also attract flies, some of which may carry pathogens that may contaminate food or cause skin infections following bites.

The risks of insect borne diseases for workers and the local population will depend on their proximity to insect breeding grounds, the potential for being bitten and the effectiveness of control measures. Waste management practices will be rigorously enforced and thus the likely impacts from vector-borne diseases is not significant.

Sexually Transmitted Diseases (STDs)

As discussed in Section 9.5, there will be approximately 750 workers who will live in the worker camps adjacent to the terminal site, the SPS yard and other construction yards. These workers will most likely be male and without their families.

These men are likely to attract sex workers, giving rise to an increased incidence of STDs, including Hepatitis B, AIDS, syphilis, gonorrhoea, chlamydia in the workforce and the local population. There may also be an increase in the number of unwanted pregnancies. The local population may be particularly at risk from STDs because of the difficulty of providing appropriately targeted health education and medical support.

Workers may create a demand for prostitution or form relationships with local women during recreational periods. Such impacts may occur in Baku, and to a lesser extent in Sahil, where it is likely many of the workers will visit for recreational activities given the lack of entertainment facilities currently in existence in Sangachal and Umid. Nevertheless, such impacts may occur also in these communities. As discussed earlier there is unlikely to be a trend of large numbers of economic migrants who would compound this problem.

The measures to be implemented to minimise the risks of STDs including HIV/AIDS include;

- Providing appropriate health education and healthcare to site workers;
- Reducing the contact between construction workers and surrounding villages;
- Supporting community initiatives to provide appropriate health education and care to those at risk in the wider community, including prostitutes; and,
- Preventative measures such as the provision of free condoms and education programmes.

Even with provision of adequate medical support for local communities, workers and sex workers, the overall risks to health to local communities, from STDs, are likely to be significant and adverse.

Water-Borne Illnesses

Food and water-borne illnesses may arise in the workforce as a result of poor food hygiene, or if arrangements for the provision of clean drinking water prove inadequate. These include gastrointestinal infections, *Giardia lamblia* (a chronic debilitating illness caused by an internal parasite) and Hepatitis A. Poor sanitary arrangements would contribute to increased risks of food and water-borne illnesses. These infections are likely to spread among workers and into the local population. Individuals will be particularly susceptible to strains of infection imported from outside the project area.

At present, gastrointestinal illnesses are likely to be most prevalent in this area during the summer reflecting the exacerbation of the risks associated with poor hygiene by high temperatures. Workers will carry infections with them from other areas of Azerbaijan and other countries and these infections are likely to spread rapidly through the worker camps if there is poor sanitation and food hygiene. The interaction of workers with local communities is likely to lead to infections becoming established in local communities. This will be compounded by the poor state of the sewage and water infrastructure in Umid, Sangachal and Sahil (see **Section 7.4**). Local communities will be particularly vulnerable to infections originating elsewhere and the risks of serious illness, including fatalities, will be highest for young children, the elderly and chronically sick.

Measures to be taken to substantially reduce the risks of gastrointestinal illnesses include;

- Ensuring that all drinking water is adequately treated and that there is sufficient drinking water readily available to discourage use of other sources;
- Adequate sanitation and sewerage will be in place to prevent the potential microbiological contamination of watercourses and/or groundwater;
- Encouragement of hand-washing;
- Solid waste management will be undertaken to 'best practice' standards; and,
- A catering management plan and inspection scheme will be initiated for site catering facilities.

There may likely be some residual impact arising from cultural resistance to improving food hygiene standards. However, the residual health impact should not be significant.

9.9.2 Other Health and Safety Impacts

Non infectious illnesses include road traffic and other accidents affecting communities, psychological impacts including increased stress, changes in lifestyle, and local environmental change (air, water, noise) which will affect community health.

Road Traffic Accidents

As described in **Section 7.4**, accidents are a common cause of mortality in Garadagh. The project will increase traffic density associated with transportation of workers and construction activities, increasing the risk of road traffic accidents. Driver training (focusing on issues such as defensive driving, use of seat belts and lights at dusk) and road safety awareness education in the community would greatly reduce the risks of road traffic accidents occurring. The impact of road traffic accidents is considered significant given the size of the project and number of people involved.

Stress

Stress arises when individuals feel that they no longer have control over their own lives and destinies. Some individuals in the local communities will experience stress associated with enforced changes in their living conditions arising from the project, for example, the few people whose homes or livelihoods are directly impacted. Others may also already be experiencing stress arising from unemployment that may be exacerbated by their failure to gain employment on this project. Stress arising from anxiety associated with the presence of the terminal and the work camp workforce is not, however, expected to be a major impact in local communities. The communities have been accustomed to the presence of large industrial facilities, some inward migration and ethnic diversity. Stress may affect some workers and their dependents near to the time when they know when the job and the income will cease.

Stress may increase for individuals who support their livelihoods by illegal fishing and whose ability to fish is affected by damage to nets, restricted access or an event such as a major oil spill. There is sufficient scope for fishermen to find and exploit alternative areas in the Bay so stress should be short-lived.

Overall, stress levels may increase and affect some people, but it is not considered to be a significant impact. Indeed, the winning of a job may alleviate stress in a number of families even if only for a period of two years.

Ill Health Associated with Industrial Pollution

Air pollution is a factor in the cause and exacerbation of respiratory illnesses. Emissions of NOx and SO_2 were modelled to give a conservative prediction of future air quality in the Sangachal Terminal area (the actual levels of these pollutants are very likely to be less) for terminal operations combined with offshore activities described in full in **Chapter 10**: Cumulative Impacts). The emissions of SO_2 were based on an assumed level of H_2S in the gas, as the actual amount of H_2S that may be present in the reservoir is unknown. Further modelling of ACG FFD for SO_2 levels will need to be carried out when the H_2S content of the reservoir is known.

A number of scenarios were modelled. Some contained the start up and normal operations of Phase 2, however it is not possible to identify the impacts of Phase 2 alone. The predicted levels are therefore likely to be higher than would be the case if the Phase 2 contribution was modelled alone. The results obtained from the modelling refer to a period from 2006 when Phase 2 enters start up. The predictions for the receptors show that the emissions of NOx and SO_2 are all well within the internationally recognised air quality standards and guidelines (see **Table 10.1**).

The modelling did not include a factor for a changing baseline during the life of the scenarios. The air quality baseline may in fact be improving (in terms of concentrations of certain air pollutants) through lower emissions from the Garadagh cement works as a result of recent modernisations.

There is some evidence to suggest that children in Umid settlement may exhibit higher than average incidences of respiratory diseases and they may therefore be a vulnerable group. It is likely that overall air quality is improving and that the air quality predictions are conservative. However, AIOC will undertake regular monitoring of air emissions (see **Chapter 12**) to ensure that the situation does not deteriorate.

There is little potential for contamination of drinking water supplies arising as a result of emissions from the development given the proposed mitigation measures.

Ill Health Associated with Poverty

Relatively few people within local communities will benefit directly from employment on the project, although a larger number of people will experience some indirect benefits arising from economic growth. The less advantaged members of local communities may, however, suffer from the effects of food price inflation and a more general rise in the cost of living including costs of medical care. Problems of malnutrition and reduced access to health care could lead to increased problems of ill health among the poorest members of local communities.

Occupational Illness

The occurrence of occupational illness will be minimised by the implementation of an appropriate health and safety management programme at the terminal. Following these measures, the health impacts of occupational illness will not be significant both for the workforce and for local communities.

9.9.3 Residual Health Impacts

There is a risk that several significant health impacts may occur as a result of the ACG Phase 2 Project. These are summarised in **Table 9.5**. The mitigation measures will reduce both the frequency of occurrence and scale of the impacts. However, should they occur then they would be significant, albeit in some cases for a relatively short time period.

Table 9.5: Residual Health Impacts

Significant Impact	Description and Rationale
Development of infectious respiratory diseases such as tuberculosis or influenza	Increased Morbidity and Mortality
Increased incidence of sexually transmitted diseases including Hepatitis B, AIDS, syphilis, gonorrhoea and chlamydia in the workforce and local population.	
Road traffic accidents affecting both workforce and general public	

9.10 Impacts on Cultural Heritage

The impacts on cultural heritage have been discussed fully in the Phase 1 ESIA. Potential impacts were considered to be of low significance.

An Archaeological Management Plan has been developed and implemented for ACG Phase 1 and this will be extended and/or amended to incorporate Phase 2. Any finds that are rescued and interpreted will add new knowledge to the cultural history of Azerbaijan providing a positive impact.

9.11 Conclusions

Table 9.6 below summarises the most significant local-level positive and negative impacts and the associated enhancement and mitigation measures to manage these issues. Impacts displayed in italics are those that are expected to remain significant following mitigation.

There is a potential for the increased government revenue, from ACG Phase 2, to result in macro-level beneficial impacts such as improved health and education services through increases and well targeted public spending, but it is impossible at present to reach a firm conclusion on this matter.

The key positive impacts include direct and indirect employment, albeit short-term, created by the project and the training provided to build the capacity of local populations to work in both the oil and gas and other sectors. Also, there is likely to be an improvement in health due to increased incomes, contingent upon availability of improved health care.

The key negative impacts are potentially associated with unrealised expectations of employment in the settlements of Sangachal, Umid and Sangachal. Following demobilisation, there will be significant impacts in terms of unemployment, as there is unlikely to be any immediate projects, of a similar scale requiring employment.

There is also a potentially significant adverse impact on the livelihoods of informal fishermen and herders. Impacts on the herders will depend on the timely and successful implementation of the RAP following the completion of the Phase 1 ESIA. If RAP implementation is successful then Phase 2 activities should not affect the herders. The impact of increases of transmissible diseases, especially gastro-enteritis, STDs, and respiratory diseases could be significant, if appropriate mitigation measures are not in place. Over the period of Phase 2, it is also likely that road traffic accidents will be a significant impact given the volume of traffic generated by the project and the baseline driving conditions. Finally, there may be an adverse impact on the respiratory health of people (especially young children) in Umid settlement (and nearby receptors) from increases in air pollutants. Further work needs to be done to examine this possibility.

Flaring may result in community noise criteria (World Bank Guidelines) to be exceeded for some receptors. This potentially significant adverse impact will be avoided by a implementation of an appropriate flaring policy.

The implementation of the mitigation and enhancement measures will ensure that the residual impacts are not significant, but it is essential that these measures be carefully designed, planned, implemented under systematic and effective supervision. The monitoring of selected impact indicators will also be an essential companion activity to ensure that the potentially adverse residual impacts are managed to ensure that they remain at an acceptable level to all the stakeholders.

The employment and associated benefits will be spread among a number of communities (including those in Baku if Fels and Zykh yards are used). Any adverse impacts will be borne in the main by the local communities of Sahil, Sangachal and Umid.

Table 9.6: Summary of significant positive and negative impacts of ACG Phase 2

Positive Impact	Enhancement/ mitigation measures
Employment • During the peak construction period of almost two years, direct jobs will include 76 expatriate managerial workers, 176 foreign skilled workers and approximately 1,010 workers sourced from Azerbaijan (evenly divided between skilled and unskilled). • During operations over 300 direct jobs will be created for over 10 years • Indirect/induced employment of possibly 315-630 other workers due to the multiplier	• Establishment of information centres to maximise Sangachal, Umid and Sahil input in employment • Training Programmes to maximise local employment and growth of local service sectors • Social investment programme actions to build the capacity of local service providers and local resources.
Increase in the local skills base. • Approximately 2,500 workers will gain skills such as welding. • The numbers of training in transferable skills is still to be determined. This can encourage further investment in Garadagh	• Training programmes both directly related to the project for potential employees and training in transferable skills (language, personal finance and technology training.)
Fiscal impacts • Direct expenditure of CAPEX and OPEX in Garadagh, Baku, resulting in increased tax revenues • Increased national tax revenue in Azerbaijan	• AIOC support to the government on policy priorities for government expenditures.
Improved health and access to services • Improved access to health care facilities and other services as a result of increased direct (or indirect) income levels	• Direct and indirect employment will increase household income and improve access to facilities.
Negative Impact	
Employment-related impacts • *Unmet expectations of employment: Over 5,000 people have registered in the information centres. Employment is the key issue mentioned during consultation. However jobs sourced in Sangachal, Umid and Sahil at any one time may not exceed 1,000.*	• Information centres and consultation programmes are communicating that not everyone will get work • Policies of maximising local employment may reduce resentment to external workers • Training in transferable skills will increase growth of other sectors.

• *Following demobilisation, there will be a drop in local employment related to Phase 2 from up to 1,000 down to below 200.*	• Unemployment can be managed through early implementation of training in transferable skills • Clear communication to workers regarding their contracts • Collaboration with other projects to maximise alternative employment possibilities following demobilisation.
Disruption to livelihoods • There are potential impacts to all fishery activities and yields as a result of landtake, access prevention, accidental damage to nets, discharges or abnormal operations. Impacts to formal fishermen have been addressed through the RAP. There are also an unknown number of illegal fishermen, which may be as many as 150-200 individuals. • There are also potential impacts of resettlement on one extended family group of traditional herdsmen, and a garage/café-owner, (depending on the timing of RAP implementation) These are assessed in the RAP • Restricted fishing by exclusion zones surrounding offshore facilities and pipelines may reduce livelihoods of the up to 100 fishing boats operating 40-60km from the shore	• RAP and associated mitigation measures including compensation, training etc. • Consultation and information disclosure programmes to maintain engagement with groups and to inform illegal fishermen of activities. • Social Investment Programme to encourage development of small and medium enterprises to growing the legal fishery sector or other sectors.
Impacts on social relations and lifestyle • Influx of workers potentially resulting in tension between “insiders” and “outsiders”, problems of alcoholism, drug abuse, and crime.	• Design of camps (self contained and include leisure and canteen facilities) • Maximise local employment • Consultation programmes • Codes of Conduct
Nuisance caused by project activities: • The project will result in an increase in traffic. In addition noise levels are likely to increase (though this is not expected to be at significant levels) • Flaring has the potential to cause localized short-term non-compliance with World Bank noise levels	• Consultation programmes • Transport management (including timing and routing of vehicles) • Flaring policy and appropriate technical mitigating measures to be formulated to ensure this non-compliance does not occur
Increase in incidence of infectious diseases: • *Respiratory diseases likely to increase due to close proximity of workers and the inward migration of some workers.* • *STDs, including Hepatitis B, HIV/AIDS, can spread rapidly if workers have access to sex workers and rates may increase* • *Gastrointestinal diseases are likely to increase and be most prevalent during the summer and is associated with poor food hygiene and provision of drinking water* • Possible increase in respiratory illnesses (especially at Umid settlement)	• Provision of adequate space and ventilation in workers camps • Pre-employment health screening including chest X-Ray. • Community health education programme • Reducing contact between workers and surrounding villages • Treatment of water, adequate sanitation/ sewerage, solid waste management plan and catering management plan • Provision of fresh fruit and vegetables • Monitoring to ensure that air quality levels do not deteriorate.
Increase in accidents • *Given the volume of road traffic, accidents are likely to occur during Phase 2.* • In addition, there are risks, albeit minor, of marine accidents such as if a fishing boats trawling gear becomes snagged and damages the pipeline	• Emergency response procedures • Driver safety training programme • Information disclosure and consultation regarding the nature of project activities and infrastructure.

Note: Impacts in italics are those that are significant even following mitigation

10. CUMULATIVE IMPACTS

This Chapter addresses environmental and socio-economic issues that may have a cumulative impact when taking into consideration other developments, which are planned in the vicinity of the ACG Phase 2 Project. Each issue is discussed in turn and the key impacts identified are summarised in the final section.

10.1 Introduction

The International Finance Corporation Procedure for Environmental and Social Review of Projects (IFC, December 1998) states that environmental assessment should include consideration of:

"Cumulative impacts of existing projects, the proposed project and anticipated future projects."

To identify which other projects need to be considered alongside the project being assessed the IFC Procedure states that:

"Assessment of cumulative impacts would take into account projects or potential developments that are realistically defined at the time the environmental assessment is undertaken, where such projects and developments could impacts on the project area".

Cumulative impacts are those that may result from the combined or incremental effects of past, present or future activities. While a single activity may itself result in an insignificant impact, it may, when combined with other impacts (significant or insignificant) in the same geographical area and occurring at the same time, result in a cumulative impact that may have a detrimental effect on important resources. Cumulative impact assessment has a number of components including;

- Assessment of the effects of subject activities (i.e. those under review) over the area of the impact of the project resulting from interactions between the subject activities and other activities in the same geographical area; and,
- An assessment of the effects of subject activities over an extended timeframe including the past, present and future resulting from interactions between the subject activities and other activities occurring at the same time.

10.2 Spatial and Temporal Boundaries

Chapter 1 of this report describes how the ACG Phase 2 Project has to be seen in the context of the planned phased Full Field Development of the ACG Field, the Shah Deniz development and the associated infrastructure required to export oil and gas to international markets. The individual and cumulative impacts related to export pipeline construction and operation from the Sangachal Terminal through Azerbaijan, Georgia and Turkey are addressed in separate ESIAs. For purely environmental issues the spatial boundary of the cumulative impacts to be addressed below will be confined to the Caspian marine environment and the general area in the vicinity of Sangachal Terminal. The temporal boundary will consider the anticipated lifetime of the ACG field up to 2024. Socio-economic issues will be addressed in a wider National and Regional context.

10.3 Schedule of Activities

Figure 10.1 gives an overview of various activities associated with ACG FFD and the Shah Deniz development and gives an indication of their timing in relation to each other.

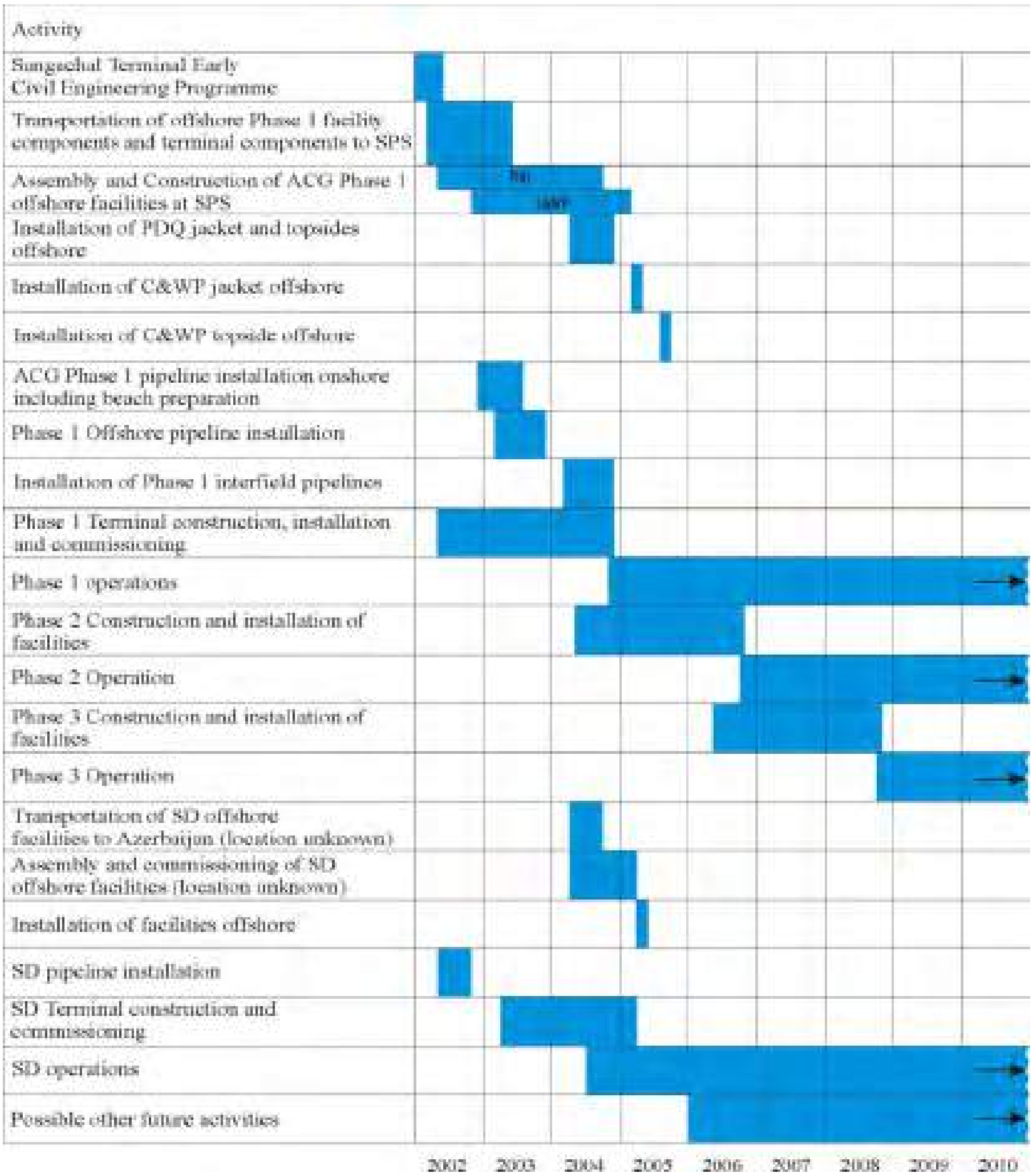


Figure 10.1: Estimated schedule of regional development activities

ACG Phase 2 construction will have started by the time ACG Phase 1 production has commenced. Phase 3 construction is also likely to have started by the time Phase 2 is operational and producing oil. Shah Deniz timelines are preliminary but indicate that overlap of activities will occur.

The overall estimated recoverable reserves in the ACG field are forecast to be around 5.2 billion barrels of oil within the PSA period. The schedule for the production of ACG is illustrated in **Figure 10.2**.

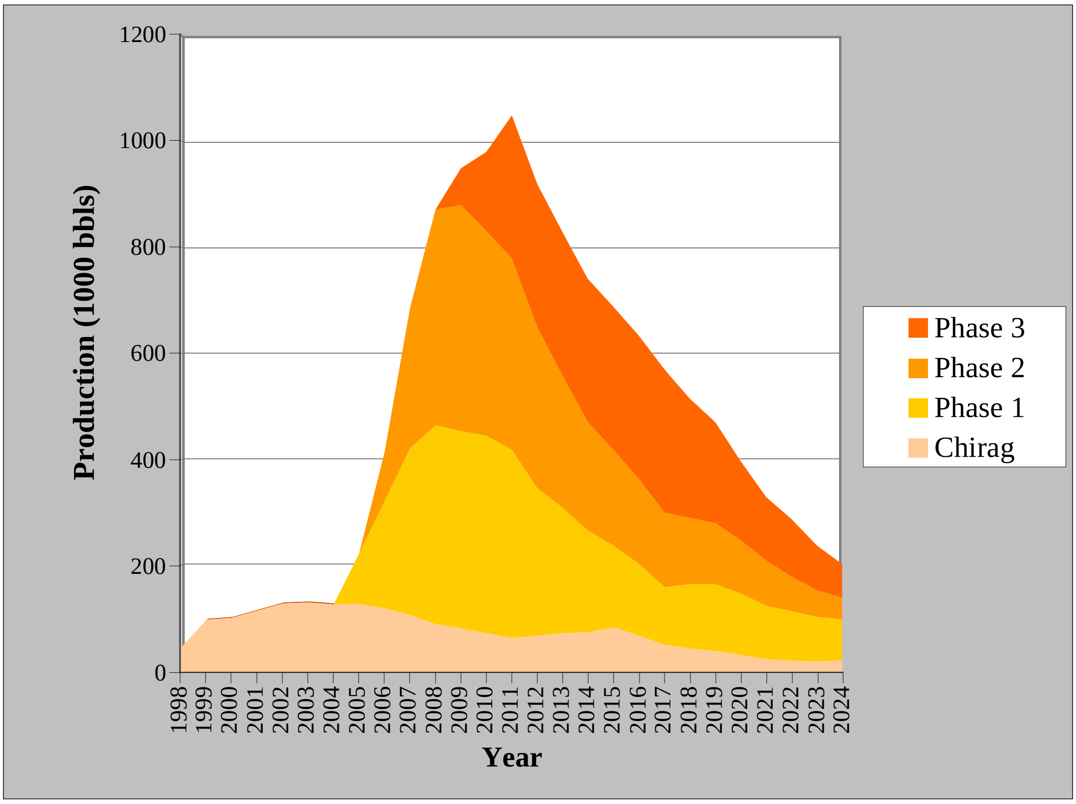


Figure 10.2: Estimated Production Profiles from ACG FFD

10.4 Basis for Assessment of Cumulative Impacts

Within the spatial and temporal boundaries set for the assessment, the issues that are discussed in terms of cumulative impacts have been selected based on the following information;

- The ACG Phase 2 Scoping Report and stakeholder consultations;
- The ACG Phase 2 Impact Assessment carried out in this report (**Chapters 8** and **9**);
- The ACG Phase 1 ESIA (URS, 2002);
- Information on the Phase 3 and Shah Deniz developments presented in the Phase 1 ESIA; and,
- Socio-economic fieldwork and consultations carried out for the Phase 2 ESIA.

10.5 Marine Issues

At present the only PSAs that have proceeded into the development phase are the BP operated ACG and Shah Deniz fields. Exploration activity in other PSA areas has yet to yield a discovery of commercial quantities of hydrocarbons. These exploration activities will continue and there is still a possibility for future development of new fields. In addition to the BP operations there are also a large number of SOCAR installations such as those at Oily Rocks, which are of varying age and of varying maintenance level and operational integrity. These installations are shown in **Figure 10.3** while **Figure 10.4** shows an aerial view of Oily Rocks.

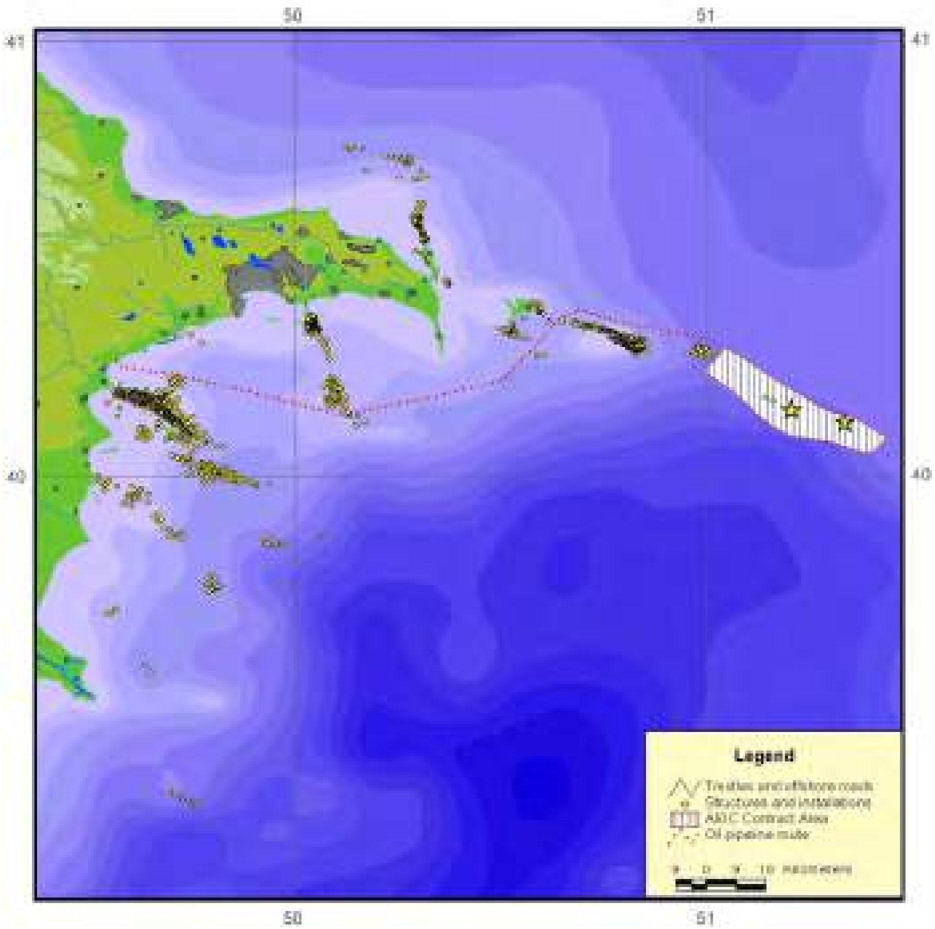


Figure 10.3: Other Installations

Figure 10.4: Aerial View of Oily Rocks

10.5.1 Pipeline Construction

Subsea pipelines from the ACG and Shah Deniz offshore facilities to the terminal at Sangachal will share a common pipeline corridor for a distance of 43 km from the shoreline into Sangachal Bay (**Figure 10.5**). East of this point, two separate corridors will be established; one out to the ACG field and one out to the Shah Deniz field. The ACG pipelines will follow the same route as the existing Chirag-1 to Sangachal oil pipeline route (part of the EOP).

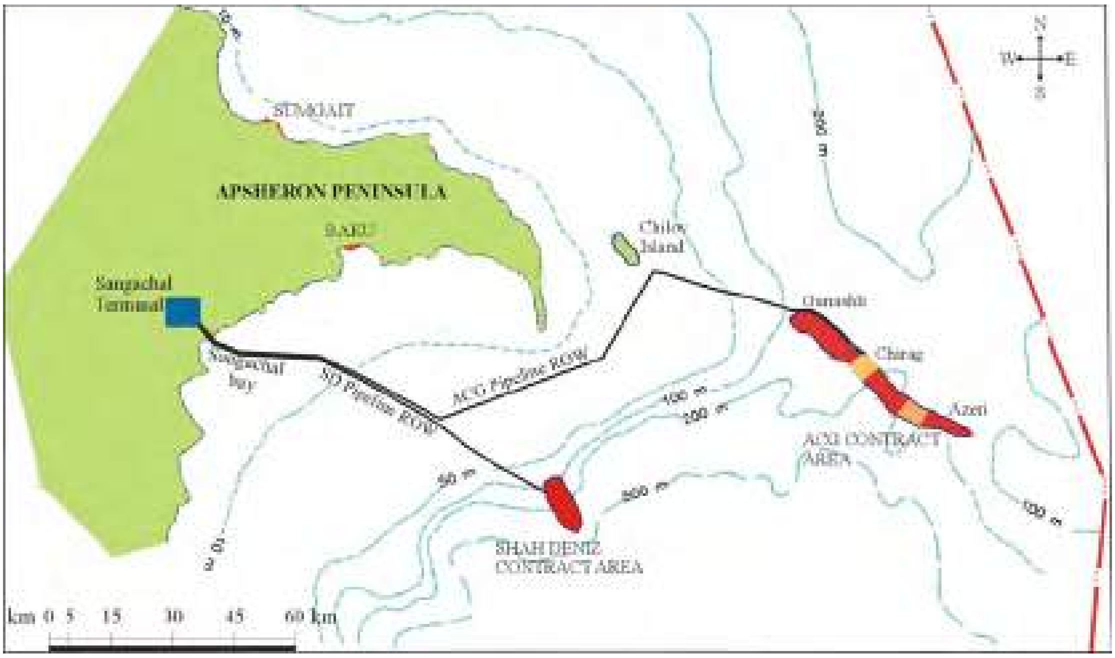


Figure 10.5: ACG and Shah Deniz Contract Areas and Pipeline Routes

It is proposed to trench the ACG and Shah Deniz subsea pipelines from the terminal (approximately 2 km inland from the shoreline) out to a water depth of approximately 5 m (a distance of approximately 650 m, but which may be extended to 3500 m).

The cumulative area impacted by the pipeline construction activities connected to the various phases of the ACG and Shah Deniz Field Developments will be reduced by utilising the same pipeline corridor for the nearshore sections out to 43 km. However, the current construction schedules are such that the pipelines will be installed at different times. There is a potential cumulative environmental impact connected to this strategy that is likely to manifest itself in the shallow nearshore areas in particular. As stated in the impacts chapter (**Chapter 8**) Sangachal Bay contains a number of sensitive receptors, particularly associated with the sea grass and red algae beds. Finger pier construction, trenching and the pipelay itself will result in habitat destruction and temporary increases in turbidity levels and sediment redistribution. Areas of sea grass and algae beds may be smothered resulting in reduced growth and possible mortalities of macrobenthos, crustaceans, fish larvae and juveniles. These impacts are expected to be temporary and a relatively rapid recovery after the cessation of construction activities is anticipated. However this recovery time could be delayed by the nearshore pipelaying activities of the various project phases being extended over time, such that receptors would be subject to a new wave of impacts before recovering from the previous activity.

AIOC is fully aware of this issue and is studying the options for nearshore pipeline sections to be laid concurrently. There are also significant benefits of this strategy related to reduction in mobilisation costs and creating a possible option for disposal of hydrotest water (see **Section 8.3.6**).

In order to meet Project targets the Phase 1 30″ pipeline beach pull is scheduled for May 2003. It is not possible for reasons of logistics and materials acquisition for the Phase 2 beach pull to run concurrently with this. However, there is a window of opportunity in connection with the Phase 1 28″ gas pipeline beach pull scheduled for September 2003. A beach pull operation is estimated to have a duration of 3 weeks and it may be possible to utilise a slot prior to the gas pipeline installation in order to lay an 8 km section of the Phase 2 30″ pipeline. The pipeline lengths will be welded and tested on the laybarge, and winched ashore along the line of an excavated trench as described in **Section 3.8.4**. Floatation pontoons will keep the pipeline afloat. The laybarge will initially be anchored at a minimum operating depth (8m of water) some 3 km from the shore in Sangachal Bay. An 8 km section will be laid and then filled with water that will contain an oxygen scavenger and biocide to prevent internal corrosion and fouling. The seaward end will then be lowered to the seabed and marked with a buoy for later retrieval. The laybarge will then move directly on to the 28″ beach pull and will continue the pipelay of the entire line out to the Phase 1 offshore installations. Other opportunities for concurrent pipelay will be fully assessed in the future. Although cumulative impacts on the nearshore communities are anticipated as a result of the pipelay activity this will be mitigated by concurrent beach pulls where these are possible. This strategy will help to reduce the recovery time for the ecological components in Sangachal Bay. The status of Sangachal Bay will be an element of AIOC's monitoring programme as described in **Chapter 12**.

As mentioned above, entrenching of the pipelines in the nearshore and landfall area will require the construction of finger piers (temporary jetties). As has been shown for the jetty constructed in connection with the Early Oil Project these structures typically result in an interruption to long shore sediment transport so that sediments accrete up-current of the jetty whilst on the down current side of the jetty the shore is starved of sediments resulting in erosion. Mitigation of long term cumulative impacts of jetty construction will be achieved by BP's policy of removal of the jetties after the pipeline laying has been completed.

10.5.2 Physical Presence of Installations

A statutory safety zone comprising an area with a radius of 500 m area around each fixed offshore installation would prohibit vessels from entering the area without permission. In addition to the exclusion zone around the fixed platforms, there would be a 1,000 m wide safety zone along the length of the pipeline corridors. Each phase of the FFD will entail the deployment of additional platforms in the ACG Contract Area resulting in further exclusion zones. However, the overall impact on maritime activities is expected to be minimal. As a general rule, mariners will be informed by a published notice notifying the timing and location of construction/installation activities. In the longer-term, the presence of the offshore facilities and their surrounding exclusion and safety zones will be included on Caspian Sea charts.

10.5.3 Discharge of Mud and Cuttings

In the Phase 2 Project drill cuttings resulting from the 26" surface hole and from the top hole section during pre-drilling will be discharged. The results of mud and cuttings dispersion modelling are presented in **Chapter 8**. Discharge of cuttings is also anticipated from Phase 1 and Phase 3 drilling activities. In all cases the area of impact on benthic organisms will be limited to within a few hundred metres of the discharge site. Impacts resulting from the different phases of the FFD will therefore not overlap. East Azeri and West Azeri will be approximately 9 km and 5 km respectively from the Phase 1 installations. Phase 3 will be approximately 40 km from Phase 1. The FFD will obviously impact a larger seabed area than each phase considered separately, but the overall area will still be minor compared to the total seabed area of the Azerbaijan sector of the Caspian Sea. Recolonisation of impacted areas by benthic organisms will occur after cessation of drilling.

10.5.4 Other Discharges to the Marine Environment

Black and grey waters and putrescible wastes will be discharged from the Quarters platforms of the various phases of the FFD. The impacts of discharges of this type are low as described in **Chapter 8** and there is no potential for cumulative impacts since the receiving environment will have ample capacity to assimilate the organic and chlorine loadings in question and the waste steams will not contain chemicals that are persistent or will bioaccumulate.

The cooling water discharges associated with both Phase 1 and Phase 2 have been modelled and the results indicate the water quality standard required by the IFC are maintained at all times even in the vicinity of the C&WP platform where the largest discharge volumes will occur. The copper-chlorine technology utilised as anti-fouling in the cooling water system uses a very low input of these components as discussed in **Chapter 8**. Although copper, as a heavy metal, would have some persistence in the environment, the levels in the discharges are a likely to be close to the ambient levels in Caspian Sea Water.

10.6 Air Emissions

10.6.1 Air Emissions Modelling

The possible cumulative impact of air emissions on air quality at receptor locations have been investigated taking into consideration the various phases of the FFD and the Shah Deniz Development.

The air quality impacts were modelled using the dispersion model AERMOD-Prime. Modelling included the offshore C&WP platform with all equipment installed for both ACG Phase 1 and Phase 2. These offshore emissions were modelled to assess the impact that they may have at onshore locations.

Average NO2 and SO2 concentrations were predicted at pre-determined receptors corresponding to sensitive onshore locations (see **Table 10.2**). Input information included process conditions, meteorological data, topography of the area and buildings in the vicinity that may influence the airflow. The modelling assumed continuous operations throughout. Normal operations were assumed to show the effect of start up of the different phases up to peak production, as well as Emergency Shut Down situations with flaring for ACG FFD Phase 1, 2, 3 and EOP, and separately for Shah Deniz Stage 1. The addition of low NOx burners was also considered. It should be noted that predictions from offshore are inaccurate due to the large distances involved; therefore they merely give an indication of air quality effects.

Overall, a conservative approach was assumed, therefore the predictions are almost certainly over-estimates of the actual levels that are likely to arise in practise. Due to the unknown concentration of H_2S in the reservoir (500 ppm was assumed), SO_2 predictions are uncertain; further modelling will be carried out once the concentration of H_2S has been determined. Predicted Environmental Concentrations (PEC) were calculated by adding the predicted values to the background values as determined by the baseline study (see **Section 6.2.3**).

The current international air quality standards and guidelines used in assessing the significance of the predicted concentrations of SO_2 and NO_2 are presented in **Table 10.1**.

Table 10.1: International Standards and Guidelines of Air Quality used

Pollutant	Air Quality Objectives		
	Concentration μgm^{-3}	Averaging period	International Standard or guideline
Nitrogen Dioxide	200	1 hour mean (99.8%ile)	WHO, EC, UK
	40	Annual mean	WHO, EC, UK
Sulphur Dioxide	266	15 minutes (99.9%ile)	EC, UK
	50	Annual mean	WHO

NB 99.9%ile = standard not to be exceeded more than 35 times per year

The significance of PEC values was assessed relative to the relevant Air Quality Standard (AQS) using the percentage ratio PEC/AQS. The AQS refers to the maximum concentration of a substance in the environment that is acceptable for safeguarding human health or other exposed species (Environmental Analysis Cooperative, 1999). Below these exposure levels any effects on the species concerned are not considered harmful.

In the majority of scenarios, predictions gave NO_2 levels less than 30% of the AQS. **Table 10.2** compares PEC with the relevant AQS for a "normal operations scenario".

Table 10.2: 2010 ACG Phases 1, 2 & 3, Shah Deniz C&WP "normal operations" nitrogen dioxide emissions

Receptor	AQS $\mu g.m^{-3}$	Background $\mu g.m^{-3}$	Process Contribution NO_2 $\mu g.m^{-3}$	PEC $\mu g.m^{-3}$	PEC/AQS %
Maximum hourly average (99.8%ile)					
Sangachal Town	200	8	41	49	25
Railway Barrier	200	6	45	51	26
West Hill herders	200	6	51	57	29
Cheyildag	200	6	43	49	25
Cement works	200	6	50	56	28
Cement camp	200	6	40	46	23
Annual average					
Sangachal Town	40	4	1.5	5.5	14
Railway Barrier	40	3	2.4	5.4	14
West Hill herders	40	3	2.8	5.8	15
Cheyildag	40	3	2.2	5.2	13
Cement works	40	3	<1	4	10
Cement camp	40	3	3	6	15

The worst-case scenario during periods of flaring gave PEC 40-48% of the AQS for NO_2, in other words, still below levels that are harmful to the environment. This is shown in **Table 10.3**.

Table 10.3: 2006, EOP normal operations, ACG Phase 1 second year start up, Shah Deniz start up – "worst case scenario" nitrogen dioxide emissions

Receptor	AQS μgm^{-3}	Background μgm^{-3}	Process contribution NO_2 μgm^{-3}	PEC μgm^{-3}	PEC/AQS %
Maximum hourly average (99.8%ile)					
Sangachal Town	200	8	65	73	37
Railway Barrier	200	6	73	79	40
West Hill herders	200	6	90	96	48
Cheyildag	200	6	85	91	46
Cement works	200	6	50	56	28
Cement camp	200	6	75	81	41
Annual average					
Sangachal Town	40	4	4	8	20
Railway Barrier	40	3	6	9	23
West Hill herders	40	3	6	9	23
Cheyildag	40	3	3.5	6.5	16
Cement works	40	3	2	5	13
Cement camp	40	3	5	8	20

Predicted SO_2 levels were also below the AQS levels although the data needs to be verified once the concentration of H_2S in the reservoir is determined.

The results of the modelling show that the predicted emissions of NO_2 and SO_2 are all well within the Internationally accepted Air Quality Standards.

10.6.2 CO_2 Emissions

Cumulative CO_2 emissions from the ACG FFD and Shah Deniz Developments are shown in **Figure 10.6**. Information on the sources of CO_2 for Shah Deniz and ACG Phase 1 can be found in their respective ESIAs. Information on the CO_2 sources for Phase 2 has already been provided in **Chapters 3 and 5** of this document.

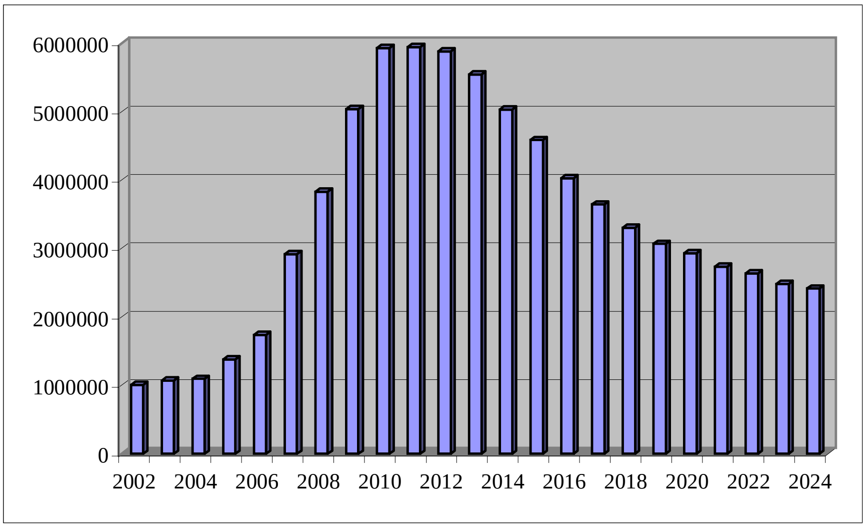


Figure 10.6: Estimated cumulative CO_2 emissions generated from from ACG FFD and Shah Deniz FFD (tonnes)

10.7 Terminal Construction

The land acquisition at Sangachal for the development of terminal facilities will provide enough land for both the ACG and Shah Deniz FFD requirements. Terminal construction will begin with the development of the ACG Phase 1 facilities adjacent to the existing EOP facilities and will progress more or less directly through the construction programmes for all ACG FFD phases and Shah Deniz FFD Stages. This planning and integration and also footprint minimisation was part of the Phase 1 strategy and Early Civils assessment. The issues related to the Early Civil Works and Terminal Construction have been fully covered in two earlier ESIAs which have been approved by the MENR (URS, 2001,2002) and are in the public domain and will therefore not be further addressed in this report.

10.8 Socio-Economic Impacts

10.8.1 Noise and Community Disturbance

The existing noise levels at the nearest sensitive receptors, measured during the November 2001 Baseline Noise Survey, are below the World Bank Guidelines of 45 dB(A) for night time and 55 dB(A) for day time for residential locations, and 70 dB(A) for day and night time for commercial locations (See **Section 6.2.4**).

A noise modelling study was undertaken by Halliburton KBR (2002) to assess the likely community noise impact of the various phases of the proposed expansion at the Terminal (see also **Section 9.6.1**). This was achieved through the development of a plant noise model, which predicts operational in-plant and community noise levels. Construction activities were not included in the modelling study. The predicted community noise levels were then evaluated in the context of the World Bank Environmental Guidelines. Results of this study are shown in **Chapter 9, Table 9.4**.

The modelling indicates that once Phases 1, 2, and 3 of ACG and Shah Deniz are operational, the current location of the herders settlement will be subject to noise levels of 46.9 dB (A). This exceeds the World Bank Guidelines by nearly 2 dB (A). When only Phase 1, and 2 of ACG and Shah Deniz operate these noise levels are below this threshold.

However, by the time Phase 3 is completed, noise requirements of WB are unlikely to be exceeded as;

- For health and safety reasons, it is most likely that the herders settlement will be relocated. (see **Section 9.3.1**);
- The modelling data presented in **Table 9.4** is based on estimates for specifications of equipment to be used for Phase 3. The modelling has therefore used a worst case scenario. Remodelling with detailed equipment information is expected to result in lower estimates; and,
- If, following further modelling, noise levels exceed World Bank Guidelines, the project will mitigate the effects through the use of acoustic barriers.

In addition the noise modelling, based on the preliminary data, shows that noise levels with ACG FFD HP flare or Shah Deniz HP flare in operation may exceed World Bank Guidelines at the residential receptors. However, the noise impacts of the flares are short-lived, as the HP flares will only operate for periods between 3 minutes and two hours. The peak noise levels will occur for periods of between 3 and 15 minutes when the flow of gas is at the maximum. The Project is designed and will be operated to minimise flaring. The flare is necessary to provide protection to the facility itself, the workers and neighbouring community and the environment. The likelihood of the flares having to operate together is very low. Although the Guidelines will be exceeded, the impact of noise from flaring is not considered to be significant and there is little likelihood of an adverse impact on individual well being or community well being.

10.8.2 Health

The cumulative impact of the additional employment and increase in incomes should have a significant beneficial effect on the health status of the families of those employed in the Baku and Garadagh areas, particularly in the settlements of Sahil, Umid and Sangachal. The ability to buy more and better food coupled with enhanced access to improved health care through purchase of health services will be major contributing factors to the improvement in health. However, this improvement will be for a limited period and be at its most prominent during the peak construction period. It will continue at a lower level (in terms of numbers) during the construction phase.

Conversely, health will be threatened by transmission of communicable diseases through interaction between male workers, based in camps, and local residents. There will be specific measures taken to manage this risk (see **Chapter 9**). Nevertheless, it is likely that an increase in morbidity rates will occur.

There is likely to be an increase in traffic accidents during the main construction period (2002-2007). The upgrading of the Baku-Tbilisi-Astara may contribute to the accident rate for the period of this work, but once completed it may contribute to a reduction in accidents. Thus, the baseline situation will be one in which the base accident rate is lower than at present. Past experience shows, however, that any increase in traffic ‘hours on the road’ (as will occur during the overlapping construction and operational phases) increases the likelihood of accidents. Thus, the impact of an increased accident rate is significant and adverse, and measures are needed to minimise their occurrence. The preparation of contractor transport plans will make an important contribution, but other actions taken in conjunction with the Ministry of Transport and highway police (signage and traffic management measures) will assist in traffic accident prevention.

The air modelling carried out (see **Section 10.6.1**) showed that the predicted emissions of NO_2 and SO_2 are all well within the internationally recognised air quality standards and guidelines. There is some evidence to suggest that children in Umid settlement may exhibit higher than average incidences of respiratory diseases and they may therefore be a vulnerable group. It is likely that overall air quality is improving and that the air quality predictions are conservative. However, AIOC will undertake regular monitoring of air emissions (see **Chapter 12**) to ensure that the situation does not deteriorate.

10.8.3 Impacts of Land take

The current land acquisition at Sangachal for the development of terminal facilities would take enough land for both the ACG and Shah Deniz FFD requirements. Terminal construction has begun with the development of the ACG Phase 1 facilities adjacent to the existing EOP facilities and will progress more or less directly through the construction programmes for all ACG FFD phases and Shah Deniz FFD Stages. No significant cumulative impact is expected on the assumption that the herders are resettled successfully according to the RAP.

10.8.4 Employment

Figure 10.7 illustrates the overall employment figures for both the ACG as a whole and a Maersk semi-submersible rig construction project (described as ‘Maersk’ in **Figure 10.7**).

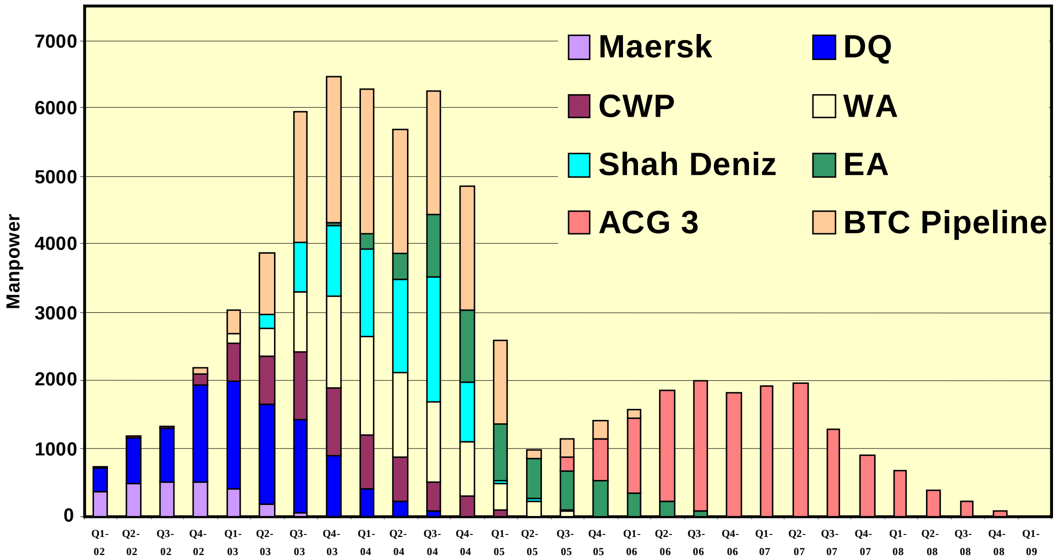


Figure 10.7: In-country employment from construction of ACG FFD, Shah Deniz and Maersk project

It can be seen from **Figure 10.7** there are two employment peaks. The first peak consists of approximately 6000 workers over a period between the third quarter of 2003 and late 2004 followed by a very rapid demobilisation of workers in a very short time in late 2004 and early 2005. The second peak is much lower at approximately 1500 workers over a slightly longer period between the fourth quarter of 2005 and the third quarter of 2007. The operation of the multiplier (1.25 and 1.5 see **Chapter 7**) shows that there will be approximately between 1500 and 3000 indirect jobs created at the time of the first peak and between 370 and 750 during the second period of peak employment. In addition to these jobs ACG Phase 2 will contribute towards maintaining the jobs of the 960 people (of which 80% are national staff) providing accounting, human resources, HSE, community relations, external affairs and administrative support services for all activities. This level of central function staff could potentially grow 10% by 2005.

Approximately 80% of these jobs will go to Azeri nationals with about 40% being sourced within the Baku and Garadagh district jurisdictions. Depending on which construction yard is chosen, a significant proportion of the jobs may be taken by workers living near or within the ‘travel to work’ distance of the Zykh, Fels, or the SPS yards. The number of jobs created has a significant beneficial impact at national, regional and local levels. The demobilisation, however, constitutes a significant adverse socio-economic impact, as there is not likely to be a project of sufficient scale to absorb the redundant workers. This impact is likely to be exacerbated in the immediate vicinity of the Sangachal terminal (Sahil, Umid and Sangachal settlements) because the Garadagh cement plant is likely to shed more jobs in the near future.

These figures reflect the employment required for construction phases. Many of the employees will have worked and will be working on similar construction projects in the region. Following demobilisation, it is expected that some of the more mobile workers may go internationally (e.g. to Kazakhstan or Russia). The number of employees required for operations of each phase is not yet established. It is expected that there will be less demand for unskilled/semi-skilled employment and will not involve large scale local employment.

The ACG FFD and Shah Deniz Development Projects will form a significant proportion of the local economy. Other sectors currently operating in the region may experience a reduced availability of suitable staff and increased costs. Once the project is completed, if these other sectors are unable to recover due to labour non-availability and/or lack of finance to enable investment in machinery to replace labour, then the project may not have left a sustainable legacy. The current unemployment and under-employment levels are such that a labour shortage is not considered likely, although there may be very localised instances of a skills shortage. The training programme to be operated by BP will help ensure that such eventualities are unlikely to occur. Hence, this impact is considered to be insignificant.

The impact of the rapid demobilisation may be mitigated by devising a schedule for all project-related activities that will reduce the rate of demobilisation and/or the numbers demobilised over a specific time period. Also, other measures implemented through a Social Investment Programme may assist in alleviating this major increase in unemployment through;

- skills capacity-building;
- creation of conditions conducive to small and medium size business creation; and/or
- expansion and supply chain management to ensure maximum local input to supporting the ACG and related investments.

10.8.5 Macro-Economic Issues

As discussed in **Chapter 9** there will be a significant impact on the national economy through capital and operational expenditures and tax contributions to the national government. Management of accrued revenues is primarily a matter for the national government decision-making, but AIOC and the major financial backers (e g. IFC) are legitimate stakeholders in this process.

As **Figure 10.2** illustrates, the ACG FFD production from 2004 to 2024 will contribute towards overall revenue flows from the oil and gas industry to the Azerbaijan economy. For example;

Beyond 2005, oil revenues from the projects will rise very rapidly and represent a considerable proportion of GDP. The revenues, if sensibly used, have the potential to result in real and sustained economic progress in Azerbaijan. Management of oil and gas revenues is the responsibility of the Azerbaijan government. AIOC's role, beyond these contributions, will be that of a long-term business stakeholder and be based on good business practice.

The revenues from the output of contracted oil and gas deposits (including the ACG and Shah Deniz field) will make an important contribution to the State Oil Fund. This Fund will be an important source of monies for the Government to alleviate poverty and improve the well being of its citizens.

One important macro-economic issue relates to the impacts of increased oil and gas investment and revenues on the national economy. There are a number of possible dangers collectively referred to as the ‘Dutch disease’ (Rosenberg, and Saavalainen, 1998);

- Risks to monetary stability and increase in the inflation rate;
- Appreciation of the national currency making imports cheaper and exports dearer. The exchange rate appreciation can inhibit the development of new non-oil or gas traded activities; and,
- Promotion of ‘rent-seeking’ behaviour and increased risk of consequent growth in

bureaucracy and corruption.

Avoiding 'Dutch disease' requires the economy to be insulated from the revenue inflows and their effects on the macro-economy neutralised. This requires disciplined and prudent fiscal management, which may be supported by the creation and sound operation of some sort of oil fund. Managing these risks will be the responsibility of the Government of Azerbaijan assisted by International Finance Institutions as appropriate and will play an important role in preserving the value and effectiveness of the State Oil Fund.

As indicated in **Chapter 9**, the optimisation of the business multiplier is the area where BP can make a significant contribution to Azerbaijan and the communities where the profits are made. BP will take practical action to maximise the multiplier through;

- promoting integration of the labour market;
- helping to improve vocational training and developing human resources;
- promoting the creation of new jobs and businesses;
- sharing international standards and business practices;
- establishing technology development and transfer; and,
- establishing physical and institutional infrastructure.

10.8.6 Supplier Network

A considerable amount of equipment and materials is required for the ACG and Shah Deniz field developments. The ACG Phase 1, ACG Phase 2, and Shah Deniz Stage 1 projects estimate that $1.7 billion, $1.3 billion and $1 billion respectively, will be spent in Azerbaijan during the projects' construction. Wherever possible these would be sourced in Azerbaijan. However, specialist equipment and materials (such as drilling tools) will need to be imported, as the Azerbaijani supplier network is at present relatively undeveloped. As discussed in **Chapter 9**, local infrastructure is currently being developed or upgraded, such as the SPS yard and quayside upgrades, rig upgrades, development of pipe lay barge, and the development of a new training centre in Baku.

It is anticipated, however, that as the developments progress through the construction and installation phases and on to operations, the continued demand for goods and services will result in the development of Azeri companies able to service the oil and gas industry. An established service industry will increase employment opportunities in the region.

Operating expenditure (Opex) typically involves a few large value contracts as well as many smaller value low-volume contracts across many sectors, which can be split into four key support areas;

- Support services to run day-to-day operations;
- Engineering/equipment (such as hardware);
- Special services (for example high skill consultancy); and,
- Modifications (such as hardware modifications).

Total Opex covering the ACG and Shah Deniz projects in Azerbaijan is expected to rise to $150 million per annum by 2006, peaking at $310 million by 2010. **Figure 10.8** below illustrates the breakdown of Opex costs between the different phases of ACG and Shah Deniz. Two-thirds of this expenditure is expected to go to suppliers and contractors. Support services and special services pose the greatest increase in value of spend between 2001 and 2006. For support services, spend is projected to increase from $28 million in 2001 to $90 million by 2006.

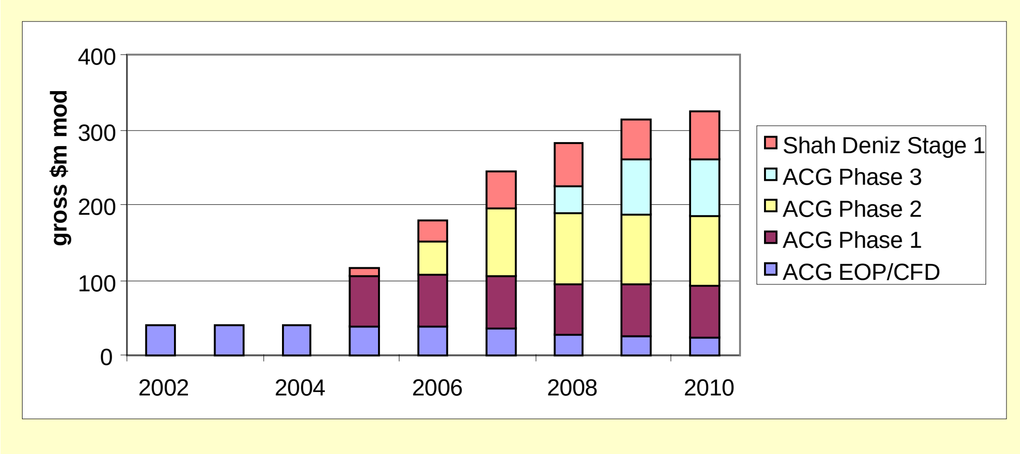


Figure 10.8: Opex costs for BP operated sites in Azerbaijan between 2002 and 2010

Whilst perhaps not occurring in the near future, the development of a strong Azeri supplier network can be regarded as a positive cumulative impact resulting from the ACG and Shah Deniz FFD projects. The Social Investment Programme can make a positive contribution to ensuring that a sustainably growing Azeri supplier network becomes a reality.

10.8.7 Transport Systems

Increase in transportation, from all project phases will result in a cumulative impact on the main transport corridors to/from Azerbaijan, within Azerbaijan and on the transport infrastructure in the Garadagh District in particular.

The transportation methods for the offshore installation of pre-fabricated components and pipe sections for the subsea pipelines are still under evaluation and are not yet finalised. It is likely that a considerable volume of the facility components and pipe sections will be transported by sea and the number of vessels required for this transportation is significant. Sea transportation routes could include: from Europe to the Black Sea and into the Caspian through the Don Volga canal; from Europe to the Baltic Sea and into the Caspian through the Baltic Volga canal; and from the Middle East across the Persian Gulf to Iran.

Figures for current volumes of traffic are not available for all sections of all routes. However, it is known that vessel traffic is extremely high in the Turkish Straits generally, and especially in the Bosporus Strait. There are reported to be upwards of 600,000 small boats operating in the Bosporus and Canakkale Straits. In addition, Tengiz oil from Kazakhstan began transportation by tanker from the Russian Black Sea port of Novorossiysk in July 2001, which increased the tanker traffic volume through the Bosporus. At this stage of the development of transportation logistics it is unknown how many vessel transfers will be made through the Straits, however there is expected to be an increased volume of vessel traffic.

Some of the loads into the Black Sea will be transferred onto rail wagons or international road trailer for onward transfer and it is also unknown at this stage how many loads will pass onto the Caspian Sea through the Baltic-Volga and Volga-Don canals.

The increased volume of cargo movements is likely to be within the capacity of the main transport modes and routes and the impact is not significant.

There will be increased pressure on transport systems within Azerbaijan and especially within Baku and Garadagh Executive Power areas. There is spare capacity in terms of the railway and highway connections (especially after the highway improvements are completed) between Baku and the Sangachal area. The increased pressure on the transport system will be obvious to the local population and may be considered by some to be a nuisance (health aspects are considered above in **Section 10.8.2**). This impact is not significant.

To ensure that any impacts cause the minimum disruption a detailed logistics plan has been developed that will take into account the existing infrastructure, road safety and transportation management in the area in order to reduce congestion, the potential for accidents and inconvenience to other road (and rail) users. The contractors will also be required to prepare Transport Management Plans. All staff requiring transport to and from the site would commute using private buses so as not to impact on the public system.

10.8.8 Domestic Energy

Consultations, during preparation of previous ESIAs, have identified access to energy as a major concern for the communities living near AIOC's project activities. These concerns stem from limited availability of energy in communities, caused by lack of infrastructure, intermittent supply and poverty. There are high expectations that AIOC, as an international energy company, will lend resources, either through engagement in government planning, technical assistance or direct investment, to help address these challenges.

The solution to the access to energy issue is complex and is not AIOC's responsibility. However, as the major foreign investor with a long-term commitment to secure operations in these countries, AIOC has an interest in the effectiveness of the domestic energy systems. The ACG projects will contribute to improvements in the domestic energy systems as a result of the financial resources they will provide to governments, the energy supplies they will generate, and the technical and other support that the projects bring.

In particular, the AIOC PSA specifies that associated gas is delivered free of charge to SOCAR. The benefits of this have already been seen in the EOP where the gas taken by SOCAR has significantly reduced the amount of flaring required. It will be increasingly important as the ACG projects develop offshore and the volume of associated gas increases. Gas is necessary to meet Azerbaijan’s energy needs, and the associated gas can supply Baku area power stations and help meet local energy demands.

10.9 Summary of Key Cumulative Impacts

10.9.1 Environmental Impacts

Key environmental impacts are related to the following issues:

Pipeline Construction Activities

Nearshore pipeline construction activities will impact areas of benthic communities and sea grass and red algae beds in Sangachal Bay. Recovery of affected communities may be delayed by successive waves of construction activity associated with the different phases of the ACG and Shah Deniz Development Projects. BP is studying the options for the nearshore pipeline sections to be laid concurrently in order to minimise area of impact and reduce recovery time.

Air Emissions

Air emissions modelling has shown that Internationally accepted Air Quality Standards for NO_2 and SO_2 will not be exceeded at receptor locations as a result of emissions from the ACG FFFD and Shah Deniz Developments.

10.9.2 Socio-Economic Impacts

Key cumulative socio-economic impacts are related to the following issues:

Noise

Noise levels for the combined ACG Full Field and Shah Deniz developments at Sangachal will exceed the World Bank Guidelines of 45 dB(A) (night time) in the area currently occupied by herders by approximately 2 dB(A). This change is not significant because it is unlikely that the herders will remain in their current location. If they do remain then acoustic barriers will be used to reduce the noise level below the **Guideline level.**

Also, there is a very low probability of the Guidelines being exceeded, for all residential receptors, for very short periods due to emergency flaring events (particularly when both HP fares may be operational together). The low probability and short time periods involved mean that the community well being impact is not significant.

Health and Safety

There is a range of significant potential health impacts that include increased incidence of transmissible diseases, increased probability of road accidents, and possibly, although the data are inconclusive, increased respiratory problems, especially in Umid. The mitigation of these impacts are discussed in **Chapter 9**.

Employment

There are significant positive, but short-term, social impacts associated with the ACG/Shah Deniz projects as a result of increased employment and enhanced family incomes. There is a significant adverse impact associated with rapid demobilisation. These impacts can be both enhanced and mitigated (to some extent in the latter case) through training, building capacity of local SMEs who can employ construction workers, and managing the supply chain for the project to maximise local employment opportunities.

Economy

The ACG/Shah Deniz developments will provide a considerable contribution to the Azerbaijan economy, through taxes, employment and other social investment activities.

Transport

There will be increased pressures on a number of external and internal transport modes and routes. It is expected that the impacts will not be significant because the magnitude of the change will be small in relation to the available capacities. There may be very localised areas of difficulty, but these can be avoided or minimised by preparation and implementation of a logistics plan focusing on important transport modes and corridors in Azerbaijan (Baku-Sangachal).

Domestic Energy

The gas produced through the project and the contributions to the local economy from Phase 2 will contribute to BP's wider efforts to assist in addressing the current issues of ensuring access to energy for the wider Azerbaijan population.

11. TRANSBOUNDARY IMPACTS

This Chapter addresses issues which may have impacts that could potentially cross the territorial boundaries of Azerbaijan into neighbouring countries. The issues are discussed in the context of the Convention on Environmental Impact Assessment in a Transboundary Context 1991 (the Espoo Convention).

11.1 Introduction

In 1991 at Espoo in Finland, the Convention on Environmental Impact Assessment in a Transboundary Context 1991 (The Espoo Convention) was established. The Espoo Convention addressed the need to enhance International cooperation in assessing transboundary environmental impacts and highlighted a number of activities that are likely to cause significant adverse transboundary impact, amongst them, offshore hydrocarbon production.

Under the terms of the Espoo Convention on Environmental Assessment, a transboundary impact is defined as:

> *"any impact not exclusively of a global nature, within an area under the jurisdiction of a Party caused by a proposed activity the physical origin of which is situated wholly or in part within the area under the jurisdiction of another party".*

The Espoo Convention requires that if the proposed activity is found to cause significant adverse transboundary impact, the ‘party’ i.e. the Government of the Country undertaking the activity shall, for the purposes of ensuring adequate and effective consultations, notify any other party (other Country’s Government) which it considers may be affected by the activity as early as possible and no later than when informing its own public about the proposed activity. Therefore, if it is believed that transboundary effects are possible in neighbouring states from the Phase 2 activities, it is the responsibility of the Azerbaijan Government to inform these states of the potential effects. However, in the case of the ACG Phase 1 Project a mechanism of communication has been adopted which is likely to also apply to the ACG Phase 2 ESIA. In the course of the Phase 1 ESIA the obligations for notification and consultation under the Espoo Convention have been discussed with the MENR. AIOC has submitted copies of the Phase 1 ESIA to the Caspian Environmental Programme who will in turn forward the document to the other Caspian riparian states as agreed via a letter from MENR.

An issue to be considered in the context of transboundary impacts is the fact that the jurisdictional boundaries of the Caspian Sea have not been fully agreed and there is an ongoing debate between the five riparian states concerned.

11.2 Transboundary Impacts from Phase 2 Activities

A number of potential transboundary impacts were discussed in the Phase 1 ESIA and were deemed to have low significance in this context, i.e.;

- Transportation of equipment and resources;
- Introduction of exotic marine species; and,
- Regional health issues.

As the ACG Phase 2 Project does not differ significantly from Phase 1 in respect of the above issues they will not be discussed further in this report.

In the same way as for Phase 1, the Phase 2 Project will result in significant sourcing of supplies and employment outside Azerbaijan. This has already been discussed in **Section 9.2 and 9.21.**

Other issues associated with Phase 2 that may have significant transboundary implications requiring reference to the Espoo Convention are;

- Accidental oil spills; and to a lesser extent,
- Atmospheric pollution.

These are discussed in the sections below.

11.2.1 Atmospheric Pollution

Acid rain

Acid rain has historically been shown to lead to stress of ecosystems and damage to natural and man-made structures such as those constructed of limestone.

Acid rain and its impact have been reported downwind of cities and countries where extensive and sustained generation of SO_2 and NO_x in the atmosphere has taken place. For example, impacts of acid rain have been reported within ecosystems several hundreds of kilometres downwind of the UK, where UK based industry, transport and high domestic fuel consumption lead to the generation of over 1,500,000 and 1,700,000 tonnes of SO_2 and NO_x respectively (Year 2000 data, NETCEN UK National Inventory). Currently, reliable historical or forecast inventories for emissions of NO_x and SO_2 for Azerbaijan are not available.

In the same way as discussed for the Phase 1 ESIA, the amounts of SO_2 and NO_x produced in connection with the Phase 2 Project would not result in any significant transboundary impacts downwind of the proposed development sites.

11.2.2 Accidental Oil Spills

As discussed in **Section 8.4.2** the probability of a large scale oil spill resulting from ACG Phase 2 activities is very low. However, if such an event were to occur it is possible that the spill could impact neighbouring countries. The modelling exercise that has been carried out has been described in full in **Section 8.4.2** and shows that in some circumstances beaching of oil could be expected in Turkmenistan and Iran. It should be noted that these refer to a "worst case" scenario and do not take into account the implementation of the Oil Spill Response Plan (see **Section 8.4.2**) which is designed to respond to the spilled oil close to the source and minimise oil reaching the shoreline where the most sensitive ecological components are located. BP would work with the Azerbaijan Government to implement regional and international response to any spill.

12. ENVIRONMENTAL AND SOCIO-ECONOMIC MANAGEMENT

This Chapter deals with overall Environmental and Socio-Economic Management strategies that will be in place for the ACG Phase 2. These strategies and solutions will build upon those developed for the Phase 1 Project.

12.1 Introduction

Chapters 8 and **9** identified a number of mitigation measures selected to reduce potential impacts that may arise from Project activities. The most important of these are reiterated here together with appropriate monitoring programmes that will be in place to provide input on the accuracy of impact predictions. The implementation of the Phase 1 Project will also provide information on the performance of mitigation measures and monitoring programmes to further enhance, if necessary, the Phase 2 mitigation activities.

BP Azerbaijan Business Unit's environmental policy includes commitment to legislative compliance, continual improvement and pollution prevention. The Environmental Management System described below in **Section 12.2** indicates how the assurance process is geared to continuous improvement and adjustment to ensure the best possible environmental performance. **Section 12.4** describes the Socio-Economic mitigation and monitoring issues applicable to the project.

12.2 Environmental Management Systems

Environmental performance will be one of the key performance parameters of the ACG FFD project throughout all of its phases. As discussed in **Chapter 2** Health, Safety and Environmental (HSE) expectations to be adopted by BP management are described in the document 'Getting HSE Right.' This Corporate standard is implemented at a local level through the formulation of an HSE policy that is Business Unit specific both in terms of the nature of the operations to be conducted and in terms of local conditions, customs and legislation.

During the construction and commissioning of the Phase 2 facilities, all Corporate, national, and international requirements will be embodied in a comprehensive Environmental Management Plan (EMP). ACG contractors will be required to align their own EMPs and implement environmental procedures for their specific work activities.

During operations, the HSE Policy will be implemented through a range of instruments including environmental plans, guidelines, procedures and instructions. These instruments will form part of BP Azerbaijan Business Unit's existing Environmental Management System (EMS).

Environmental management follows a hierarchical structure as shown in the **Figure 12.1.** The philosophy sets the requirement for policy that in turn sets the requirements for the management system to be developed. The management system requires a management plan to be implemented for site-specific operations. The plan is dependent upon a number of components that ensure that environmental issues are managed in a practical sense on a day-to-day basis.

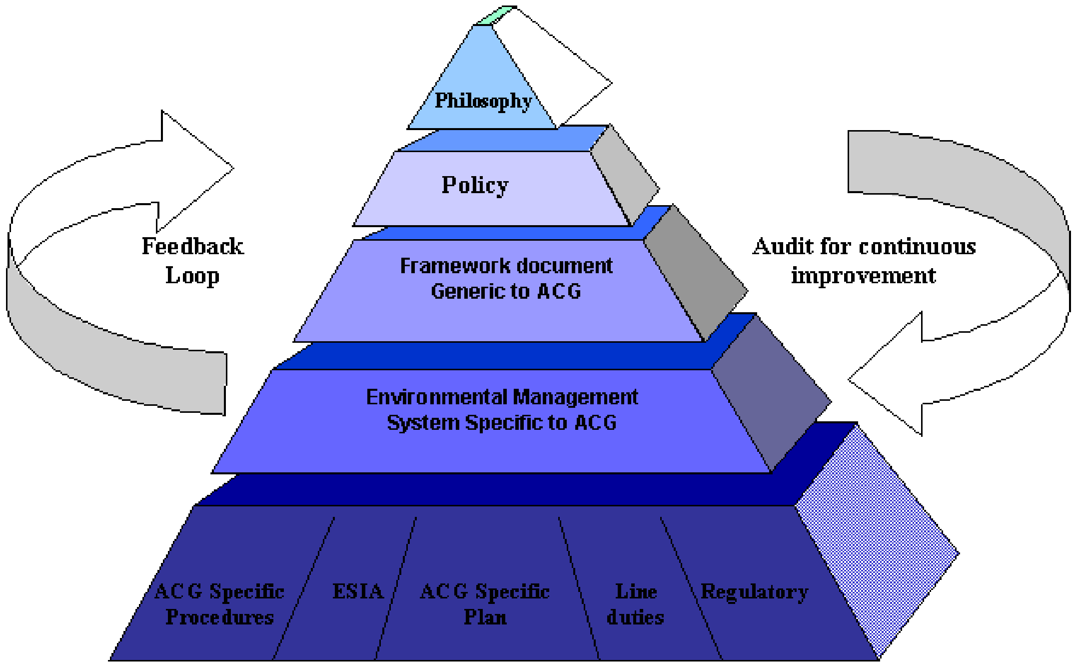


Figure 12.1: Hierarchy of the environmental management system (EMS)

BP will allocate the necessary resources to implement the EMS. There are many synergies between ACG Phase 1 and 2 such that many of the environmental issues will be dealt with in a similar fashion after ACG Phase 2 enters the project implementation stage. There will therefore be a need for a central environmental assurance function to cover both Projects. However, the delivery of each Project's site-specific environmental commitments will remain the responsibility of the individual on-site construction or operation teams.

The responsibilities of the central environmental assurance function will include;

- Developing environmental strategies for the ACG Projects (e.g. for produced water, waste compliance monitoring, etc.);
- Ensuring consistency in EMS implementation;
- Alignment between BP corporate, the Business Unit and the individual Project's standards and expectations; and,
- Ongoing review and advice on environmental improvement and performance throughout all ACG Projects.

The Azerbaijan Business Unit EMS is certified to the international standard for environmental management systems, ISO 14001, and has been structured to address the following elements;

- Identification of significant environmental impacts;
- Identifying legal and other requirements;
- Establishing objectives and targets;
- Establishing environmental management programmes;
- Establishing environmental improvement plans;
- Defining organisation and responsibilities;
- Operational control;
- Control of contractors and suppliers;

- Document control;
- Records;
- Monitoring and measurement;
- Emergency preparedness and response;
- Training, awareness and competence;
- Communication;
- Non-conformances, corrective and preventative actions;
- Audit; and,
- Continuous improvement.

BP's expectation is that Upstream projects should be certified under ISO 14001 within the first year of operation. When the operational phase is entered, the project EMS will be incorporated within the overall Azerbaijan Business Unit EMS, which is already certified. Compliance with ISO 14001 requirements will be verified by an external audit. The project EMS will address all project activities and will be the key mechanism under which the environmental plans will be implemented and monitored.

In the same way as for Phase 1, the results of this ESIA for Phase 2 and the identified significant impacts will be used to develop an Environmental Aspects Register that will enable the identification of the specific environmental objectives and goals for the project and drivers for the project EMS.

It is important to note that environmental assessment is an iterative process and the results of this ESIA have identified impacts at the Front End Engineering Design (FEED) stage of the project planning process. The process will continue through further project definition during the Detailed Design stage. Project specific procedures and training requirements for personnel can then be developed with the roles and responsibilities of company and contracted personnel clearly stipulated. As a result, impacts and thus management methods will change over time.

12.2.1 Contractor Management

The environmental performance of all project contractors will clearly be fundamental in the successful environmental management of the project. The implementation of site-specific environmental procedures will be the responsibility of the principal contractors involved including;

- The drilling contractor;
- The offshore facilities construction contractors;
- The pipelay contractor;
- The terminal construction contractors;
- The shipping contractor; and,
- The waste management contractor.

AIOC will implement contractor management procedures to ensure compliance by the contractors with all stipulated mitigation measures. The project and contractors will be required to demonstrate that their environmental management procedures and systems meet the stipulated requirements. A bridging document will be prepared to link the AIOC standards and procedures with contractor procedures. The bridging document will consist of information on the following:

1. Commitment and Accountability;
2. Human Resource Management;

3. Communications;
4. Incident Reporting and Documentation;
5. Emergency Preparedness;
6. Documentation; and,
7. Change Management.

A series of contractor audits will be conducted by AIOC to ensure that the commitments to environmental mitigation and management are being implemented.

Environmental and social awareness and management training programmes will be developed and these will include sessions to ensure an understanding of the main sensitivities present in the project activity areas. The training programmes will be a key component in the successful implementation of procedures adopted to mitigate and monitor environmental impacts. All personnel will receive such training and training records will be kept. Personnel selected for specific responsibilities associated with environmental management procedures will receive more detailed training in these areas. These will include, but not be limited to;

- Waste management training;
- Chemical and fuel handling and transfer procedures;
- Spill prevention, handling and response training;
- Site specific environmental sensitivities
- Environmental audit; and,
- Environmental monitoring.

The Contractor Management Strategy as outlined above is the same as described for the ACG Phase 1. This is logical since Phase 1 and Phase 2 are both components of the same FFD Project. It is clearly important that BP carefully monitors the implementation of these systems. In the case of Phase 1, specific BP personnel have been assigned the responsibility of working with the main contractors to support the development of appropriate procedures and plans during 2002. The tracking of the required contractor documentation is held on file by BP. Beyond 2002, responsibility for overseeing that these plans are implemented will be passed to the existing BP HSE teams who are already acting as onsite environmental inspectors. It is anticipated that the Phase 2 Project will develop in a similar fashion and benefit from the experience of the preceding Phases of the FFD Project.

12.2.2 Waste Management

A number of waste streams will be generated during the development of the ACG Phase 2 project. Waste management will be designed to comply with international, BP corporate and national regulator requirements, standards and expectations.

Waste management is primarily concerned with hazardous and non-hazardous waste products, which are either not handled as part of specific process design technologies (e.g. produced water) or their disposal is not possible at any given time due to unavailability of the particular system (e.g. cutting re-injection system).

Waste management will consist of two main components;

- Site waste management; and,
- Contractor (or third-party) waste management.

Site waste management

Each BP operation or construction site will have a waste management procedure, developed as part of an overall environmental management system developed at each site and these procedures will include principles of;

- Waste minimisation and recycling;
- Primary waste segregation; and,
- Waste storage and handling at the site.

Contractor (or third-party) waste management

A contractor (or third-party) responsible for transportation, storage or disposal of waste from AIOC operations will be required to have a system including following procedures;

- Waste transportation;
- Waste storage and handling procedures; and,
- Waste treatment and disposal.

Specifically a contractor (or third-party) will be expected to;

- Demonstrate a commitment to a waste management practices that comply with both AIOC and national regulator requirements;
- Have all required permits/licences/approvals in place;
- Have an auditable and traceable document management system; and,
- Have no discharges to the water or ground unless an appropriate regulatory authority has given discharge consent.

All mandatory requirements will be built into contractual arrangements and contracted companies will have to demonstrate compliance. AIOC has a duty of care on waste management issues outside of its immediate control and employs a “cradle to grave” philosophy, which will be applied in its operations activities during the ACG Phase 2 development.

Integrated Waste Management Plan (IWMP)

It is recognised that the increased amount of work associated with FFD and Shah Deniz developments will create significant volumes of waste. To accommodate these wastes, BP will develop an Integrated Waste Management Plan (IWMP). Its main purpose will be to assess waste streams arising from existing and future activities and identify and recommend an option for each waste stream. The plan will include waste elimination as the first option, followed by waste reduction, recycling and as the last resort disposal.

Waste streams

Non-hazardous waste

Currently, non-hazardous domestic wastes are disposed of at the licensed landfill site in Azerbaijan. This site has the necessary municipality permit for handling this type of waste. Future improvements could include the development of incineration facilities followed by landfill of the incinerator ashes. This improvement option is dependant on incineration facilities becoming available through the licensed site operator. The key advantage of incineration is a significant reduction in the volume of waste going to landfill. It also removes the gas and leachate issues associated with the landfilling of putrescible wastes. The ACG Phase 2 project will encourage waste operators to improve existing facilities wherever possible. Non-hazardous non-combustible solid waste mainly comprises scrap metal and will be recycled.

Hazardous Wastes

The disposal routes for hazardous wastes generated as part of the ACG project are under evaluation. Currently, all hazardous wastes generated by the ACG project and detailed below will be stored at the Serenja waste storage site until suitable treatment & disposal facilities are identified. The Serenja site will be operated in line with International best practice with regard to handling and storage of hazardous waste materials.

NWBM drill cuttings

The ACG Phase 2 design philosophy includes cuttings re-injection offshore at the platforms. However, should this option become unavailable for a specific period of time, other treatment technologies associated with shipping cuttings ashore are being evaluated. These include;

- Bioremediation;
- Incineration in the kilns at the Karadaq Cement Plant; and,
- Thermal desorption.

The selection process for suitable treatment and disposal options involves assessment against critical criteria including safety, cost, environmental impact, engineering feasibility, and Regulator approvals.

Wastes handled as part of Specific Process Design Technologies

For some waste streams, the ACG Phase 2 project uses a number of disposal options, which are integrated into the design of the facilities. These are as follows;

- Produced Water Onshore;
- Produced Water Offshore;
- Hydrotest Water;
- NWBM drill Cuttings from 16”, 12 ¼” and 8 ½” hole sections; and,
- Produced Sand.

The systems dealing with these waste streams are separately described in the various parts of this document.

12.3 Environmental Mitigation and Monitoring

12.3.1 Overview

AIOC will conduct its operations in a manner that aims to minimise the impact of its operations on the environment. The mitigation measures that will be in place to ensure that this objective is achieved are indicated in the Environmental Impact Assessment (**Chapter 8**).

As shown in **Chapter 1**, **Figure 1.4**, the findings and commitments of this ESIA report will feed into Environmental Programmes developed for the operation of the Project. These programmes will ensure that there is a system in place to implement the commitments, monitor their performance and adjust if necessary.

Some the most important mitigation measures for the ACG Phase 2 Project have already been incorporated at the design stage. These include;

- Drill cuttings reinjection. NWBM will be used for sections of wells below the 26” section. A cuttings reinjection (CRI) system will be in place so that all NWBM mud and cuttings will be reinjected into dedicated disposal wells offshore. If there is any downtime on the CRI system then NWBM cuttings will be contained and shipped to shore for disposal. Drilled out cement will also be reinjected or shipped to shore;

- Disposal of produced sand into dedicated disposal wells offshore using the CRI or ship to shore if the CRI is out of operation; and,
- Reinjection of produced water offshore for reservoir pressure maintenance. If the reinjection system is out of operation for any reason then treated produced water may be discharged.

In addition there are a number of issues that are still under evaluation, i.e.;

- Disposal of the hydrotest water for the Phase 2 30" oil pipeline;
- Disposal of hydrotest water from the testing on onshore installations at the Sangachal Terminal;
- Storage and disposal of produced water from the Sangachal Terminal;
- The possible need for disposal of sulphur should the levels of H_2S be sufficiently high in the Azeri reservoir well stream to require separation so that the produced oil is of marketable specification; and,
- Development of an Integrated Waste Management Plan.

Once final solutions have been selected for these issues, the environmental implications will be the subject for separate assessments and appropriate documentation will be provided to the MENR and other stakeholders as applicable.

The impact assessment process as described in **Chapter 8** has identified a number of Key Issues related to the ACG Phase 2 Project, which have been discussed in further detail. These issues were identified as either having a **medium** environmental significance or being the subject of stakeholder concern. These issues are divided into those related to Normal Operations and Accidental Events as follows;

Normal Operations

- Nearshore Construction Activities;
- Discharge of seawater with viscous sweeps (or WBM as a contingency), cuttings and cement;
- Intake and discharge of cooling water offshore;
- Discharge of other effluents offshore; and,
- Radioactivity.

In addition there are issues related to Normal Operations that have been discussed in **Chapter 10:** Cumulative Impacts, i.e.;

- Air emissions both onshore and offshore.

Accidental Events

- Hydrocarbon spills both offshore and onshore.

The mitigation measures associated with these key issues and other important mitigation measures are brought together in **Sections 12.3.2** and **12.3.3**.

12.3.2 Mitigation Measures – Normal Operations

Nearshore Construction Activities

There is evidence that the finger pier that has been left in place after completion of the EOP construction has resulted in some changes in the coastal erosion processes in Sangachal Bay. For this reason AIOC has decided to remove the finger piers after each construction activity and stockpile the materials for use in subsequent trenching operations.

There is a concern that the planned construction activities in Sangachal Bay for the various phases of the ACG and Shah Deniz Projects could have a cumulative impact on the ecosystem components in the Bay. This is discussed fully in **Chapter 10**. The concern relates to successive waves of construction impacting upon flora and fauna and prolonging the overall recovery time. AIOC is studying the options for nearshore pipeline sections to be laid concurrently.

Discharge of WBM, Cuttings and Cement

Discharge of mud and cuttings from drilling operations is an issue that receives considerable attention from the national Regulators and other stakeholders. For the ACG Phase 2 Project AIOC have a number of measures in place to mitigate any impacts related to discharges of mud and cuttings. There include;

- Using sea water and viscous sweeps to drill the 26” hole section – a section from which cuttings will be discharged;
- A more complex WBM mud is a contingency option for drilling the 26” hole section. Selection of components for the WBM system will ensure that only low-toxicity and biodegradable chemicals will be used, as confirmed by toxicity testing with Caspian species. Barite used will meet the following criteria for heavy metals: Hg < 1 mg/kg and Cd < 3 mg/kg dry weight. There will be no discharge of drilling fluids unless the maximum chloride concentration is < 4 x the ambient concentration; and,
- The cuttings discharge caisson is situated at a water depth of 97 metres – well below the productive upper water column layers.

Intake and Discharge of Cooling Water Offshore (Largest Volumes from CW&P Platform)

Mitigation or control measures that have been applied to the Cooling water System include;

- The seawater intake is at 101 m depth and the outlet at 67 m depth well below the productive upper water column layers;
- Modelling has confirmed that the thermal discharge is in compliance with IFC Guidelines (see **Section 8.3.3**); and,
- The antifoulant system employs chlorine and copper that work synergistically enabling the use of low concentrations.

Discharge of Other Effluents Offshore

Domestic and sanitary waste will be treated in accordance with PSA requirements and IFC standards and are assessed as having a low environmental impact.

Impacts related to long term discharges of produced water offshore are mitigated by the fact that the produced water will be mixed with sea water for reinjection to maintain reservoir pressure. Only intermittent discharge of produced water will occur in situations of downtime for the reinjection system. The produced water will be treated to reduce oil and grease such that the concentrations will not exceed <42 mg/l on a daily basis or <29 mg/l monthly average.

Radioactivity

As part of the EOP radioactivity has been measured regularly in the produced sand and crude oil stream from the Chirag-1 Platform. There have been no indications of elevated radioactivity levels. This practice is anticipated to continue as part of ACG Phase 1 and 2 in order to ensure that the situation is the same for the Azeri reservoir.

Air Emissions Onshore and Offshore

Mitigation measures applied to reduce emissions include;

- Low NO_x burners on Sangachal Terminal gas turbine generators;
- Low NO_x burners on Sangachal Terminal crude oil heaters;
- Flare gas recovery at Sangachal Terminal;
- Diversion of dehydration unit off-gas into the flare header (for control of BTEX and CH_4) – applies to East and West Azeri PDUQs, the C&WP platform and Sangachal Terminal; and,
- Crude oil storage tank design at Sangachal Terminal.

Summary

Table 12.1 summarises potential impacts related to key issues and the associated mitigation measures.

Table 12.1: Summary of mitigation/enhancement measures associated with key environmental impacts for Normal Operations

Aspects/Potential Impact	Mitigation / Enhancement Measures
Nearshore pipeline construction: • Impacts on coastal hydrodynamics relating to finger pier construction and presence. • Impacts on benthic fauna, sea grass and red algae in Sangachal Bay related to habitat destruction by finger piers and trenching operations • Impacts related to smothering of benthic organisms, sea grass and red algae caused by sediment redistribution.	• Removal of finger pier and stockpiling of material for use in later phases of the FFD • Timing of nearshore pipelay operations to reduce number of construction operation and related disturbance (see Cumulative Impacts **Chapter 10**)
Discharge of WBM mud and cutting from template and platform drillings: • Impacts on the benthic fauna related to smothering. • Impacts related to high chloride discharge • Impact on planktonic organisms resulting from increased water turbidity	• Use of low toxicity chemicals in WBM • Dilution of WBM before discharge to reduce chloride level to below 4 x ambient • Discharge caisson 97 m below sea surface to reduce dispersion and minimise impacts in the productive photic zone
Intake and discharge of sea water for cooling purposes at the PDUQ and C&WP platforms: • Impacts related to intake of water column organisms • Impacts related to discharge of anti-fouling chemicals	• Intake at 101 m below sea surface • Commissioning of modelling to confirm rapid dilution to comply with IFC standard • Synergistic use of copper and chlorine reduces necessary concentrations to low levels
Air emissions from offshore and onshore installations: • Reduction in air quality at onshore receptors • Carbon dioxide emissions • Global warming	• Low NO_x burners on Sangachal Terminal gas turbine generators; • Low NO_x burners on Sangachal Terminal crude oil heaters; • Flare gas recovery at Sangachal Terminal; • Diversion of dehydration unit off-gas into the flare header (for control of BTEX and CH_4) – applies to East and West Azeri PDUQs, the C&WP platform and Sangachal Terminal; and • Crude oil storage tank design at Sangachal Terminal.
Operational impacts of sanitary and domestic waste, temporary short-term discharges of produced water: • Impacts on planktonic organisms (low impact significance but issue of stakeholder concern)	• Compliance with PSA (see **Section 12.3.4**)
Radioactivity • Exposure of flora, fauna or humans to elevated radioactivity levels	• No need for mitigation is anticipated but regular measurements will be undertaken.

Issues that are still under evaluation and where mitigation/enhancement measurers are still being investigated are;

- Disposal of the hydrotest water for the Phase 2 30" oil pipeline;
- Disposal of hydrotest water from the testing on onshore installations at the Sangachal Terminal;
- Storage and disposal of produced water from the Sangachal Terminal;
- The possible need for disposal of sulphur should the levels of H_2S be sufficiently high in the Azeri reservoir well stream; and,
- Development of an Integrated Waste Management Plan.

12.3.3 Mitigation Measures – Accidental Events

The accidental events that have been identified as having potentially the most significant impacts (medium–high) are related to hydrocarbon spills in the marine environment and onshore. These are described in detail in **Section 8.4**. The most important mitigation measure will be the Oil Spill Response Plan that is described in outline in **Section 12.3.5**. **Table 12.2** summarises mitigation measures and includes measures that are related to reducing the probability of an event occurring rather than mitigating the impacts once an event has occurred.

Table 12.2: Summary of mitigation/enhancement/risk reducing measures associated with key environmental impacts for Accidental Events

Potential Impact	Mitigation / Enhancement/ Risk Reduction Measures
Offshore blowout or nearshore pipeline rupture: • Impacts on planktonic organisms • Impacts on shoreline and nearshore communities • Impacts on birds and seals	• Geohazard survey in order to avoid shallow hazards • Burying of pipelines in the nearshore zone • Pigging and maintenance of pipelines • Oil Spill Response Plan
Onshore pipeline leak or rupture: • Impacts on terrestrial ecological components in the vicinity of the pipeline.	• Burying of pipeline • Pigging and maintenance of pipelines • Oil Spill Response Plan

12.3.4 Monitoring Plans

PSA Requirements

The PSA imposes a number of monitoring requirements on the AIOC consortium. These are summarised in **Table 12.3.**

It should be noted that in some cases AIOC has imposed more rigorous discharge limitations than those specified in the PSA. Examples of this are;

- Discharge limitations for oil and grease in produced water must not exceed <42 mg/l on a daily basis or <29 mg/l monthly average; and,
- Residual chlorine at <1.0 mg/l in sanitary waste effluent offshore.

Details of specific Phase 2 design Standards are shown in **Appendix 2**: HSE Design Standards ACG Phase 2.

Table 12.3: Specific monitoring / recording and reporting as required by the PSA

Discharge	Monitored Parameter	Discharge Limitation	Monitoring Frequency	Sampling & Testing
PRODUCED WATER (non-routine only – base case is reinjection)	1. Oil and grease concentration	42 mg/l on a daily basis or 29 mg/l on a monthly average	1.Record daily, report monthly	1.Gravimetric (extraction) test method US EPA 413.1 (79)
DRILLING MUD SYSTEM WBM only to be discharged	1. Toxicity prior to drilling programme start 2. Toxicity during drilling 3.Drilling fluid additives 4. Discharge volume 5. Chlorides content	1.30000 ppm 2. Low toxicity 3 Not applicable 4. Not applicable 5. 4 x ambient	1. Prior to drilling only 2. One sample taken below shale shaker during drilling 3. Daily inventory of mud additives 4. Record daily, report monthly 5. Record daily, report monthly	1.Toxicity 96hr LC-50 (suspended particulate phase (SPP) with *Mysidopsis bahia* following approved test method (superseded by Caspian specific tests) 2.Sample to be tested utilizing Caspian species 3. Record either mass or volume 4. Estimate volume 5. API chloride test
DRILL CUTTINGS WBM cuttings only	1. Volume	1. Not applicable	1.Record daily; report monthly	1.Estimate volume
SEWAGE (SANITARY WASTE)	1. Discharge volume 2. Residual Chlorine	1. No floating solids 2. >0.5 mg/l <2.0 mg/l	1.Record daily; report monthly 2. Record daily; report monthly	1.Estimate volume 2. Hach CN-66-DPD
GREY WATER (DOMESTIC)	1.Discharge volume	1.No floating solids	1.Record daily; report monthly	1. Estimate volume
DECK DRAINAGE AND WASH WATER	1. Volume	1. No visible sheen	1.Record daily; report monthly	1. Estimate volume; record days sheen is observed
AIR EMISSION FROM IC ENGINES/ TURBINES LARGER THAN 500 HP	1. NO_X and CO	1. Manufacturers specification	1.Annually	1. Portable analysers should be calibrated before each test using a known reference gas

Other Monitoring Plans

This section gives a brief overview of the status of the Monitoring Plans relevant to the ACG Phase 2 Project. These will substantially follow on from Phase 1 initiatives and provide continuity of monitoring effort. A planned monitoring strategy will help in quantifying the level of impact that has occurred during field developments. Additionally, environmental monitoring data can enable a better understanding of the processes by which impacts may arise and assist in the development of more effective mitigation plans.

A substantial amount of monitoring work has been carried out in the ACG Contract Area, in the nearshore zone in Sangachal Bay and onshore around the Sangachal Terminal site. Most of the work carried out to date has either been to comply with regulatory requirements, or to fill perceived data gaps. Given the scale of the ACG FFD operations, Phase 2 will carefully consider the outputs from monitoring work completed as part of the Phase 1 studies and subsequently design monitoring programmes that ensure that the ecological status and trends in the receiving environment are adequately captured, in a way which allows the impact (or lack of impact) of FFD activities to be determined with the greatest possible confidence. There is a clear need to devise programmes that take a long term view of monitoring requirements and that take into consideration all Phases of the ACG FFD, the Shah Deniz development and any other activities in the area that may have an environmental impact.

Current monitoring programmes associated with Phase 1 that will provide input for future strategies are summarised below:

Surveys in Sangachal Bay

Planned or ongoing surveys include;

- Seagrass and red algae mapping survey;
- Beach profiling and sediment transport study;
- Fish monitoring survey; and,
- Met-ocean data collection including currents and turbidity measurements.

The purpose of these surveys is to monitor the impacts on the physical and biological environment of Sangachal Bay resulting from the construction activities that have already been carried out and those that will take place in the future.

Sangachal Terminal Area Flora and Fauna Annual Monitoring

Planned continuation of a long-term monitoring programme, including monitoring of the onshore pipeline construction reinstatement.

Onshore Wetlands Survey

Survey to characterise the wetlands in the vicinity of Sangachal Terminal and assess their ecological significance, permanence and vulnerability to Terminal operations.

Watershed Modelling Study

Modelling of the effect that the Terminal Site has had on watershed conditions in the area.

Offshore Benthic Survey

As stated, future plans will build on the results of ongoing and previous studies. A post-drilling benthic survey programme will be designed specifically for Phase 2 in order to monitor the effects of operational discharges and physical disturbance on benthic communities, including drill cuttings discharges at the East and West Azeri platform locations. The survey is likely to include sediment chemistry, water column chemistry and temperature, sediment grain size analysis, sediment total organic carbon (TOC) and benthic macrofauna community assessment.

Air Emissions Monitoring

AIOC has carried out ambient air quality monitoring in the vicinity of the Sangachal Terminal (most recently in 2000, see **Section 6.2.3**). It is intended that further surveys will be carried out in the future. The frequency of these surveys is not defined precisely, but they will occur at a minimum, whenever a new Project Phase, such as ACG Phase 2 comes on line. The surveys will measure SO_2, NO_x and particulates (PM_{10}) for a continuous two-week period.

12.3.5 Oil Spill Response Plan

The key tool for reducing or removing negative impacts as the result of a spill is the Oil Spill Response Plan (OSRP). The purpose of the OSRP is to provide guidance to those involved in responding to an oil spill incident and to initiate all necessary actions to stop or minimise any potential adverse effects of oil pollution on the environment. The primary step in AIOC's response to an accidental release of oil is to first notify the relevant contacts of the occurrence of the incident and to categorise the size of the oil spill, using the following criteria (International Petroleum Industry Environmental Conservation Association, (IPIECA) definitions), to determine the appropriate action:

- **Tier 1**:

  Operational-type spills that may occur at or near a company's own facilities as a consequence of its own activities. An individual company would typically provide resources to respond at this Tier.

- **Tier 2**:

  A larger spill in the vicinity of a company's facilities where resources from other companies, industries and possibly government agencies can be called in on a mutual aid basis.

- **Tier 3**:

  Larger spills where substantial further resources will be required and support from national or international cooperative stockpile may be necessary. Tier 3 incidents are very large, possibly ongoing, spills, which may require additional resources outside Azerbaijan.

This system is internationally recognised as the most pragmatic approach, avoiding excessive costs and seeking shared resources for large, infrequent events. Using this system, the level of response will be dependant on a number of factors including;

- the quantity of oil spilled and spill location;
- the nature of the oil; and,
- the proximity of the oil spill to available resources.

BP has prepared an OSRP for the Azerbaijan Business Unit that addresses: onshore and offshore incidents, incident reporting, oil spill remediation contractor databases and response resource availability. This plan will be updated to incorporate Phase 1 and future phases of development including Phase 2. The plan contains all necessary contact details for appropriate logistical support, together with pertinent contact details for local authorities, NGOs and other relevant bodies for responses to the different tier events. This will allow direction and guidance in responding to an oil spill. The plan will also include an assessment of the adequacy of available response equipment and mobilisation effort required for the spill scenarios identified in the risk assessment with recommendations provided (where necessary). Particular attention will also be paid to appropriate shoreline protection and prioritisation of protection to sensitive coastal areas identified as being at risk from the potential beaching of a large oil spill. A sensitivity map and coastal protection plan have been developed.

The process for developing the OSRP is summarised in **Figure 12.2.**

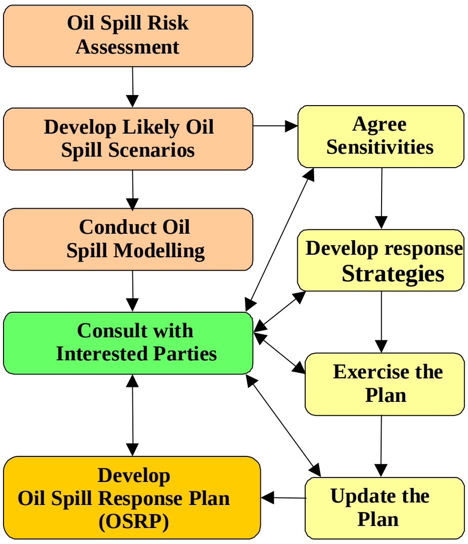


Figure 12.2: Summary of the OSRP process

The littoral states of the Caspian Sea are working towards developing National Oil Spill Response Plans. Azerbaijan has yet to prepare a plan, whilst other states are believed to have plans in various states of completion. Therefore, in the event of an international oil spill incident, where there is a potential for oil to travel into the territorial waters of, for example, Iran or Turkmenistan, oil spill response would be complicated by this fact. As a result, discussions to ensure cooperation and coordination of international effort between neighbouring countries on a spill response exercise will be conducted. This would present a difficult political and logistical situation for any response exercise and this situation is currently under discussion, with an aim of securing agreements on the appropriate response to an international oil spill incident.

BP recognises the potential problems and risks and is working with industry and government to provide international support. To this end BP has provided;

- Financial and technical support and involvement in the delivery of the National Oil Spill Plan Workshop in Baku (November 2001);
- Participation in the Caspian mutual aid initiative and workshop (November 2001); and,
- Financial and technical input with the industry 'steering group' looking at spill response preparedness and mutual aid in the Caspian and Black Sea region.

The BP Azerbaijan OSRP was originally produced to describe the oil spill response arrangements for the facilities and activities that are now known as the EOP. As such, it was based on an assessment of the oil spill risks associated with the Chirag platform, the sub-sea pipeline, the existing Sangachal Terminal operations and the export pipeline. A response strategy was devised and the oil spill response equipment was procured to undertake the required oil spill response. The BP Azerbaijan OSRP still applies to these facilities and activities, but as described above there is an ongoing process to ensure that the risks associated with the Phase 1 and subsequently the Phase 2 developments are taken into consideration. This process together with a preliminary schedule for the Phase 1 OSRP is described in a Framework document currently being produced under the auspices of the Phase 1 Project. Phase 2 will adopt, where appropriate, the systems and strategies developed for Phase 1.

12.4 Socio-Economic Mitigation and Monitoring

12.4.1 Overview

The Socio-Economic Impact Assessment including mitigation measures is presented in **Chapter 9**. This section summarises the mitigation and enhancement measures to minimise the residual impacts, and possibly enhance benefits, of the project. It also provides a summary of appropriate monitoring activities (**Table 12.4**). The purpose of the monitoring programme is to confirm that the mitigation and enhancement measures have occurred, and, to the extent possible, review and evaluate any residual impacts. Where the results of monitoring indicates a deviation from the conclusions of the Phase 2 ESIA, which represents a significant and unexpected adverse consequence, then a focused study into the reasons for the discrepancy needs to be conducted and further mitigation measures developed.

Table 12.4: Summary of mitigation/enhancement actions and monitoring associated with categories of potential social and economic impacts

Potential Impact	Mitigation / Enhancement Measures	Monitoring Programme
Impacts on employment (Overall employment requirements of the project, local employment opportunities, impacts of demobilisation)	• Information centres • Training (both project related and transferable skills) • Tender requirements • Recruitment Procedures • Supply chain management • Project scheduling • Social Investment Programme to assist SME development	• Recruitment monitoring • Periodic audit (employment procedures) • Consultation Reports and monitoring of community attitudes and complaints • Periodic performance reviews of Social Investment Programme
Impact on Livelihoods (nearshore fishing activities, impacts on herding, café/garage owner, impact on sea users)	• Social Investment Programme • Public Consultation and Disclosure Plan • Resettlement Action Plan	• Consultation Reports and monitoring of community attitudes and complaints • Periodic performance reviews of Social Investment Programme implementation and outcomes • Monitoring of Resettlement Action Plan implementation and outcomes including incomes of resettled individuals and families
Impacts on economic development (including regional impacts of transportation of project components)	• Public Consultation and Disclosure Plan • Procurement Policy	• Periodic review of use of local suppliers
Management of workforce	• Camp Management Plan • Codes of Conduct • Public Consultation and Disclosure Plan	• Periodic audits of community attitudes and complaints • Monitoring of implementation and outcomes of Camp Management Plan and Codes of Conduct

Potential Impact	Mitigation / Enhancement Measures	Monitoring Programme
Nuisance and disturbance (Noise, disruption to utilities, and transportation infrastructure)	• Public Consultation and Disclosure Plan • Complaints procedure • Transport Management Plan • Dust management • Flaring policy and flare design and maintenance	• Periodic audits of community attitudes • Noise monitoring • Periodic audits of implementation and outcomes of Transport Management Plan Complaints log
Cultural heritage impacts	• Archaeological Management Plan	• Periodic audits of implementation and outcomes of Archaeological Management Plan
Use of social infrastructure	• Transport management Plan • Road Repairs • Social Investment Programme	• Collaborative monitoring (with Executive Power organisations of status of social infrastructure provision against government norms and/or standards) • Periodic performance reviews of Social Investment Programme implementation and outcomes
Impacts from infectious diseases (respiratory illnesses, vector-borne diseases, sexually transmitted diseases, gastrointestinal illness).	• Screening of workers • Communicable disease strategy • Camp Management Plan • Code of Conduct • Public Consultation and Disclosure Plan • Information Disclosure • Waste and sewage management • Additional air quality impact modelling • Communicable Diseases Strategy	• Periodic checks on health data obtained by the Executive Power organisations (e g. respiratory illness rates at sensitive locations such as Umid settlement) • Ground level concentrations of particulates, NOx and SOx at sensitive receptors (especially Umid settlement)
Impacts from non-infectious illness (road traffic accidents, stress, impacts on diet and lifestyle and occupational illnesses).	• Camp Management Plan • Public Consultation and Disclosure Plan • Community road safety training.	• Periodic checks on health data obtained by the Executive Power organisations • Monitoring of implementation and outcomes of Camp Management Plan

Mitigation and enhancement measures can be divided into two components. On the one hand there are the measures that will form part of the project management systems. These include the camp management plan, codes of conduct, waste management plan, transport management plan, recruitment procedures, procurement policy, tender requirements, resettlement action plan and training plans.

On the other hand, there are mitigation and enhancement measures that have to be developed and implemented with greater emphasis on collaboration and community engagement. In particular, the Social Investment Programme depends on partnership with stakeholders. This will be managed in collaboration with NGOs, the government, and affected communities. This is still in an early stage of development, but may include supporting local supply chains, building capacity of small and medium enterprises outside the oil and gas sector, providing assistance to increase access to energy at the domestic level and other cultural and education programmes.

Social monitoring can be divided into two categories of collaborative monitoring and direct monitoring by project staff. Collaborative monitoring will involve AIOC working with government agencies, NGOs or local communities (the combination of partners depends on the issue), to establish acceptable indicators. The partnership can also be used to collect the data and to review next steps together. For all monitoring, the project will clarify indicators, roles, responsibilities and details in the Environment and Social Action Plan.

12.4.2 Direct Project Monitoring

Monitoring of recruitment and training

As discussed in **Chapter 9**, one of the primary concerns of local communities is that of recruitment. It is therefore important that an accurate record of local employment is maintained by the project. Recruitment monitoring will have two components:

- The project will confirm the process listed in the employment plan. This involves regular auditing to ensure that recruiting processes are followed such that there is preference given to the residents of Sahil, Umid and Sangachal, and the process is transparent and fair; and
- The project will maintain employment figures and report on percentage of jobs provided to each settlement, location of skilled, unskilled employees. The summary employment data will be publicly available.

This information will be used in order to rectify any shortcomings in the levels of local employment achieved.

Training will be monitored through a similar approach to the recruiting. There will be periodic audits to confirm that the training process is being followed. In addition, data will be disclosed indicating number of people trained, settlement, age, gender and skills trained in. This information will be backed up by an annual survey in the three settlements of Umid, Sangachal and Sahil on the skills level within the community.

The training and employment impacts can also be verified through comments provided through consultation and the complaints procedure.

Camp management plan and code of conduct

This plan and the codes of conduct will be monitored through periodic audits that the processes for implementing these plans are being followed. This will be verified by annual questionnaires to workers to confirm their knowledge of the plans and through regular consultation with local communities combined with review of complaints received by the project.

Procurement policy

The procurement policy aims to maximise the number of local contracts and to build the local capacity to provide services and resources. This policy will be monitored through a periodic audit to confirm it is being implemented. In addition, figures will be collected in terms of size and number of contracts awarded to local firms.

Transport management plan

The monitoring of the transport management plan will have several components: Firstly, the project will review numbers of employees commuting to the Sangachal terminal, to SPS or other construction yards. For these same employees, the project will record the following variables for each employee: the location of their residence, the mode of transport, and the times of transport. Secondly, the project will maintain figures on density on traffic related to movement of equipment of materials. Thirdly, there will be an audit to ensure traffic management procedures are being implemented (e.g. maintenance of vehicles).

12.4.3 Collaborative Monitoring

Health Monitoring Programme

Regular analyses of community and employee-related health trends is needed to establish trends in the incidence of disease and injuries that have been identified as being important (see **Chapter 9**). Such monitoring will identify, early, any developing disease epidemics or other health threats that require urgent protective measures to be taken. Such monitoring will provide data that can be used by AIOC when/if there are allegations that its activities may be the cause of increases in morbidity and/or mortality both amongst its workforce and in the Sangachal area. With regard to the local population, health statistics are collected locally and reported to the Ministry of Health. AIOC will consider entering into consultations and negotiations with the local health authority to help ensure that official health statistics include the health impact issues that are of interest to AIOC. Thus, there will be a set of statistics that meet the needs of the local health authority, the Ministry of Health and AIOC.

The monitoring will include;

- Levels of infection (such as TB, STD including HIV/AIDS, gastro-enteritis, malaria, hepatitis B influenza) among employees;
- Incidence of workplace and traffic accidents; and,
- Incidence of respiratory infections in Sangachal and Umid.

AIOC will be responsible for monitoring employee health trends and the effectiveness of the Communicable Diseases Strategy and health awareness campaigns and actions.

Social Investment Monitoring

The Social Investment Programme has as a central theme the need to build the capacity of communities, businesses and other organisations such that the project leaves a sustainable legacy following decommissioning. Therefore, a detailed monitoring programme on all these activities, which enhance the impacts of the project, is critical. Each of the Social Investment Programme proposed projects will have an ultimate goal and subsidiary objectives and a series of actions. Monitoring will be conducted on each of these levels to first confirm the actions are completed, and second to review if the objectives and goals of the Programme-related projects are met. These projects will be conducted by implementing agencies and will be audited and reviewed by AIOC.

AIOC will also commission periodic, strategic independent reviews on the performance of Social Investment Programme(s). This will assess the change in livelihoods of affected people and the various organisations that support them. These studies will use both a combination of participatory, interview and quantitative approaches. These studies will be supplemented by periodic workshops/fora where implementing agencies, affected people and project staff can review progress of these Programmes.

13. MAIN CONCLUSIONS

This Chapter summarises the main conclusions regarding the Environmental and Socio-Economic Impact Assessment of the ACG Phase 2 Project.

13.1 Introduction

This ESIA has considered the environmental and socio-economic impacts of the ACG Phase 2 Project as well as cumulative impacts related to the FFD and other related projects in the area. The document has described the selected Phase 2 development option and the baseline-receiving environment. All relevant aspects of the project that have the potential for impacting the environment, including the socio-economic environment have been assessed, together with the mitigation and control measures that will be in place. The majority of the residual impacts were found to be of low significance. Impacts that were still significant or were of particular stakeholder concern have been discussed in greater detail, together with an overview of the plans for the future environmental and socio-economic management of the project. The assessment identified a number of issues that are still being evaluated and where appropriate documentation will be provided to the MENR at a later date.

13.2 Environmental Impact Assessment of Normal Operations

The ACG Phase 2 Project Design has incorporated a number of measures to mitigate some of the potentially most important environmental impacts. These include;

- Drill cuttings reinjection. NWBM will be used for sections of wells below the 26” section. A cuttings reinjection (CRI) system will be in place so that all NWBM mud and cuttings will be reinjected into dedicated disposal wells offshore. If there is any downtime on the CRI system then cuttings will be contained and shipped to shore for disposal. Drilled out cement will also be reinjected or shipped to shore;
- Disposal of produced sand into dedicated disposal wells offshore using the CRI or ship to shore if the CRI is out of operation; and,
- Reinjection of produced water offshore for reservoir pressure maintenance.

The Environmental Impact Assessment process took into consideration all operations connected with the ACG Phase 2 Project together with their associated aspects and sources of impact. This process enabled the identification of key issues, which together with issues of particular concern were assessed in greater detail. The key issues that were identified for Normal Operations comprised;

- Nearshore Construction Activities;
- Discharge of WBM drill cuttings and drilling mud offshore;
- Intake and discharge of cooling water offshore; and
- Other offshore operational discharges; and,
- Air emissions.

As part of the additional assessment process model simulations were carried out for marine discharges as well as for air emissions both onshore and offshore. The overall conclusions are presented below for each of the above issues.

In addition to the above, the ESIA process has identified a number of issues that are still in the evaluation stage and where there are a number of possible options. The issues in question are;

- Disposal of the hydrotest water for the Phase 2 30” oil pipeline;

- Disposal of hydrotest water from the testing of onshore installations at the Sangachal Terminal;
- Storage and disposal of produced water from the Sangachal Terminal;
- The possible need for disposal of sulphur should the levels of H_2S be sufficiently high in the Azeri reservoir well stream; and,
- Development of an Integrated Waste Management Plan.

Once final solutions have been selected for these issues, the environmental implications will be the subject for separate assessments and appropriate documentation will be provided to the MENR and other stakeholders as applicable.

13.2.1 Nearshore Construction Activities

The laying of pipelines in the nearshore requires the use of finger piers specifically constructed for this purpose. For the EOP a finger pier construction was used and left in-situ following completion of installation. Localised erosion/accretion has been identified on either side of the structure and a similar pattern of seabed mobility could be expected for further piers left in the bay.

Changes in sediment patterns will impact on benthic fauna community composition as this is usually strongly correlated with particle size distribution. Increase in turbidity and sedimentation could also impact on the sea grass and red algae habitats in Sangachal Bay. The base case for construction in Sangachal Bay is therefore removal of finger piers after use in a manner designed to minimise sediment resuspension.

The trenching required to bury the nearshore pipeline will obviously result in a degree of habitat destruction and impacts related to sediment deposition and turbidity. While the area affected by pipeline installation and particularly trenching would be kept to a minimum by utilising the same pipeline corridor for the developments, the current construction schedule has pipelines for the various ACG FFD Phases and Shah Deniz FFD Stages being installed at different times. However, BP is studying the options for nearshore pipeline sections to be laid concurrently (see **Section 13.5** Cumulative Impacts).

13.2.2 Discharge of Mud and Cuttings

Drill cuttings produced from the 26” hole section will be discharged to the marine environment. The base case drilling fluid is seawater with added viscous sweeps (natural organic cellulose or gum substances). The sweeps are non-toxic and biodegradable. The assessment was therefore centred on a more complex Water Based Mud (WBM) system that may be used as a contingency. The assessment concluded that the impacts of the discharges of WBM cuttings will be confined to a limited area around the East and West Azeri platforms, which will be caused by physical smothering of benthic communities that are widespread in the area rather than any toxicity to marine organisms. Recolonisation and recovery of impacted areas would be expected after cessation of drilling, although differences in particle size distribution may result in differences in faunal composition compared to those present before the start of drilling operations.

The extent of impacts will be verified by a post-drilling monitoring survey.

13.2.3 Intake and Discharge of Cooling Water

This is an issue that has been carried forward in the discussion because it has been the subject of stakeholder interest.

It was assessed that mortality of planktonic organisms entrained in the water intake will have no impact on populations of these organisms.

The modelling of the cooling water discharge from the East Azeri, West Azeri and C&WP platforms indicate that temperatures will rapidly drop to within 3°C of ambient and any impacts to aquatic organisms would therefore be limited to the immediate vicinity of the discharge.

Biofouling control in the cooling water system is achieved by using a system that releases both chlorine and copper. These components work synergistically at very low levels (in the order of 10 ppb and 1 ppb respectively in the intake caisson). These levels will be much lower in the cooling water at the point of discharge and further dilution will occur on release to the marine environment. No measurable impacts on marine organisms are anticipated.

13.2.4 Other Offshore Operational Discharges

Other discharges to the offshore environment resulting from ACG Phase 2 operations are;

- Sanitary and domestic waste water; and,
- Produced water during periods of down time for the water reinjection system.

For sanitary and domestic waste water it was concluded that the level of dilution and dispersion in the marine environment would be such that the discharges would not result in any significant impacts on water quality or marine organisms.

Discharges of produced water would occur only as a contingency in the event of any down-time on the water injection facilities and treatment prior to discharge would be to standards that exceed the requirements of the PSA resulting in only very low concentrations of oil in the discharge stream, the effects on marine organisms in the mixing zone were expected to be insignificant. Overall, impacts associated with produced water discharges were considered to be of low significance.

13.2.5 Air Emissions

Air Quality

Air modelling has been carried out to investigate the impacts of the ACG FFD and Shah Deniz Development combined on the air quality in the vicinity of the Sangachal Terminal (see **Chapter 10** – Cumulative Impacts and **Section 13.5**). It was concluded that internationally accepted Air Quality Standards for NO_2 and SO_2 will not be exceeded at receptor locations as a result of emissions from the ACG FFD and Shah Deniz Developments.

13.3 Environmental Impact Assessment of Accidental Events

A range of accidental events scenarios was examined. The key issues identified and examined further were;

- Hydrocarbon spills in the marine environment resulting from a well blow-out, pipeline rupture or other accidental event; and,
- Hydrocarbon spills onshore resulting from a pipeline rupture or loss of storage containment.

Oil spill modelling was carried out as part of the assessment process for marine oil spills.

13.3.1 Marine Hydrocarbon Spills

The results from the oil spill modelling indicate that in the unlikely event of an offshore blowout in the ACG Contract Area, the area of high probability for oil pollution is restricted to the open sea, towards the south-southeast. There is however a 5 to 10 %

probability of oil reaching the coastline of the Caspian, with the highest probability in the winter season. The coastal area that could be contaminated with oil (the area of influence) stretches from south of Baku to the Kura River delta. The areas of influence also include sections of the Iranian and Turkmenistan coastline.

In the unlikely event of a pipeline leak or a pipeline rupture, this may occur at any point along the pipeline route. As the major part of the pipeline is located in nearshore waters south of the Absheron peninsula, this is also the area most likely affected by a nearshore pipeline leak or rupture.

In the ACG Phase 1 ESIA, an offshore pipeline rupture was modelled, and the model results were comparable with the results from an offshore blowout.

Based on the probability for presence of oil from accidental events, the spatial and the temporal distribution of Valued Ecosystem Components, the following areas were identified as having the highest risk for impacts;

- **The vicinity of the landfall at Sangachal**. The area has a high probability of contamination from a pipeline leak and rupture. The entire area has water depths less than 10 m, and seagrass communities are observed within the area. In addition, seabirds are distributed in these nearshore waters throughout the year and on the Pirsagat Islands;
- **The eastern part of the Absheron peninsula and islands**. This area has a high probability of oil contamination from a pipeline leak or rupture. It also has a high probability of oil from an offshore blowout in the winter season. Caspian seals are frequent in this area in summer. The area also contains shoreline of high sensitivity;
- **The Kura River delta**. This area is within the area of influence from an offshore blowout in the winter season. The area is important for fisheries, are nursing grounds for juvenile sturgeons, and also has high densities of seabirds throughout the year. A significant part of the shoreline in this area is of high sensitivity; and,
- **An area that includes the Kyzyl-Agach Bay**. Although this is outside the area of influence as defined by the oil spill modelling, it is still designated as a potential risk area since Kyzyl-Agach is a Ramsar site, containing bird populations of global significance. This, combined with a high sensitivity shoreline ranks this area as extremely vulnerable.

The risk of impact to Valuable Ecosystem Components (VECs) (particularly shoreline and coastal) will be reduced by implementation of the Oil Spill Response Plan that has the key aim of containing the oil as close to the source as possible and minimising oil reaching the nearshore areas.

The possibility on an oil spill reaching the Iranian or Turkmenistan coast would require notification of these countries in accordance with the Espoo Convention (see **Chapter 11**).

13.3.2 Onshore Hydrocarbon Spills

Hydrocarbon spills at the Sangachal Terminal will generally be contained by bunds. The oil storage tanks are in bunded areas that have the capacity to contain the tank contents and the distance between tanks is designed to prevent a fire in one tank spreading to others. The tanks are also designed to withstand earthquake events. It was concluded that any spills within the terminal area are unlikely to affect an area beyond the boundary of the terminal site.

Between the landfall and the terminal the pipeline crosses a wetland area that drains into a stream flowing into the Caspian to the north east of the landfall. It is likely therefore that a spill in the pipeline section between the landfall and the terminal could potentially result in contamination of the pipeline corridor, the wetland area and the coastal margin. Impacts would be greater in the small wetland areas than in the semi-desert areas. Generally the amount of habitat that could be affected is likely to be limited in extent compared to the overall habitat distribution.

The probability of significant onshore spills will be reduced by the maintenance and inspection procedures that are in place.

The implementation of the Oil Spill Response Plan will seek to contain any spills and reduce the environmental impacts to a minimum.

13.4 Conclusions of the Socio-economic Impact Assessment

The conclusions are summarised in **Chapter 9** (**Section 9.11**). To reiterate: the key positive impacts include: a significant positive impact on the national economy of Azerbaijan through capital and operational expenditures and tax contributions to the national government; direct and indirect employment, albeit short-term, created by the project and the training provided to build the capacity of local populations to work in both the oil and gas and other sectors. Also, there is likely to be an improvement in health due to the increased incomes.

They key negative impacts are potentially associated with unrealised expectations of employment in the settlements of Sangachal, Umid and Sahil. Following demobilisation, there will be significant impacts in terms of unemployment, as there is unlikely to be any immediate projects, of a similar scale requiring employment. This can be mitigated to a certain extent by implementation of the following measures;

- Management of unemployment through early implementation of training in transferable skills;
- Clear communication to workers regarding their contracts; and,
- Collaboration with other projects to maximise alternative employment possibilities following demobilisation.

As regards cumulative impacts, the FFD and related projects will have a significant positive impact on the national economy of Azerbaijan through capital and operational expenditures and tax contributions to the national government. However, there are a number of possible dangers related to the impacts of increased oil and gas investment and revenues on the national economy, i.e.;

- Risks to monetary stability and increase in the inflation rate;
- Appreciation of the national currency making imports cheaper and exports dearer; and
- Growth in bureaucracy and corruption.

Managing these risks will be the responsibility of the Government of Azerbaijan assisted by International Finance Institutions as appropriate. Other socio-economic impacts related to Phase 2 are covered in **Section 13.5.2** below.

13.5 Cumulative Impacts

13.5.1 Environmental Impacts

Key environmental impacts are related to the following issues:

Pipeline Construction Activities

Nearshore pipeline construction activities will impact the benthic communities and sea grass and red algae beds in Sangachal Bay. Recovery of these communities may be delayed by successive waves of construction activity associated with the different Phases of the ACG and Shah Deniz Development Projects. BP is studying the options for nearshore pipeline sections to be laid concurrently.

Air Emissions

Air emissions modelling has shown that internationally accepted Air Quality Standards for NO_2 and SO_2 will not be exceeded at receptor locations as a result of emissions from the ACG FFFD and Shah Deniz Developments.

13.5.2 Socio-Economic Impacts

Key cumulative socio-economic impacts are related to the following issues:

Noise

Noise levels for the combined ACG Full Field and Shah Deniz developments at Sangachal will exceed the World Bank Guideline of 45dB (A) (night time) in the area currently occupied by herders by approximately 2 dB (A). This change is not significant because it is unlikely that the herders will remain in their current location. If they do remain then acoustic barriers will be used to reduce the noise level below the Guideline level.

Also, there is a very low probability of the Guidelines being exceeded, for all residential receptors, for very short periods due to emergency flaring events (particularly when both HP fares may be operational together). Formally, the increase in noise above the Guidelines may be considered significant because a Guideline has been breached. However, the low probability and short time periods involved mean that the community well-being impact is not significant.

Health and Safety

There is a range of significant potential health impacts that include increased incidence of transmissible diseases, increased probability of road accidents, increased respiratory problems, especially in Umid. The mitigation of these impacts are discussed in **Chapter 9.**

Employment

There are significant positive, but short-term, social impacts associated with the ACG/Shah Deniz project as a result of increased employment and enhanced family incomes. There is a significant adverse impact associated with rapid demobilisation. These impacts can be both enhanced and mitigated (to some extent in the latter case) through training, building capacity of local SMEs who can employ construction workers, and managing the supply chain for the project to maximise local employment opportunities.

Economy

The ACG/Shah Deniz development will provide a considerable contribution to the Azerbaijan economy, through taxes, employment and other social investment activities.

Transport

There will be increased pressures on a number of external and internal transport modes and routes. It is expected that the impacts will not be significant because the magnitude of the change is small in relation to the capacities. There may be very localised areas of difficulty, but these can be avoided or minimised by preparation and implementation of a logistics plan focusing on important transport modes and corridors in Azerbaijan (Baku-Sangachal).

13.6 Transboundary Impacts

Issues identified that could have significant transboundary implications requiring reference to the Espoo Convention (see **Chapter 11**) are;

- Accidental oil spills; and to a lesser extent,
- Atmospheric pollution.

These are discussed below:

13.6.1 Atmospheric Pollution

Acid Rain

It was concluded that the amounts of SO_2 and NO_x produced in connection with the Phase 2 Project would not result in any significant transboundary impacts downwind of the proposed development sites.

13.6.2 Marine Oil Spills

The Oil Spill Modelling carried out for the ACG Phase 2 Project has identified the potential for a large-scale accidental event to impact Iran and Turkmenistan. However, the probability of this occurrence is very low. The results of the Oil Spill Modelling are discussed in **Section 13.3.1.**

13.7 Environmental and Socio-Economic Management

The ESIA has identified a number of possible impacts and associated mitigation and control measures. As described in **Chapter 12**, the ACG Phase 2 Project will use the findings of the ESIA as input into an Environmental Management Plan and socio-economic management strategies. These systems will ensure that the feedback as a result of auditing and monitoring, together with training of staff and contractors will enable the objective of continuous improvement and best possible environmental performance to be achieved.

Taking all of the issues raised in this report into consideration and evaluating potential positive and negative impacts it is concluded that there is an overall economic and social benefit from the continued development of the Phases of the ACG fields.

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AZERI, CHIRAG & DEEP WATER GUNASHLI
FULL FIELD DEVELOPMENT PHASE 2

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT

TECHNICAL APPENDICES

SEPTEMBER 2002

APPENDIX 1
ACG PSA EXTRACT

ARTICLE XXVI

ENVIRONMENTAL PROTECTION AND SAFETY

26.1 Conduct of Operations

Contractor shall conduct the Petroleum Operations in a diligent, safe and efficient manner in accordance with generally accepted international Petroleum industry standards and shall take all reasonable actions in accordance with said standards to minimise any potential disturbance to the general environment, including without limitation the surface, subsurface, sea, air, lakes, rivers, animal life, plant life, crops, other natural resources and property. The order of priority for actions shall be the protection of life, environment and property.

26.2 Emergencies

In the event of emergency and accidents, including but not limited to explosions, blow-outs, leaks and other incidents which damage or might damage the environment, Contractor shall promptly notify SOCAR of such circumstances and of its first steps to remedy this situation and the results of said efforts. Contractor shall use all reasonable endeavours to take immediate steps to bring the emergency situation under control and protect against loss of life and loss of or damage to property and prevent harm to natural resources and to the general environment. Contractor shall also report to SOCAR and appropriate Government authorities on the measures taken.

26.3 Compliance

Contractor shall comply with present and future Azerbaijani laws or regulations of general applicability with respect to public health, safety and protection and restoration of the environment, to the extent that such laws and regulations are no more stringent than the then current international Petroleum industry standards and practices being at the date of execution of this Contract those shown in Appendix IX, with which Contractor shall comply. If Appendix IX specifies more than one standard with respect to a matter, Contractor will use the standard most appropriate relative to the ecosystem of the Caspian Sea. In the event any regional or multi-governmental authority having jurisdiction enacts or promulgates environmental standards relating to the Contract Area, the Parties will discuss the possible impact thereof on the project. The provisions of Article 23.2 shall apply to any compliance or attempted compliance by Contractor with any such standards, which adversely affect the rights or interests of Contractor hereunder.

26.4 Baseline Study and Ongoing Environmental Monitoring

(a) In order to determine the state of the environment in the Contract Area at the Effective Date, Contractor shall cause an environmental base line study (under the Minimum Obligatory Work Programme as referred to in Appendix X) to be carried out by a recognised international environmental consulting firm selected by Contractor, and acceptable to SOCAR. SOCAR shall nominate representatives to participate in preparation of the study in collaboration with such firm and Contractor representatives. The costs of such study shall be borne by Contractor, except that SOCAR shall be liable for all costs associated with the representatives nominated by SOCAR. The costs associated with this study shall be subject to Cost Recovery in accordance with Article XI. Contractor shall conduct ongoing environmental monitoring of its operations. Data collected will be evaluated at least annually to determine if any practices and discharge standards need to be revised.

The Environmental Strategy included in Appendix IX outlines the environmental program that Contractor (and SOCAR in the event it carries out operations on the Chirag-1 platform pursuant to Article 10.3 or operations with or without a Third Party pursuant to Article 15.2(e)) will follow during the course of Petroleum Operations within the Contract Area. The evaluation of data collected during the ongoing monitoring program, together with the baseline study, will provide a basis for determining whether any unacceptable environmental impact has been caused by Contractor in the course of conducting Petroleum Operations and for which Contractor may be liable under Article 20.2, or whether the conditions leading to such impact existed prior to the commencement of Petroleum Operations or otherwise from activities conducted by a party other than Contractor. SOCAR and Contractor shall review the environmental base line study and consult to determine whether any remedial action is warranted to mitigate the effects of any impact which occurs or has occurred from such prior conditions, and if so, whether a programme of remediation could be carried out by Contractor, it being agreed among the Parties that Contractor shall not be liable for any of the expense of such a remedial programme. Any such remedial program undertaken will be considered outside the scope of the Environmental Strategy and will be conducted pursuant to the terms of a separate agreement between SOCAR and Contractor.

(b) In the event SOCAR operates the Chirag-1 platform as provided pursuant to Article 10.3 and/or SOCAR and/or any Third Party operates any other facilities with respect to development of Non- Associated Natural Gas pursuant to Article 15.2(e), then in connection with performance of the ongoing monitoring program Contractor shall have the right to make periodic inspections of the Chirag-1 platform and such other facilities and SOCAR's and/or any Third Party's operations with respect thereto, including, but not limited to, the placement of monitoring devices and collection of samples relevant to the monitoring program. Contractor's above referenced inspections, sampling and placement of monitoring devices shall be performed by Contractor in a manner which does not unreasonably interfere with SOCAR's and/or any such Third Party's operations on the Chirag-1 platform or such other facilities.

26.5 Environmental Damage

(a) Contractor shall be liable for those direct losses or damages incurred by a Third Party (other than the Government) arising out of any environmental pollution determined by the appropriate court of the Azerbaijan Republic to have been caused by the fault of Contractor. In the event of any environmental pollution or environmental damage caused by the fault of Contractor, Contractor shall reasonably endeavour, in accordance with generally acceptable international Petroleum industry practices, to mitigate the effect of any such pollution or damage on the environment.

(b) Contractor shall not be responsible and shall bear no cost, expense or liability for claims, damages or losses arising out of or related to any environmental pollution or other environmental damage, condition or problems which it did not cause, including but not limited to those in existence prior to the Effective Date of this Contract, as well as any environmental pollution or other environmental damage, condition or problems arising out of SOCAR's operation of the Chirag-1 platform pursuant to Article 10.3 and SOCAR's and/or any Third Party's development of Non-Associated Natural Gas pursuant to Article 15.2(d); and SOCAR shall indemnify and hold harmless Contractor, its Sub-contractors and its and their consultants, agents, employees, officers and directors from any and all costs, expenses and liabilities relating thereto.

(c) Any damages, liability, losses, costs and expenses incurred by the Contractor arising out of or related to any claim, demand, action or proceeding brought against Contractor, as well as the costs of any remediation and clean-up work undertaken by Contractor, on account of any environmental pollution or environmental damage (except for such pollution or damage resulting from the Contractor's Wilful Misconduct) caused by the Contractor shall be included in Petroleum Costs.

APPENDIX IX

ENVIRONMENTAL STANDARDS AND PRACTICES

I. Environmental Sub-Committee

A. The formation and organisation of an environmental sub-committee shall be set forth in a proposal of Contractor which will be submitted to the Steering Committee for approval. Once approved by the Steering Committee, the environmental sub-committee shall be formed in accordance with the approved recommendation and shall be composed of environmental representatives of Contractor Parties and SOCAR, Gipromorneftegaz, other research institutes, and State Committee of the Azerbaijan Republic on Ecology and Control over the Use of Natural Resources.

B. Responsibilities of the environmental sub-committee

(i) - Design Annual Monitoring Program for monitoring of selected environmental parameters

- Coordinate Annual Monitoring Program
- Review results and propose recommendations
- Publish annual report

(ii) Select research projects

- Administer environmental protection research projects
- Allocate funding as designated for this purpose in any Annual Work Programme and Budget
- Review progress
- Publish results

II. Environmental Strategy

The environmental strategy to be pursued pursuant to Article 26.4 shall be as follows:

A. Baseline Data

1. Literature review

2. International standards review

3. Audit of existing operations and practices

4. Environmental data collection
   - Atmospheric
   - Water Quality
   - Benthic
   - Flora and Fauna
   - Meteorological and Oceanographic
   - Sediment
   - Background Radiation

B. Environmental Impact Assessment (existing facilities, exploration and production activities and new facilities)

Project description

2. Environment description

3. Technology assessment

4. Air emission inventory

   – Dispersion modelling
   – Impact evaluation

5. Water discharge inventory

   – Fate and effects modelling
   – Impact evaluation

      – Treat and discharge offshore
      – Treat onshore and discharge
      – Injection onshore or offshore

6. Waste Inventory

   – Disposal options
   – Impact evaluation
   – Offshore treatment and disposal
   – Transportation and onshore disposal

7. Abandonment studies

   – Disposal options
   – Impact evaluation

8. Cost benefit analysis

9. Environment statement of preferred options

C. Oil Spill Response Planning

1. Sensitivity mapping

   – Habitats
   – Fisheries
   – Birds
   – Animals
   – Benthic organisms
   – Marine flora

2. Risk Assessment

3. Prediction modelling

4. Equipment and material resourcing

5. Evaluation of chemical treatments

6. Response organisations

7. Treatment and disposal of oil and chemical contaminated material

III. Effluent Guidelines

The following are general and specific guidelines relating to discharges associated with oil and natural gas exploration and production activities.

A. General Guidelines

1. There shall be no discharge of waste oil, produced water and sand, drilling fluids, drill cuttings or other wastes from exploration and production sites except in accordance with the following guidelines.

2. There shall be no unauthorised discharges directly to the surface of the sea. All discharges authorised by these guidelines shall be controlled by discharging into a caisson whose open end is submerged, at all times, a minimum of sixty (60) centimetres below the surface of the sea.

B. Discharge Guidelines and Monitoring

1. Produced Water

(a) Contractor will endeavour to utilise produced water for reservoir pressure maintenance if, through standard compatibility testing with Caspian Sea water, no damage to the reservoir resulting in a reduction in overall hydrocarbon recovery would occur by mixing the two water streams. In the event that the two water streams are compatible, Contractor may only discharge a volume of produced water after treatment to the Caspian Sea that exceeds the total volume required for reservoir pressure maintenance or in the event of an emergency, accident or mechanical failure. In the event that the two water streams are not compatible, Contractor may discharge produced water to the Caspian Sea after treatment. Treatment of produced water will result in an oil and grease concentration that does not exceed 72 mg/l on a daily basis or 48 mg/l on a monthly average. The gravimetric (extraction) test method EPA 413.1 (79) shall be used to measure the oil and grease concentration.

2. Drill Cuttings and Drilling Fluids

(a) There shall be no discharge of oil based drilling fluids, other than low toxicity and biodegradable drilling fluids.

(b) There shall be no discharge of drill cuttings generated in association with the use of oil based drilling fluids, invert emulsion drilling fluids, or drilling fluids that contain waste engine oil, cooling oil, gear oil, or other oil based lubricants, other than cuttings generated in association with the use of low toxicity and biodegradable drilling fluids.

(c) There shall be no discharge of drill cuttings or drilling fluids if the maximum chloride concentration of the drilling fluid system is greater than four (4) times the ambient concentration of the receiving water.

(d) Prior to the start of the drilling programme, a drilling mud system will be designed and laboratory tested under the U.S. EPA, 96-hour acute toxicity test using mycid shrimp. Those muds that achieve an LC50 value in concentrations of more than 30,000 ppm will be authorised for discharge during the drilling programme.

(e) During drilling operations, mud samples will be collected periodically to determine toxicity using procedures established for the
Caspian Sea.

(f) The composition of the mud system may be altered as necessary to meet changes in the drilling operations. The modified mud system may be discharged if it has been shown to meet the above limits on oil, salinity and toxicity.

3. Other Wastes

(a) Sanitary waste may be discharged from a U.S. Coast Guard certified or equivalent Marine Sanitation Device (MSD) with total residual chlorine content greater than 0.5 mg/l but less than 2.0 mg/l as long as no floating solids are observable. The Hach method CN-66-DPD test shall be used to measure the residual chlorine.

(b) Domestic wastes and grey water may be discharged as long as no floating solids are observable.

(c) Monitoring of floating solids shall be accomplished during daylight by visual observation of the surface of the receiving water in the vicinity of the sanitary and domestic waste outfalls. Observations shall be made following either the morning or midday meals and at a time during daylight and maximum estimated discharge.

(d) Desalinisation unit wastes shall be discharged.

(e) Deck drainage and wash water may be discharged as long as no visible sheen is observable.

(f) Trash shall not be discharged offshore. Trash shall be transported to an appropriate land-based disposal facility.
(a) Produced water

1. The volume of produced water discharged and concentration of oil and grease contained in the discharge will be monitored daily.

2. The daily maximum and monthly average oil and grease concentration will be reported monthly.

(b) Drill Cuttings and Drilling Fluids

1. An inventory of drilling fluids additives and their volumes or mass added to the drilling fluid system will be maintained for each well.

2. Drilling fluid properties, including volume percent oil and concentration of chlorides, will be monitored daily for each well.

3. The estimated volume of drill cuttings and drilling fluids discharged shall be recorded daily and reported monthly.

(c) Other Wastes

1. The estimated volume of other wastes discharged shall be recorded daily and reported monthly to include:

- Sanitary waste
- Domestic waste
- Deck drainage and wash water

IV. Air Emission Guidelines and Monitoring

Contractor is authorised to discharge air emissions. Such discharges will be limited and monitored as follows:

A. Any building, structure, facility, or installation that emits or may emit nitrogen oxides (NOx), sulphur dioxides (SOx), carbon monoxide (CO), volatile organic compounds (VOCs), or particulate (PT) in an
amount equal to or greater than 227 metric tons per year (MTPY) per individual pollutant (250 short tons per year) shall install the best available control technology on all equipment creating the emissions suitable for the equipment creating the emissions and its location. If the source is above 227 MTPY, screening modelling will be conducted to determine potential impacts on sensitive receptors. This trigger amount may be less in cases where sensitive receptors are in close proximity to the source. (NOTE: Any individual item of equipment emitting less than 23 MTPY (25 short TPY) or IC engines/turbines below 500 break horsepower would be exempt from this requirement.) Emergency flares on facilities will be designed to operate smokeless and with continuous pilots or equivalent ignition systems.

B. Any storage vessel with a capacity greater than 1,590 cubic meters (10,000 Barrels) used for Petroleum or condensate storage shall install necessary control technology to minimise emissions.

C. IC engines/turbines larger than 500 HP should be monitored on an annual basis to assure that the NOx and CO emissions are at the specified levels. Portable analysers for monitoring the NOx and CO should be calibrated before each test using a known reference gas sample.

All new facilities will comply with the above standards. Existing facilities within the Contract Area being operated by Contractor will be brought into compliance with these standards according to a schedule to be negotiated, taking into account the condition, function and economic viability of the facilities.

V. Safety Guidelines

Contractor shall take into account the following international safety and industrial hygiene standards in conducting its Petroleum Operations under the Contract:

A. Oil Industry International Exploration and Production Forum (E&P Forum) Reports - Safety.
B. International Association of Drilling Contractors (IADC) – Drilling Safety Manual.
C. International Association of Geophysical Contractors (IAGC) - Operations Safety Manual.
D. American Conference of Governmental Industrial Hygienists – Threshold Limited Values for Chemical Substances in the Work Environment

APPENDIX 2
ACG PHASE 2 HSE DESIGN STANDARDS

HEALTH

Descriptions	Phase 2 HSE Standards
Medicals	All project personnel will be medically screened prior to starting work offshore, with particular consideration to hearing and dermatitis checks. Medical support will be provided to all project construction work sites.
Hygiene	Routine assessment of water quality and catering facilities will be conducted at project construction work sites in Azerbaijan. Changing, toilet and washing facilities will be provided at project construction work sites in Azerbaijan. Lunch will be provided at project construction work sites in Azerbaijan.
Noise	During project execution, tasks and working environments will be assessed for noise and measures put in place to ensure that levels will be kept as low as possible. The codes used are Noise & Statutory Nuisance – EPA 1990 / 1995 and UK HSE “Control of Noise (COP for Construction and Open Sites Orders 1984 / 1987)” and “Noise at Work Regulations 1989”. The design will be assessed for noise and the following measures used: 85 dBA (average level) exposure for a maximum of 12 hours. 45 to 60 dBA inside the accommodation (depending upon location – such as office or sleeping areas).
Health Risk Management	Workplace, environmental, and travel health hazards are identified and risks assessed and managed.

SAFETY

Descriptions	Phase 2 HSE Standards
Training	All project personnel will receive an appropriate level of safety and environmental training. A training matrix will be developed for each site. Project leadership will be trained in Advanced Safety Auditing and Accident and Incident investigation.
Design Safety Reviews	A risk-based design approach will be adopted, supported by blast calculations, escape and evacuation assessments, HAZOPs, HAZIDs, formal project safety reviews, and Temporary Refuge impairment analysis. A QRA will be carried out to confirm the Individual Risk and Temporary Refuge Impairment values achieved and to assist in demonstrating that risk has been reduced to ALARP.
Hazard Management Plan	An overall Hazard Management Plan to explain the hazards and the measures included to manage them will be prepared and approved by the Business Unit Leader.
SIMOPS	Simultaneous Operations (eg drilling and HUC, drilling and production, installation and production) will be assessed and procedures will be prepared to control the identified risks to an acceptable level.
Manual Handling	A lifting and access assessment of the design will be completed to eliminate the need for manual handling > 50 kg between two men in the operating phase. During project execution tasks will be assessed and the need for manual handling > 50 kg between two men will be eliminated.
Hazardous Substances	The design will be based on eliminating the exposure of individuals to hazardous substances in the operating phase, including well work. Particular emphasis will be placed, in the design phase, on assessing and eliminating the gaseous emission of the carcinogens benzene, toluene, and xylene (BTX) in the operating phase. During project execution tasks will be assessed to ensure adequate controls are in place to minimise the impact of hazardous substances on individuals.
Seismic Event	The platform will be designed to withstand the 500-year return period seismic event where no loss of life, no loss of containment and little or no damage to the platform is expected. Design will be checked against the 3,000-year return period, where the platform can sustain damage but should not collapse and there should not be major health or safety consequences.
Storm	The off-shore design will be such that personnel can survive a 100-year storm without leaving the platform.

Descriptions	Phase 2 HSE Standards
Road Safety	A Road Safety Strategy will be developed and implemented for the Project in line with the Business Unit's Road Safety Management, with the aim of eliminating or minimising transportation risks. The strategy will focus on the areas of: – Safe driving procedures; – transportation logistics and journey planning – vehicle standards and maintenance; – training, competence and behaviour of drivers, passengers and others; – road and access planning – safe driving performance measures and assessment; – assurance that management of Road Safety is implemented and functioning as intended.

ENVIRONMENT

Description	Phase 2 HSE Standards
Applicable Guidelines	The project will be designed to comply with the environmental guidelines, standards and practices of relevant International Finance Institutions (IFIs) and Export Credit Agencies (ECAs) that are involved with the project.
Monitoring and Measurement	The design will provide sufficient sample and measurement points to enable adequate monitoring of emissions and discharges during the operating phase.
Ozone Depleting Substances (ODS)	These substances will not be used. ODS are defined as those substances which are controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer.
Other Halocarbons with Potential for Global Warming	Other halocarbons that do not deplete the ozone layer, but which have other environmental concerns such as a high global warming potential (GWP) will not be used unless suitable alternatives are not available. These include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Description	Phase 2 HSE Standards
Water Based Drill Fluids and Cuttings	Water based cuttings and fluids from the Top Hole (i.e. the conductor hole, nominally 36”) will be discharged to sea in accordance with the Standards below. Note that it is not technically feasible or safe to return the mud and cuttings from this section to the rig, and therefore in accordance with normal safe drilling practice they will continue to be discharged directly to the seabed in accordance with the PSA. Options for the management and disposal of all other water based mud and cuttings will be evaluated. Options to be considered include: a) cuttings re-injection, b) ship to shore, and c) discharge to sea. The final decision will be based on a balance of all relevant considerations through a Best Practical Environmental Options (BPEO) Assessment. Where it is necessary to discharge water-based cuttings and associated fluids to sea the following conditions shall be met: The mud systems used are tested and meet US EPA 96 hour LC_{50} toxicity tests (ie > 30,000 ppm) or Caspian Specific Ecotoxicity Tests, should these be agreed. Discharge is via a caisson that will be at a depth of at least 15m to 20m below the sea surface in all instances except the Top Hole (nominal 36” section) where returns are directly to seabed. All barite used will meet the following heavy metal criteria: Hg < 1 mg/kg and Cd < 3 mg/kg dry weight (Total). Products known or suspected to cause taint, endocrine disruption or contain heavy metals as defined by UK Off-shore Chemical Notification Scheme (OCNS) will be avoided. In the event that suitable alternatives are not available, the impact of the chemical will be risk assessed and mitigation measures agreed as part of the EIA process. There will be no discharge of drill cuttings or fluids unless the maximum chloride concentration is less than four times the ambient concentration in the receiving water.
Land-take at Sangachal	The design of Sangachal will minimise the foot-print without compromising safety.
Nuisance at Sangachal	During project execution the impact on the community of dust, noise, light, odours and general disruption will be minimised.
Open Drains Off-shore	There will be no visible sheen from deck and open drain discharges. Sample points will be provided to enable measurement of the oil in water discharge quantity.

Description	Phase 2 HSE Standards
Open Drains On-shore	Clean drains will discharge to the Caspian at less than 10 mg/l monthly average and 19 mg/l on a daily basis. Any fluids discharged will be treated to ensure there is no significant or long-lasting impact on the environment. Sample points will be provided to enable verification of the above standard (ie measurement of water quality and quantity). Dirty drains will be routed to the produced water disposal facility.
Venting Unburned Gas	During project execution cold venting will not take place unless it is required for safety reasons. The design will ensure that during normal operation there will be no disposal of gas by continuous venting.
Chemicals	The design will challenge the need for all chemical use. A management strategy will be put in place to minimise the environmental impact of chemicals through correct selection, transportation, storage, deployment and disposal. Chemicals known or suspected to cause taint, endocrine disruption or contain heavy metals as defined by UK OCNS will be avoided. In the event that suitable alternatives are not available, the impact of the chemical will be risk assessed and mitigation measures agreed as part of the EIA process. Only heavy metal-free pipe dope will be used. Chemicals will be evaluated and tested, based on the European Harmonised Off-shore Chemical Notification Format (HOCNF) and UK OCNS classification, until such time as Caspian-specific standards are agreed. No chemicals will be discharged to land or sea in the project execution phase (eg chemically treated hydrotest fluids) without complete identification and a thorough assessment of their impact. The facility design will prevent, so far as reasonably practical, the need to discharge production and utility chemicals to land or sea.
Sewage	Off-shore design for sewage treatment will be discharge to sea following treatment using US coastguard approved Marine Sanitation Device without chemical treatment (ie chlorine – subject to approval by the SCE). The design will ensure that there are no floating solids. Discharge will be via a caisson that is permanently submerged and at least 60 cm below the surface.
Desalination Waste	Desalination unit waste shall be discharged via a caisson that is permanently submerged and at least 60 cm below the surface.
Pipeline Construction	Activities will be timed to ensure impact on the fish population and other marine life is minimised.

Description	Phase 2 HSE Standards
Sand	The design will enable sand and any associated liquid to be re-injected off-shore. In the event that re-injection is not possible sand will be transported to shore, treated and disposed of on-shore at a location approved by the regulator.
Liquid and Solid Waste	There will be no discharge of solid and liquid waste to sea during project execution or operations except as provided for elsewhere in these standards. During project execution waste will be managed according to the following hierarchy: reduction at source, re-use, recovery, re-cycle and render harmless through treatment. The design will ensure waste production in the operating phase is minimised and waste can be handled safely. Wax disposal and handling – Alternative methods of wax treatment and disposal will be reviewed using the BPEO process and taking into consideration BACT. An effective option will be selected so that the impact of wax waste on the environment is minimised. In the event that sulphur is recovered as a by-product in the onshore sweetening process, appropriate means of sulphur handling and disposal will be reviewed using the BPEO process and taking into consideration BACT.
Cooling Water	The effluent should result in a temperature increase of no more than 3°C at the edge of the zone where initial mixing and dilution takes place. The boundary of the zone will be defined on a case by case basis taking into account factors such as the existing ecology.
Seawater Abstraction for Operations	The design will allow seawater to be abstracted during operations at depths > or = 50m.
Produced Water Off-shore	In FFD the design will permit produced water to be re-injected. In the event of the plant being unavailable, produced water discharged to the Caspian must not exceed oil and grease concentration > 42 mg/l on a daily basis or > 29 mg/l monthly average. The design will incorporate treatment facilities to meet these discharge standards. Operational procedures will be developed when the produced water facilities are installed to control the time allowed for overboard discharge.
Decommissioning	Design will ensure that the facility can be safely decommissioned without long term impact on the environment.
Fugitive Emissions – Storage Tanks	Fugitive emissions from the Sangachal oil storage tanks will be controlled using external floating roof technology with primary, secondary rim seals and low-loss fittings.

Description	Phase 2 HSE Standards
Fugitive Emissions – Compressors, Valves, Seals, Flanges	The aim will be to minimise fugitive emissions throughout the design process by measures including: Component evaluation and selection. Material evaluation and selection. Best Available Control Technology (BACT) – PSA.
Combustion Emissions	The design will be based on minimising combustion emissions (eg SOx, NOx, CO_2, CO and particulates). BACT will be used, as required by the PSA. Use the AIOC air quality standards (these are based on international standards – WHO/EC) – eg Low NOx burners.
Produced Water On-shore	Re-injection of on-shore produced water from Sangachal Terminal is the Base Case. The design implications and options for the disposal of onshore produced water during non-availability of the PW re-injection system will be reviewed using the BPEO process and taking into consideration BACT consistent with the PSA.
Routine Flaring – Onshore	The flare will be designed for continuous flaring and emergency relief. Any flaring will be smokeless under normal operations. Flare gas metering will be installed. The design will minimise flaring from purges and pilots without compromising safety. This will include installation of purge gas reduction devices and conservation pilots. Flare gas recovery will be installed. Operational flare policy for Phase 2 will be developed in conjunction with Phase I. The policy will address the potential need to flare sour gas. The design intent will be to eliminate all routine non-emergency flaring, with the exception of purges and pilots, without compromising safety.
Routine Flaring – Offshore	The flare will be designed for continuous flaring and emergency relief. Any flaring will be smokeless under normal operations. Flare gas metering will be installed. The design will minimise flaring from purges and pilots without compromising safety. This will include installation of purge gas reduction devices and conservation pilots. Source gas reduction measures will be implemented. Options to address reduction in offshore flaring and combustion emissions will be evaluated. Operational flare policy for Phase 2 will be developed in conjunction with Phase I.

Description	Phase 2 HSE Standards
Well Testing	During appraisal drilling, well testing, requiring emissions, will be 'by exception' and strongly challenged. If testing is justified, then all best available techniques will be utilised to minimise emissions to air, land and sea.
Energy Efficiency	The Phase 2 design will be based on maximising energy efficiency where technically and economically feasible, and without compromising safety or operability.
Non-water-based Drill Fluids and Cuttings	The base case is cuttings re-injection with a contingency option of shipment to shore and treatment on-shore at an approved location. There will be no discharge of oil-based or synthetic-based drilling fluids or cuttings from multiple well locations within the GCA PSA contract area, where there has been no previous discharge. Should drilling fluids be developed that meet international and Caspian acceptability criteria for discharge then they will be evaluated and the option to use and discharge considered. An operating policy will be developed to address the actions to be taken in the event of down-time of cuttings re-injection equipment. All barite used will meet the following heavy metal criteria: Hg < 1 mg/kg and Cd < 3 mg/kg dry weight (Total). Products known or suspected to cause taint, endocrine disruption or contain heavy metals as defined by UK OCNS will be avoided. In the event that suitable alternatives are not available, the impact of the chemical will be risk assessed and mitigation measures agreed as part of the EIA process. System will be designed to prevent mud loss on cuttings so far as technologically practical and economically justifiable.

APPENDIX A – FIELDWORK SURVEY 2002

INTRODUCTION

This appendix contains the data collected during the ACG Phase 2 fieldwork, which was carried out between the 19th and 22nd March 2002 in the vicinity of Sangachal Terminal.

The fieldwork team comprised the following personnel:

Name	Position
Rebecca Robinson	Fieldwork Manager (AETC)
Matthew Clegg	Deputy Fieldwork Manager (AETC)
Dr Ilyas Babayev	Ornithologist
Dr Teymur Aliyev	Herpetologist
Dr Sudjaddin Guliyev	Mammalogist
Dr Mehriban Gakhramanova	Botanist
Fariz Samedov	Interpreter
Emin Guliyev	Interpreter

METHODOLOGY

Fauna (mammals, reptiles and amphibians)
During the fauna survey, the study area was traversed on foot along predetermined transects based on those followed during the Phase 1 ACG fieldwork. All direct sightings of mammals and herpetofauna (reptiles and amphibian) species were recorded in terms of the species, time and place of observation and photographs were taken where possible. Indirect evidence of species presence, e.g. burrows, nests, tracks, scat, food remains, vocalisation, etc, were recorded by place encountered and type. Completed fieldwork proformas are presented in this appendix.

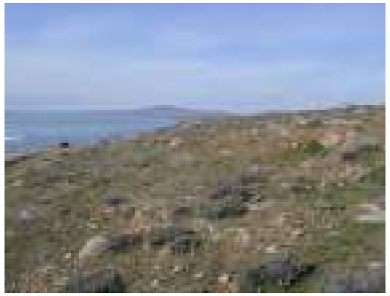
Botany
The study area was traversed on foot along predetermined transects based on those followed during the ACG Phase 1 fieldwork. All visible plant species present were identified, recorded and used to compile a species list, which is provided in this appendix. Habitat types were identified, where possible, through observation of the changes in dominant perennial species as the transect routes were traversed. In addition, quadrat plots of $2m^2$ were selected within which to record higher plant species representative of the habitat type sampled. The internationally recognised Domin. Scale of cover-abundance (*sensu* Dahl & Hadac, 1941) was used (see table below) to produce an index of vegetation cover. Completed fieldwork proformas are presented in this appendix.

DOMIN. SCALE OF COVER-ABUNDANCE

Domin scale	Cover abundance	Domin scale	Cover abundance
+	One individual, reduced vigour	6	26-33%
1	Rare	7	34-50%
2	Sparse	8	51-75%
3	<4%, frequent	9	76-90%
4	5-10%	10	91-100%
5	11-25%		

Transect Number: 1	**Date:** 19/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
+ If observe animal at some distance, take lat/long reading and state distance and direction from that point that animal was observed
++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Mammals: *Meriones erythrourus* (red tailed sanderling)	Burrows, signs		1	40.20783 N 049.54866 E	9.00	Coastal, semi-desert, highly impacted by fly tipping	
Birds: *Phalocrocorax carbo* *Podiceps nigricollis* *Podiceps cristatus* *Tringa totanus* *Larus argentatus* *Upupa epops* *Galerida cristata* *Oenanthe pleshanka* *Passer domesticus*	Direct, visual and telescope		14 60 32 4 21 2 4 2 6	40.20742 N 049.54889 E	9.30 – 10.55	Coastal, semi-desert, impacted by fly tipping *Artemisia* – ephermeral plants formation	044 - General habitat 
Mammals: *Meriones erythrourus* (red tailed sanderling)	Burrows, signs		1	40.20702 N 049.54872 E		Semi-desert, sandy shore	
Reptiles: *Eremias velox* - Rapid fringe-toed lizard	Direct visual observation		2	40.20679 N 049.5838 E		Coastal rocks and cliffs	
Mammals: *Meriones erythrourus* (red tailed sanderling)	Burrows, signs		2	40.20607 N 049.54664 E	10.00	Semi-desert, sandy shore	
Mammals: *Rattus rattus*	Burrow, tracks		1	40.20607 N 049.54664 E			

Transect Number: 1	**Date:** 19/03/02	**Proforma Reference No.**
		Surveyor: Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals:							
Rattus rattus	Burrow, tracks		1	40.20584 N 049.54482 E		Rocky coastline	
Birds:							043 - Coastline 
Podiceps cristatus	Direct, visual and telescope		64	40.19861 N 049.52623 E	11.00-11.25	Open sea area of Caspian	
P. nigricollis			23				
Tachybaptus ruficollis			28				
Phalocrocorax carbo			3				
Anas platyrhynchos			2				
Larus argentatus			5				
Tringa totanus			23			Coastline marshes	
Motacilla alba			3			Coastline marshes and sands	
Oenanthe finschii			4			Rocky areas, ephemeral *Artemisia* plant associations	
Sturnus vulgaris			32			Ephemeral *Artemisia* plant associations	
Corvus fruigilegus			8			Ephemeral *Artemisia* and halophytic plant associations	
Upupa epops			2			Ephemeral *Artemisia* plant formation and tamarisk bushes	
Galerida cristata			12			Ephermeral *Artemisia* plant formation	

Transect Number: 1	**Date:** 19/03/02	**Proforma Reference No.**
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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals: *Meriones erythrourus*	Burrows, signs		1	40.20404 N 049.53941 E		Semi-desert, sandy shore	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.20396 N 049.53817 E		Semi-desert, steppe, *Artemisia*	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.20385 N 049.53792 E		Semi-desert, steppe, *Artemisia*	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.20226 N 049.53480 E		Semi-desert, steppe, *Artemisia*	
Reptiles: *Agama caucasica* - Caucasian agama	Direct visual observation		1	40.19962 N 049.52870 E		Rocks and cliffs	041 - *Agama caucasica* 
Mammals: *Allactaga elater* (five toed jerboa)	Signs, burrows		1	40.19865 N 049.52592 E		Semi-desert, xerophytes	
Mammals: *Arvicola amphibious* (vole)	Burrows, faeces, tracks		1	40.19865 N 049.52592 E		Semi-desert, xerophytes	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.19871 N 049.52579 E		Semi-desert, steppe, *Artemisia*	

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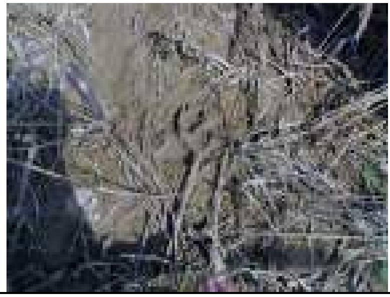
Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Reptiles: *Agama caucasica* - Caucasian agama	Direct visual observation		1	40.19525 N 049.52027 E		Rocks and cliffs	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.19525 N 049.52027 E		Semi-desert, steppe, *Artemisia*	
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.19521 N 049.52013 E		Semi-desert, steppe, *Artemisia*	
Mammals: *Allactaga elater* (five toed jerboa)	Signs, burrows		1	40.19511 N 049.51994 E		Semi-desert, xerophytes	
Amphibians: *Rana ridibunda* (marsh frog)	Direct visual observation		Many	40.19338 N 049.51658 E		Domestic drainage water channel filled with *phragmites*	
Mammals: *Canis lupus* (wolf)	Track		1	40.19312 N 049.51634 E		Within *phragmites* stands	039 – Wolf track 

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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals: *Vulpes vulpes* (fox)	Track		1	40.19288 N 049.51594 E		Within *phragmites* stands	038 – Reed area 
Reptiles: *Natrix Natrix* (European Grass snake)	Direct visual observation		1	40.19312 N 049.51634 E		Within *phragmites* stands	036 – *Natrix Natrix* 
Mammals: *Microtus socialis*	Burrow, tracks, faeces		1	40.19238 N 049.51512 E		Semi-desert, steppe, *Artemisia*	

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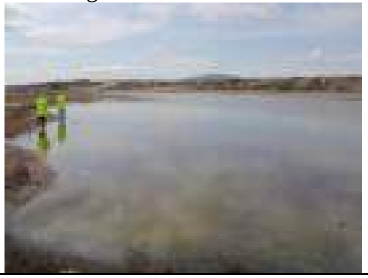
Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Birds: *Charadrius alexandrinus* *Motasilla alba* *Galerida cristata*	Direct, visual and telescope		2 1 2	40.19052 N 049.51285 E	11.30-13.00	Small area of coastal lagoon. Normally oyster catchers *Haematopus* here in June/July Top of coastline rocks	034 – Reed area of lagoon 
Mammals: *Meriones lybicus* (Libyan jird) *Vulpes vulpes* (fox) *Canis aureus* (golden jackal)	Burrow Track Track		1 1 1	40.18983 N 049. 51213 E		Semi-desert, sandy shore Semi-desert, bushes, xerophytes Tamarisk, semi-desert, gully	
Mammals: *Vulpes vulpes* (fox)	Track		1	40.18825 N 049.51057 E		Semi-desert, bushes, xerophytes	
Birds: *Podiceps cristatus* *P. nigricollis*	Direct, visual and telescope		8 18	40.18646 N 049.50880 E	13.05 – 13.15	Open sea area. Usually colony of starling *Sterna sp* come to nest in June. Open sea area	033 - Lagoon 

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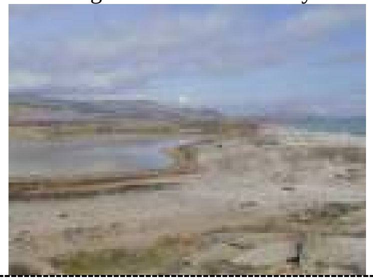
Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds continued…							032 - Lagoon and reed area beyond 
Tachybaptus ruficollis			4			Open sea area	
Anas platyrhynchos			5			Open sea area	
Tadorna tadorna (nesting)			2			Lagoon area	
Tringa totanus			2			Lagoon area	
Charadrius alexandinus			10			Lagoon area	
Ch. dubius (nesting)			8			Lagoon area	
Reptiles:							
Ophisops elegans (snake eyed lizard)	Direct visual observation		1	40.18463 N 049.50646 E		Rocky area to south of lagoon	
Eremias velox (rapid fringe-toed lizard)			2				
Birds:							
Podiceps cristatus	Direct, visual and telescope		3	40.18136 N 049.49790 E	13.20- 14.00	Open sea area	
P. nigricollis			6				
Tachybaptus ruticollis			4				
Pahalocrocorax carbo			4				
Anas platyrhynchos			3				

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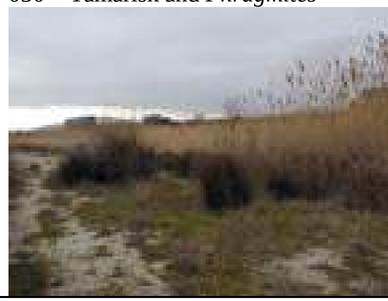
Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds:							031 – Coastline looking north 
Tadorna tadorna	Direct, visual and telescope		12	40.13047 N 049.48038 E	14.45 – 15.03	Open sea area	
Fulica atra			2				
Podiceps cristatus			84				
P.nigricollis			13				
Tachybaptus ruticollis			16				
Mammals:							
Lepus europeus (hare)	1 direct 1 tracks			40.13087 N 049.48040 E		Semi-desert, bushes	
Birds:							030 – Tamarisk and *Phragmites* 
Anas platyrhynchos	Direct, visual and telescope		2	40.17651 N 049.48225 E	15.30-15.55	Open sea area	
Larus melanocephalus			19			Open sea area	
Larus ridibundus			6			Open sea area	
Circus aeruginosus			2			*Phragmites* community	
Acrocephalus schoenobaenus			+			*Phragmites* community	
A. scirpaceus			+			*Phragmites* community	
A. arundinaceus			+			*Phragmites* community	

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Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Amphibians: *Rana ridibunda* (marsh frog)	Direct, visual sighting		2	40.17651 N 049.48225 E			
Birds: *Falco tinnunculus*	Direct, visual and telescope		2	40.15638 N 049.47648 E	16.15 – 16.50	*Salsola*, tamarisk thicket, shingle beach. Summer breeding collared pratincole *Glareola pratincola* recorded here.	
Upupa epops			2				
Mammals: *Vulpes vulpes* (fox)	Direct visual sighting		1	40.15514 N 049.47361 E			
Mammals: *Lepus europeus* (hare)	Direct visual sighting		1	40.15514 N 049.47361 E			

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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long) + Decimal degrees	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds:							
Alektoris chukar	Telescopic, auditory		6	40.22263 N 049.50796 E	9.35- 9.53	Mountain side bare rocks	029 - Mountain area 
Galerida cristata			3			Mountain side *Artemisia*, ephemeral plants	
Oenanthe finschii			2			Mountain side bare rocks	
O. isabellina			2				
Sitta neumayer			4				
Athene noctua			1			Mountain side, disused shepherd huts	
Pyrrhocorax pyrrhocorax			6			Mountain side bare rocks	
Falco tinnunculus			2			Mountain side *Artemisia*, ephemeral plants	
Mammals: *Allactaga elater* (five toed jerboa)	Burrow, tracks		1	40.22263 N 049.58796 E	9.35		Not many mammal burrows as clay soil and stoney ground. Also lot of surface water from high ground.
Birds:							
Alektoris chukar	Telescopic, auditory		4	40.22452 N 049.50696 E	10.00- 10.25	Mountain side rocks, bare cliffs	
Buteo rufinus		Proposal to include in Az. Red Data Book	2				
Oenanthe pleshanka			2				
Pyrrhocorax pyrrhocorax			6				
Galerida cristata			2			Ephermeral *Artemisia* formation	

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Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long) + Decimal degrees**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Birds: *Alectoris chukar* *Sitta neumayer* *Pyrrhocorax pyrrhocorax*	Telescopic, auditory		2 2 55	40.22571 N 049.50314 E	10.30- 10.39	Mountain side rocks	
Birds: *Alectoris chukar* *Sitta neumayer*	Telescopic, auditory		4 4	40.22622 N 049.50102 E	10.45- 11.06	Mountain side rocks	
Mammals: *Microtus socialis* (gunther's vole)	Tracks, burrow, signs		1	40.22334 N 049.49798 E	11.15 am		
Birds: *Pelecanus crispus*	Telescopic	Azerbaijan Red Data Book & IUCN Red List	10	40.21996 N 049.50389 E	12.00	Flew in northern direction over area	
Reptiles: *Eremias velox* (rapid fringe-toed lizard)	Direct visual observation		1	40.21095 N 049.51738 E	13.00	Relict mud volcano area	026 – Relict mud volcano area 

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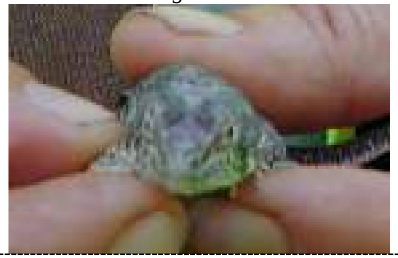
Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long) Decimal degrees**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Mammals: *Microtus socialis* (gunther's vole)	Old burrow		1	40.21248 N 049.51905 E			
Mammals: *Lepus europeus* (hare) *Canis lupus* (wolf) *Vulpes vulpes* (fox)	Tracks Tracks Tracks		1	40.21463 N 049.52169 E			025 – Wolf, hare and fox tracks 
Reptile: *Eremias arguta* – steppe racerunner	Direct visual observation Pregnant female	Proposal for inclusion in Azerbaijan Red Data Book	1	40.21473 N 049.51440 E			024 - *Eremias arguta* 
Mammals: *Microtus socialis* (gunther's vole)	Burrow		1	40.221477 N 049.52188 E			
Mammals: *Microtus socialis* (gunther's vole)	Burrow		1	40.21581 N 049.52370 E	13.45		

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Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Amphibian: *Bufo viridis* - frog	Direct visual observation. Under *Salsola* bush.		1	40.21609 N 049.52412 E			023 - *Bufo viridis* 
End of transect				40.21712 N 049.52641 E			

Transect Number: 3	**Date:** 20/03/02	**Proforma Reference No.**
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Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Birds:							
Tringa totanus	Telescopic, auditory		8	40.19921 N 049.513020 E	15.15	Small water body fed by fresh water from leaking water main	
Limosa limosa			2				
Charadrius dubius			2				
Ch. alexandrinus			4				
Larus argentatus			4				
Buteo rufinus		Proposal to include in Azerbaijan Red Data Book	2			Less birds than previously in this area, impacted by terminal expansion. Topsoil piles close by.	
Falco tinninculus			1				
Passer domestikus			Numerous				
Sturnus vulgaris			36				
Corvus cornix			2				
Amphibians: Tadpoles of *Rana ridibunda* and *Bufo viridis*	Direct visual observation		Numerous	40.19838 N 049.51233 E	16.00	Stream formed by fresh water from leaking water main	022 - Tadpoles 

Transect Number: 3	**Date:** 20/03/02	**Proforma Reference No.**
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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals: *Meles meles* (badger)	Badger hole? 13 cm wide?		1	40.19543 N 049.50271 E		Semi-desert plains	021 – Badger hole? 
				40.18873 N 049.48956 E		Water in this area in June last year. *Typha* reeds show evidence of this. Area dried out. Less birds.	020 – Dried out area 
Mammals: *Alloctaga elater* (Jerboa sp)	Burrow		1	40.18900 N 049.49005 E	17.00	Semi-desert plains	

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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Amphibians: *Rana ridibunda* (tadpoles) *Bufo viridis* (juveniles) *Hyla arborea* (juveniles)	Direct visual observation	2000 IUCN Red List	Large numbers	40.18857 N 049.48944 E		Within *typha* reed stands	
Birds: *Circus aeruginosus*	Telescopic, visual		2	40.17938 N 049.47176 E	9.00-10.15	Reeds - *phragmites*	
Falco tinninculus			2			Tamarisk bushes	
Rallus aquaticus			2			Reeds	
Motacilla alba			3			Damp ground near reeds	
Pica pica			4			Tamarisk bushes	
Acrocephalus schoenobaenus			3			Reeds	
A. scirpaceus			5			Reeds	
A. arundiraceus			4			Reeds	
Pica pica			4			Reeds	
Passer domestikus			Numerous			Gardens, cultivated areas, reeds, tamarisk	
Hippolais rama			2			Tamarisk	
Mammals: *Lepus europeus* (hare)	Tracks		1	40.17639 N 049 46924 E		Area of fly tipping close by	
Mammals: *Lepus europeus* (hare)	Droppings		1	40.17619 N 049.46899 E		Semi-desert	

Transect Number: 3	**Date:** 21/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
+ If observe animal at some distance, take lat/long reading and state distance and direction from that point that animal was observed
++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Reptile: *Mauremys caspica* (marsh turtle)	Direct observation - dead individual		1	40.17671 N 049.4670 E		Semi-desert	
Mammals: *Vulpes vulpes* (fox)	Tracks, burrow		1	40.17938 N 049.47176 E		Semi-desert	
Mammals: *Microtus socialis*	Burrow		1	40.17938 N 049.47176 E		Semi-desert	
Mammals: *Carnis lupus*	Tracks		1	40.18018 N 049.47176 E		Semi-desert	
Reptiles: *Testudo graeca*	Direct visual observation – dead individual	Azerbaijan Red Data Book & IUCN Red List	1	40.17671 N 049.46740 E		Wetland, reeds	
Amphibians: Tadpoles *Rana ridibunda*	Direct visual observation		Many	40.17671 N 049.46740 E		Wetland, reeds	

Transect Number: 4	**Date:** 21/03/02	**Proforma Reference No.**
		Surveyor: Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Amphibians: *Rana ridibunda* - tadpoles	Direct visual observation		Many	40.19114 N 049.45744 E	10.50	Stagnant rainwater pool near tamarisk thicket.	019 – Tamarisk in lowland depressions 
Mammals: *Microtus socialis*	Burrow		1	40.19084 N 049.45825 E			
Birds: *Turdus merula* *Galerida cristata* *Oenanthe pleshanka*	Telescopic, visual		2 8 2	40.19149 N 049.45890 E	11:00 – 11:38	Tamarisk bushes *Artemesia* /ephermerals *Artemisia*/ephemerals	
Mammals: *Microtus socialis*	Burrow		1	40.19066 N 049.45853 E		Semi-desert	
Mammals: *Meriones erythrourus* (red tailed sanderling)	Burrow		1	40.19066 N 049.45853 E		Semi-desert	
Mammals: *Microtus socialis*	Lots of burrows		Many	40.19019 N 049.45893 E		Tamarisk thicket	

Transect Number: 4	**Date:** 21/03/02	**Proforma Reference No.**
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Species Observations
***** Direct/ tracks/ signs
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds:							
Oenanthe oenanthe	Telescopic, visual		1	40.1958 N 049.46109 E	11.54- 12.15	*Solonchak*, ephermerals	
Galerida cristata			2			*Artemisia* / ephemerals	
Melanocorypha calandra			1			*Artemisia* / ephemerals	
Carduelis carduelis			4			Tamarisk bushes	
Reptiles: *Testudo graeca*	Direct visual observation	Azerbaijan Red Data Book & IUCN Red List	1	40.19591 N 049.46161 E		Depressions with tamarisk thicket very good for reptiles. Feeding area for surrounding area. End April beginning May best time for surveying for reptiles.	009 - *Testudo graeca* 
Reptiles: *Testudo graeca*	Direct visual observation – dead individual	Azerbaijan Red Data Book & IUCN Red List	1	40.19605 N 049.46247 E			

Transect Number: 4	**Date:** 21/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
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** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds: *Sturnus vulgaris*	Telescopic, visual		120	40.22786 N 049.44980 E	9.35- 13.15	*Solonchak*, *Artemisia*/ephemerals plains. Feeding area for birds.	2007 - *Solonchak* 
Pastor roseus			5				
Pyrrhocorax pyrrhocorax			8				
Melanocorypha calandra			300				
Columba livia			18				
Oenanthe finschi			4				
Calandrella cinerea			13				
Falco naumanni		IUCN Red List	2				
Anser anser			9			Flew in northerly direction over area	
Mammals: *Lepus europeus* (hare)	Sleeping place in bush		1	40.22045 N 049.44734 E	9.35	Lack of mammals in this area as little food. No lizards here any time of year, turns to dry desert in 2 months time.	
Reptile: *Coluber spp*. - whipsnake	Snake skin from last year		1	40.21881 N 049.44747 E		Depression in plain – slightly wetter	
Mammals: *Microtus socialis*	Burrows		Many	40.21913 N 049.44761 E		Depression in plain – slightly wetter	

Transect Number: 4	**Date:** 22/03/02	**Proforma Reference No.**
		Surveyor: Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals: *Microtus socialis*	Burrow		1	40.21910 N 049.44760 E			
Mammals: *Microtus socialis*	Burrow		1	40.21887 N 049.44680 E			
Reptiles: *Testudo graeca*	*Direct visual observation*	Azerbaijan Red Data Book & IUCN Red List	1	40.21899 N 049.44625 E		In military digout	2005 - *Testudo graeca* 
Mammals: *Allactaga elater*	Burrow		1	40.21897 N 049.44621 E		In military digout	
Mammals: *Microtus socialis*	Burrow		1	40.21897 N 049.44621 E	11.00		

Transect Number: 5	**Date:** 21/03/02	**Proforma Reference No.**
		Surveyor: Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
***** Direct/ tracks/ signs
** Status should state whether species is included in existing Azerbaijan Red Data Book (1989), is proposed for inclusion in the next Red Data Book and/ or is included on the IUCN Red List for Threatened Species (2000)
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Birds:							006 - Looking east to terminal 
Allektoris chukar	Visual and telescopic		2	40.20266 N 049.45539 E	12.30-14.15	Low rocky mountainous area	
Falco tinninculus			1			Low rocky mountainous area	
Galerida cristata			5			Low rocky mountainous area	
Sturnus vulgaris			18			Low rocky mountainous area	
Sitta neumayer			2			Low rocky mountainous area	
Mammals:							
Lepus europeus (hare)	Direct visual observation		2	40.20442 N 049.44789 E	13.30	Semi-desert, bushy mountain-side	
Birds:							
Alectoris chukar	Telescopic, visual, auditory		2	40.20386 N 049.44723 E	14:25 – 15:34	Circumventing northern side of western mountain	
Melanocorypha calandra			40			Low rocky mountainous area	
Oenanthe pleshanka			1				
Sitta neumayer			4				
O. finschi			2				
Falco tinninculus			2				
Mammals:							
Meriones erythrourus (red tailed sanderling)	Burrow		1	40.20395 N 049.44733 E		Low rocky mountainous area	

Transect Number: 5	**Date:** 21/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Mammals: *Canis lupus* (wolf)	Den – numerous entrances		1	40.20226 N 049.44598 E		Low rocky mountainous area Come here to breed in April	005 – Wolf den entrance 
Mammals: *Lepus europeus* (hare)	Direct visual observation		2	40.20221 N 049.44560 E		On plains below rocky mountainous area	
Birds: *Alectoris chukar* (partridge)	Visual observation under rocks		2	40.26276 N 049.44566 E		Low rocky mountainous area	
Mammals: *Allactaga elater*	Burrow		1	40.20314 N 049.44581 E		Low rocky mountainous area	
Amphibians: *Rana ridibunda* - frog	Direct visual observation		Large numbers	40.20565 N 049.44983 E		In wadi between mountains.	
Mammals: *Lepus europeus* (hare)	Direct visual observation		1	40.20362 N 049.44875 E		On plains below rocky mountainous area	

Transect Number: 5	**Date:** 21/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

Species Observations
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Birds:							
Alectoris chukar	Visual, telescopic, auditory		5	40.21325 N 049.46491 E	15.45-17.30	Circumventing eastern mountain	
Falco tinninculus			1				
Galerida cristata			6				
Sturnus vulgaris			12				
Oenanthe finschi			3				
Sitta neumayer			6				
Scorpion				40.21217 N 049.46588 E			004 - Scorpion 

Transect Number: 5	**Date:** 21/03/02	**Proforma Reference No.** **Surveyor:** Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

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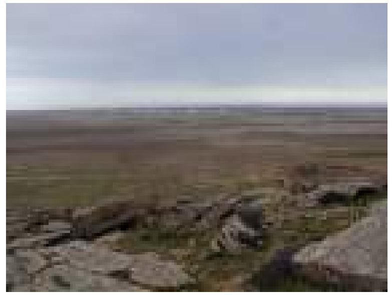
++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
				40.21161 N 049.46666 E			002 - View east from western hills to terminal site  001 – View west from western hills 

Transect Number: 6	**Date:** 22/03/02	**Proforma Reference No.**
		Surveyor: Rebecca Robinson, Dr Ilyas Babeyev, Dr Sudjaddin Guliev, Dr Teymur Aliyev

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+ If observe animal at some distance, take lat/long reading and state distance and direction from that point that animal was observed
++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Birds: *Pyrrhocorax pyrrhocorax* (chough)	Visual, telescopic		1	40.20433 N 049.47223 E	11.30 am	Classed as desert rather than semi-desert. Naturally degraded due to wind and lack of water. Lot of topsoil piles deposited in this area.	
				40.20661 N 049.46666 E			2003 - View east  2004 – View west 

Transect Number: 7	**Date:** 22/03/02	**Proforma Reference No.**
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Species Observations
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Start of transect				40.22157 N 049.42400 E	15.00	Tamarisk thickets near cemetery. Number of tamarisk chopped down for firewood.	2002 – Tamarisk thickets 
Birds:							
Galerida cristata	Visual, telescopic		6	40.21960 N 049.42258 E	14.45- 15.57	Tamarisk bushes	
Motacilla alba			1			Tamarisk bushes	
Fringilla coelebs			4			Tamarisk bushes	
Passer domestikus			28			Tamarisk bushes	
Upupa epops			2			Tamarisk bushes	
Corvus cornix			2			Tamarisk bushes	
Turdus merula			3			Tamarisk bushes	
Columba livia			12			*Artemisia*, ephemerals, grass	
Melanocorypha calandra			63			*Artemisia*, ephemerals, grass	
Mammals: *Microtus socialis*	Burrow		1	40.21805 N 049.42187 E		Tamarisk bushes	
Mammals: *Microtus socialis*	Burrow		1	40.21773 N 049.42174 E		Tamarisk bushes	

Transect Number: 7	**Date:** 22/03/02	**Proforma Reference No.**
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***** Direct/ tracks/ signs
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
Mammals: *Microtus socialis*	Burrow		1	40.21768 N 049.42171 E		Tamarisk bushes	
Mammals: *Allactaga elater*	Burrow		1	40.21762 N 049.42168 E		Tamarisk bushes	
Mammals: *Microtus socialis*	Large numbers of burrows		Many	40.21756 N 049.42166 E		Tamarisk bushes	
Mammals: *Allactaga elater*	Burrow		1	40.21741 N 049.42160 E		Tamarisk bushes	
Mammals: Meriones erythrourus	Burrow		1	40.21623 N 049.42114 E		Tamarisk bushes	
Mammals: *Allactaga elater*	Burrow and faeces		1	40.21590 N 049.42100 E		Tamarisk bushes	
Mammals: *Microtus socialis*	Burrow		1	40.21571 N 049.42107 E		Tamarisk bushes	
Reptiles *Viper libetina* - snake	Snake skin from last year		1	40.21560 N 049.42112 E		Local expert stated that snake will definitely be in burrow. Approximately 1.5 m long	
Mammals: *Microtus socialis*	Faeces		1	40.21560 N 049.42112 E		Tamarisk bushes	
End of transect				40.21378 N 049.42287 E			

Transect Number: 8	**Date:** 22/03/02	**Proforma Reference No.**
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Species Observations
***** Direct/ tracks/ signs
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++ e.g. *Salsola* desert/ *Artemisia* desert/ flat plains/ rocky hills/ bare ground/ crags

Latin Name	**Obs Type***	**Status****	**No. of Indivs**	**Location (Lat/Long)+**	**Time**	**Habitat Type++**	**Photo (Date-Time/ Roll-Frame)**
Start of transect on *Salsola* plain				40.17538 N 049.43954 E	16.30	Slasola plain	
Birds: *Circus aeruginosus*	Visual and telescopic		2	40.17266 N 049.44368 E		Tamarisk thicket. Used to be an artificial lake now dried out.	
Turdus merula			1			Tamarisk thicket	
Troglodytes troglodytes			3			Reeds	
Hirundo rustica			12			Reeds	
Delichon urbica			6			Reeds	
Galerida cristata			2			Various plant formations	
Mammals: *Microtus socialis*	Burrow		1	40.17342 N 049.44542 E			
Mammals: *Allactaga elater*	2 burrows		2	40.17342 N 049.44543 E			
Mammals: *Microtus socialis*	Burrow		1	40.17332 N 049.44544 E			
Mammals: *Meriones lybicus*	Burrows		Numerous	40.17344 N 049.44545 E			
Mammals: *Meriones lybicus*	Burrow		1	40.17345 N 049.44546 E			

Transect Number: 8	**Date:** 22/03/02	**Proforma Reference No.**
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Species Observations
***** Direct/ tracks/ signs
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Latin Name	Obs Type*	Status**	No. of Indivs	Location (Lat/Long)+	Time	Habitat Type++	Photo (Date-Time/ Roll-Frame)
				40.17319 N 049.44515 E			2001 - Looking north. Tamarisk in foreground *Salsola* desert on hills. 

Location: Sangachal South east area	**Date/ Time:10:40 19/03/2002**	**Surveyor: MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Coastal desert.**	**Quadrat Number: 1 (BQG)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°10.753 N** **Long:049°28.682 E** **Photo No** (Date/Time)**:Q1**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Vegetation growing at ground level, on sandy soil with fragments of shell.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Convolvulaceae	*Convolvulus persicus*		2
Fabaceae	*Alhagi pseudoalhagi*		+
Poaceae	*Aegilops biuncialis*		3
Chenopodiaceae	*Halostachys caspica*		2
Poaceae	*Aeluropus littoralis*		2

Location: Sangachal South east area	**Date/ Time:** **11:12 19/03/2002**	**Surveyor:**	**MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Coastal desert.**	**Quadrat Number: 2 (BQF)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°10.667 N** **Long:049°28.589 E** **Photo No** (Date/Time)**: Q2**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:** Close to the foot of nearby road embankment. Sandy soil with shell fragments and sparse vegetation cover

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Convolvulaceae	*Convolvulus persicus*		1
Chenopodiaceae	*Salsola dendroides*		2
Poaceae	*Poa bulbosa*		2
Poaceae	*Hordeum leporinum*		2

Location: Sangachal South east area	**Date/ Time:** **12:02 19/03/2002**	**Surveyor:** **MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D9** **Coastal desert**	**Quadrat Number: 3(BQE)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°09.185 N** **Long:049°28.253 E** **Photo No** (Date/Time)**: Q3**	

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Coastal inland area, 200m from the sea shore. Sandy soil with finer shell fragments than the previous quadrats.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Halocnemum strobilaceum*		1
Fabaceae	*Alhagi pseudoalhagi*		+
Poaceae	*Aegilops biuncialis*		3

Location: Sangachal South east area	**Date/ Time:**	**15:16 19/03/2002**	**Surveyor:**	**MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Coastal desert**	**Quadrat Number: 4 (BQD)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°09.028 N** **Long:049°28.305 E** **Photo No** (Date/Time)**: Q4**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:** Located at the foot of the main coast road embankment, close to classic wetland communities of *Juncus acutus* and *Phragmites australis* communities. Situated 100m fro the seashore, salty and sandy soil with pools of discoloured water stagnant.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Juncaceae	*Juncus acutus*		2
Tamaricaceae	*Tamarix ramosissima*		2
Chenopodiaceae	*Suaeda dendroides*		+

Location: Sangachal South east area	**Date/ Time:** **15:45 19/03/2002**	**Surveyor:**	**MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**
D9
Coastal desert

Quadrat Number: 5 (BQC)

Quadrat Size: 2x2m 4m2

Quadrat Location:
Lat: 40º09.014 N

Long:049º28.309 E

Photo No (Date/Time)**: Q5**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Tamaricaceae	*Tamarix ramosissima*		2
Chenopodiaceae	*Halocnemum strobilaceum*		3
Asteraceae	*Calendula persica*		1
Convolvulaceae	*Convolvulus persicus*		1

Location: Sangachal South east area	**Date/ Time:**	**15:47 19/03/2002**	**Surveyor:**	**MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Coastal desert**	**Quadrat Number: 6 (BQB)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location: Lat: N 40º09.006 Long: E 049º28.307** **Photo No** (Date/Time)**: Q6**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Sandy soil found at the edge of the road with sparse clumps of dead and emerging *Convolvulus persicus* associated with sparse clumps of *Juncus***.**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Convolvulaceae	*Convolvulus persicus*		3
Juncaceae	*Juncus acutus*		2
Asteraceae	*Artemisia fragrans*		+
Chenopodiaceae	*Halocnemum strobilaceum*		2

Location: Sangachal South east area	**Date/ Time:** **16:00 19/03/2002**	**Surveyor:** **MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Coastal desert**	**Quadrat Number: 7 (BQA)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°08.797 N** **Long:049°28.339 E** **Photo No** (Date/Time)**: Q7**	

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): No vegetation in the area, the quadrat is populated by remnants of *Alhagi pseudoalhagi* on a flat area of fine sand and fine shell fragments 20m from the sea shore.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Fabaceae	*Astragalus bakuensis*	1	+

Location: Sangachal South east area	**Date/ Time: 16:19 19/03/2002**	**Surveyor: MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**	**Quadrat Number: 8 (New)**
	Quadrat Size: 2x2m 4m^2
	Quadrat Location: **Lat: 40º09.121 N** **Long:049º28.279 E**
	Photo No (Date/Time)**: Q8**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Dried wetland area surrounded by areas of *Phragmites* and *Juncus* stands. Contamination with domestic waste, evidence of fly tipping.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Tamaricaceae	*Tamarix ramosissima*		3
Juncaceae	*Juncus acutus*		3

Location: Sangachal South east area	**Date/ Time:** **16:40 19/03/2002**	**Surveyor:** **MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD4** ***Salsola* dendroides semi desert**	**Quadrat Number: 8 (New)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40°09.787 N** **Long:049°28.343 E** **Photo No** (Date/Time)**: Q9**	

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salicornia europaea*		3
Chenopodiaceae	*Salsola dendroides*		3

Location: **Sangachal central north plains**	**Date/ Time:** 09:51 20/03/2002	**Surveyor:** MC MG	
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D11**	**Quadrat Number: 10 (CN1)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.22663º N** **Long:049.50373º E** **Photo No** (Date/Time)**: Q10**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola nodulosa*		2
Asteraceae	*Hedypnois cretica*		3
Asteraceae	*Calendula persica*		3
Boraginaceae	*Nonea rosea*		1
Brassicaceae	*Torularia contortuplicata*		+
Plantaginaceae	*Plantago praecox*		1

Location: **Sangachal central north plains**	**Date/ Time:** **10:32** **20/03/2002**	**Surveyor:** **MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D11** **SD2?**	**Quadrat Number: 11 (CN2)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.22808º N** **Long:049.49955 E** **Photo No** (Date/Time)**: Q11**	

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Poaceae	*Hordeum leporinum*		4
Chenopodiaceae	*Salsola nodulosa*		1
Asteraceae	*Calendula persica*		2
Asteraceae	*Anthemis candidissima*		3
Cuscutaceae	*Cuscuta sp.*		3
Asteraceae	*Tragopogon graminifolius*		2

Location: **Sangachal central north plains**	**Date/ Time:**	**11:00** **20/03/2002**	**Surveyor:**	**MC** **MG**

<table>
<tr><td rowspan="4">Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan):
D11</td><td>Quadrat Number: 12 (CN3)</td></tr>
<tr><td>Quadrat Size: 2x2m 4m^2</td></tr>
<tr><td>Quadrat Location:
Lat: 40.22303º N

Long:049.49445 E</td></tr>
<tr><td>Photo No (Date/Time): Q12</td></tr>
</table>

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola nodulosa*		2
Asteraceae	*Anthemis candidissima*		2
Asteraceae	*Calendula persica*		3
Ranunculaceae	*Ceratocephalus falcatus*		+
Fabaceae	*Medicago minima*		2

Location: **Sangachal central north plains**	**Date/ Time:**	**11:53** **20/03/2002**	**Surveyor:**	**MC** **MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD2?** **D11**	**Quadrat Number: 13 (CN4)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.22300º N** **Long:049.49540 E** **Photo No** (Date/Time)**: Q13**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Ranunculaceae	*Adonis aestivalis*		+
Asteraceae	*Calendula persica*		2
Chenopodiaceae	*Salsola nodulosa*		2
Asteraceae	*Anthemis candidissima*		3
Asteraceae	*Anisantha rubens*		2
Plantaginaceae	*Plantago praecox*		+

Location: **Sangachal central north plains**	**Date/ Time:**	**12:56 20/03/2002**	**Surveyor:**	**MC MG**	

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**
SD2?
D11

Quadrat Number: 14 (CN5)

Quadrat Size: 2x2m 4m^2

Quadrat Location:
Lat: 40.21300º N

Long:049.51248 E

Photo No (Date/Time)**: Q14**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Situated on a fine clay soil at the top of a gradual slope to the north and west of the terminal site.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola nodulosa*	2	1
Chenopodiaceae	*Salsola microphylla*	1	+
Scrophulariaceae	*Veronica arvensis*	3	3
Poaceae	*Cynodon dactylon*		3
Boraginaceae	*Nonea lutea*		2

Location: **Sangachal central north west plains**	**Date/ Time:** 13:54 20/03/2002	**Surveyor:** MC MG	
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D5**	**Quadrat Number: 15 (CN6)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.21969º N** **Long:049.52085 E** **Photo No** (Date/Time)**: Q15**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Close to the bank of a deeply incised channel populated by ephemeral species and old growths of *Salsola nodulosa* on very fine soil.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Brassicaceae	*Torularia contortuplicata*		2
Scrophulariaceae	*Veronica polita*		3
Asteraceae	*Tragopogon graminifolius*		2
Chenopodiaceae	*Salsola nodulosa*		2
Poaceae	*Aegilops biuncialis*		3

Location: **WSW of the Sangachal terminal**	**Date/ Time:**	**15:41** **20/03/2002**	**Surveyor:** **MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D2**	**Quadrat Number: 16 (3T1)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.20111º N** **Long:049.50764 E** **Photo No** (Date/Time)**: Q16**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): *Salsola nodulosa* and *Artemisia fragrans* dominated desert in disturbed fine clay soil.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Sasola nodulosa*		3
Asteraceae	*Artemisia fragrans*		3
Alliaceae	*Allium rubellum*		1
Poaceae	*Poa bulbosa*		3
Asteraceae	*Calendula persica*		+
Ranunculaceae	*Ceratocephalus falcatus*		1
Scrophulariaceae	*Veronica denudata*		+
Poaceae	*Cynodon dactylon*		+

Location: **WSW of the Sangachal terminal**	**Date/ Time:**	**16:18** **20/03/2002**	**Surveyor:**	**MC** **MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **D2**	**Quadrat Number: 17 (3T2)**
	Quadrat Size: 2x2m 4m^2
	Quadrat Location: **Lat: 40.19827º N** **Long:049.49801 E**
	Photo No (Date/Time)**: Q17**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): On pipeline right-of-way close to the terminal situated on fine clay soils.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Fabaceae	*Alhagi pseudoalhagi*		2
Asteraceae	*Artemisia fragrans*		3
Asteraceae	*Calendula persica*		2
Poaceae	*Poa bulbosa*		3
Asteraceae	*Carduus arabicus*		3

Location: **WSW of the Sangachal terminal**	**Date/ Time:**	**17:04** **20/03/2002**	**Surveyor:**	**MC** **MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **W5**	**Quadrat Number: 18 (3T3)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.19189º N** **Long: 049.48656 E** **Photo No** (Date/Time)**: Q18**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Heavy clay soil in gentle sloping depression.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Juncaceae	*Juncus acutus*		4
Poaceae	*Anisantha rubens*	1	+

Location: **Transect 4 West of the Sangachal terminal**	**Date/ Time:**	**09:24 20/03/2002**	**Surveyor:**	**MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**	**Quadrat Number: 19 (4T1)**			
	Quadrat Size: 2x2m 4m^2			
	Quadrat Location: **Lat: 40.19378º N** **Long: 049.45329 E**			
	Photo No (Date/Time)**: Q19**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Patchy areas of *Salsola dendroides* and *S. microphylla*. Low growth with areas of meadow grass and low growing ephemerals.

NB: the surrounding areas have patches of tamarisk close to the route of the pipeline and in topographic troughs and the foot of topographic peaks.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola microphylla*		2
Chenopodiaceae	*Salsola dendroides*		3
Asteraceae	*Artemisia fragrans*		3
Asteraceae	*Xanthium spinosum*		1
Boraginaceae	*Lycopsis arvensis*		1
Poaceae	*Poa bulbosa*		3
Asteraceae	*Carduus albidus*		1
Poaceae	*Eremopyrum triticeum*		3

Location: **Transect 4 West of the Sangachal terminal**	**Date/ Time:** **10:24 21/03/2002**	**Surveyor:** **MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**	**Quadrat Number: 20 (4T2)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.19923º N** **Long: 049.45656 E** **Photo No** (Date/Time)**: Q20**	

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**
NB: Surrounding area is flat with a patchy cover of quadrat species along with tamarisk thickets to the east. Semi-desert with low growing *Salsola dendroides* and *Artemisia fragrans* with cover of ephemerals and grasses.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		3
Asteraceae	*Artemisia fragrans*		3
Asteraceae	*Calendula persica*		3
Poaceae	*Hordeum leporinum*		2
Scrophulariaceae	*Veronica denudata*		+
Poaceae	*Poa bulbosa*		1
Boraginaceae	*Nonea lutea*		3
Poaceae	*Eremopyrum orientale*		2
Boraginaceae	*Lycopsis arvensis*		2
Fabaceae	*Vicia cinerea*		1

Location: **Transect 4 West of the Sangachal terminal**	**Date/ Time:**	**12:28 21/03/2002**	**Surveyor:**	**MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **S**	**Quadrat Number: 21 (4T3)**
	Quadrat Size: 2x2m 4m^2
	Quadrat Location: **Lat: 40.20350º N** **Long: 049.45250 E**
	Photo No (Date/Time)**: Q21**

Site and Vegetation Description **(include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**: Located at the edge of a tamarisk stand with low growing grasses and ephemeral species situated in fine clayey soils. *Salsola dendroides* and *Artemesia fra*grans dominate the surrounding area

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		2
Asteraceae	*Artemisia fragrans*		+
Fabaceae	*Alhagi pseudoalhagi*		+
Poaceae	*Hordeum leporinum*		2
Tamaricaceae	*Tamarix meyeri*		+
Poaceae	*Aeluropus littoralis*		2
Brassicaceae	*Torularia contortuplicata*		+
Asteraceae	*Calendula persica*		1
Poaceae	*Poa bulbosa*		2
Poaceae	*Cynodon dactylon*		1
Asteraceae	*Tragopogon graminifolius*		+
Asteraceae	*Silybum marianun*		1

Location: **Transect 4 West of the Sangachal terminal**	**Date/ Time:**	**13:00** **21/03/2002**	**Surveyor:**	**MC** **MG**	

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD3**	**Quadrat Number: 22 (4T4)**
	Quadrat Size: 2x2m 4m^2
	Quadrat Location: **Lat: 40.20429º N** **Long: 049.45239 E**
	Photo No (Date/Time)**: Q22**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		2
Chenopodiaceae	*Climacoptera grassa*		+
Chenopodiaceae	*Petrosimonia brachiata*		+
Asteraceae	*Calendula persica*		2
Poaceae	*Aeluropus littoralis*		2

Location: **Transect 4 West of the Sangachal terminal**	**Date/ Time:**	**13:42** **21/03/2002**	**Surveyor:** **MC** **MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD4**	**Quadrat Number: 23 (4T5)**
	Quadrat Size: 2x2m 4m^2
	Quadrat Location: **Lat: 40.20184º N** **Long: 049.45026 E**
	Photo No (Date/Time)**: Q23**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Semi desert with sparse cover of tamarisk, *Salsola dendroides*, *S. ericoides* and ephemeral species.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		2
Chenopodiaceae	*Salsola ericoides*		+
Asteraceae	*Taraxacum praticola*		3
Fabaceae	*Alhagi pseudoalhagi*		2
Asteraceae	*Calendula persica*		2
Poaceae	*Poa bulbosa*		3

Location: Transcect 4 North West of the Sangachal terminal	**Date/ Time:**	**14:30 21/03/2002**	**Surveyor:**	**MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD1**	**Quadrat Number: 24 (BQL)** **Quadrat Size: 2x2m 4m²** **Quadrat Location:** **Lat: 40.22488º N** **Long: 049.42635 E** **Photo No** (Date/Time)**: Q24**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Patchy *Artemisia* and clover /grassed areas, intermittent throughout the area.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Asteraceae	*Artemisia fragrans*		2
Fabaceae	*Alhagi pseudoalhagi*		1
Poaceae	*Aegilops biuncialis*		2
Asteraceae	*Silybum marianum*		4
Asteraceae	*Calendula persica*		2
Poaceae	*Poa bulbosa*		3
Poaceae	*Anisantha rubens*		3

Location: North Plains	**Date/ Time:**	**09:42 22/03/2002**	**Surveyor:**	**MC MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**

SD4

Quadrat Number: 25 (NP1)

Quadrat Size: 2x2m 4m^2

Quadrat Location:
Lat: 40.23024º N

Long: 049.44547 E

Photo No (Date/Time)**: Q25**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:** Clay soil on flat plain with continuous patchy cover of ephemeral flowering species and *Salsola dendroides*, short tufts of grass and white lichens.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		3
Poaceae	*Hordeum leporinum*		3
Asteraceae	*Calendula persica*		2
	White lichen sp		4
Poaceae	*Avena eriantha*		2
Fabaceae	*Ttrigonella coerulescens*		1
Brassicaceae	*Cardaria draba*		1

Location: **North Plains**	**Date/ Time:**	**10:32** **22/03/2002**	**Surveyor:**	**MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD1**	**Quadrat Number: 26 (NP2)**			
	Quadrat Size: 2x2m 4m^2			
	Quadrat Location: **Lat: 40.22173º N** **Long: 049.44352 E**			
	Photo No (Date/Time)**: Q26**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola dendroides*		2
Asteraceae	*Artemisia fragrans*		3
Chenopodiaceae	*Salsola ericoides*		+
Poaceae	*Poa bulbosa*		2
Asteraceae	*Calendula persica*		2
Poaceae	*Anisantha rubens*		4

Location: **Impacted area North of Terminal**	**Date/ Time:**	**11:35** **22/03/2002**	**Surveyor:**	**MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Disturbed ground**	**Quadrat Number: 27 (Imp1)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.20716º N** **Long: 049.46665 E** **Photo No** (Date/Time)**: Q27**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Flat expanse of desiccated, fine clay soil.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola nodulosa*		1
Chenopodiaceae	*Climacoptera grassa*		2
Poaceae	*Poa bulbosa*		1
Fabaceae	*Medicago minima*		1

Location: **Impacted area North of Terminal**	**Date/ Time:**	**11:48** **22/03/2002**	**Surveyor:** **MC** **MG**

Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Disturbed ground**	**Quadrat Number: 28 (Imp2)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.20712º N** **Long: 049.46844 E** **Photo No** (Date/Time)**: Q28**

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Flat clay cracked soil with no vegetation cover.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola microphylla*	1	+

Location: **East of Terminal**	**Date/ Time:**	**12:26 22/03/2002**	**Surveyor:**	**MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Semi Desert**	**Quadrat Number: 29 (BQH)**			
	Quadrat Size: 2x2m 4m^2			
	Quadrat Location: **Lat: 40.20614º N** **Long: 049.48994 E**			
	Photo No (Date/Time)**: Q29**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Brassicaceae	*Torularia contortuplicata*		3
Poaceae	*Colpodium humile*		2
Chenopodiaceae	*Salsola ericoides*		1
Asteraceae	*Calendula persica*		3

Location: **East of Terminal**	**Date/ Time:** **13:00** **22/03/2002**	**Surveyor:** **MC** **MG**	
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:**	**Quadrat Number: 30 (BQJ)** **Quadrat Size: 2x2m 4m²** **Quadrat Location:** **Lat: ° N** **Long: E** **Photo No** (Date/Time)**: Q30**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): *Artemisia – Salsola* association.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Chenopodiaceae	*Salsola ericoides*		3
Alliaceae	*Allium rubellum*		2
Poaceae	*Bromus japonicus*		2
Poaceae	*Eremopyrum orientale*		3
Asteraceae	*Calendula persica*		2

Location: **North West of Terminal**	**Date/ Time:**	**15:20** **22/03/2002**	**Surveyor:** **MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **Semi Desert**	**Quadrat Number: 33 (7T1)**		
	Quadrat Size: 2x2m 4m^2		
	Quadrat Location: **Lat: 40.21965° N** **Long: 049.41722 E**		
	Photo No (Date/Time)**: Q33**		

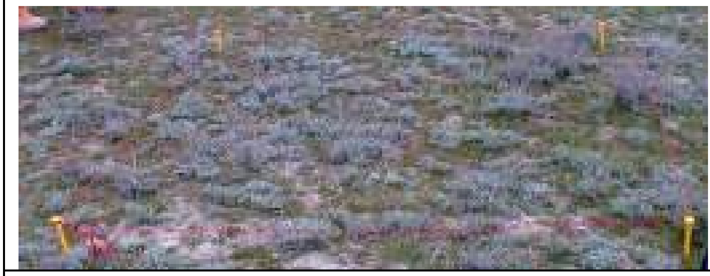
Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:** Tamarisk thickets and chal meadow with extensive cover of meadow grass and clover.
NB. Within crescent shaped tamarisk meadow area interspersed with *Salsola dendroides* and *Artemisia fragrans* semi-desert.

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Tamaricaceae	*Tamarix meyeri*		4
Poaceae	*Colpodium humile*		3
Poaceae	*Poa bulbosa*		3
Poaceae	*Eremopyrum triticeum*		3

Location: **North West of Terminal**	**Date/ Time:**	**15:20 22/03/2002**	**Surveyor:**	**MC MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD1**	**Quadrat Number: 34 (7T2)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.21846º N** **Long: 049.41685 E** **Photo No** (Date/Time)**: Q34**			

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect): Abundant cover of *Artemisia* and low growing ephemeral species.



Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Asteraceae	*Artemisia fragrans*		4
Chenopodiaceae	*Salsola ericoides*		4
Asteraceae	*Calendula persica*		1
Poaceae	*Poa bulbosa*		3
Alliaceae	*Alllium rubellum*		+

Location: **North West of Terminal**	**Date/ Time:**	**15:20** **22/03/2002**	**Surveyor:** **MC** **MG**
Vegetation Type (as identified in Table 2.1 of methodology, but can be linked to Communities on Vegetation Map of Azerbaijan)**:** **SD1**	**Quadrat Number: 35 (8T1)** **Quadrat Size: 2x2m 4m^2** **Quadrat Location:** **Lat: 40.17589º N** **Long: 049.440990 E** **Photo No** (Date/Time)**: Q35**		

Site and Vegetation Description (include information on density and type of vegetation, height and structure, soil type, altitude, slope, aspect)**:**

Species List:

Family	***Genus species***	**No. of Individuals**	**Domin Scale #**
Fabaceae	*Alhagi pseudoalhagi*		4
Tamaricaceae	*Tamarix meyeri*		1
Boraginaceae	*Nonea lutea*		1

LIST OF NON-QUADRAT SPECIES

Brassicaceae	*Sisymbrium loeselii*
Boraginaceae	*Argusia sibirica*
Nitrariaceae	*Nitraria schoberii*
Apiaceae	*Ferula persica*
Typhaceae	*Typha latifolia*
Typhaceae	*Typha angustifolia*
Chenopodiaceae	*Atriplex fomini*
Chenopodiaceae	*Suaeda confusa*
Chenopodiaceae	*Suaeda confusa*
Chenopodiaceae	*Salsola australis*
Papaveraceae	*Papaver arenarium*
Papaveraceae	*Papaver somniferum*
Fabaceae	*Medicago litoralis*
Fabaceae	*Trifolium echinatum*
Fabaceae	*Astragalus igniarius*
Fabaceae	*Clycyrrihza glabra*
Asteraceae	*Centaurea arenaria*
Asteraceae	*Scorzonera biebersteinii*
Asteraceae	*Cladochaeta candidissima*
Asteraceae	*Artemisia szowitsiana*
Asparagaceae	*Asparagus persicus*
Poaceae	*Stipagrostis pennata*
Poaceae	*Sphenopus divaricatus*
Poaceae	*Puccinellia poecilantha*
Poaceae	*Ammochloa palaestina*

LIST OF IDENTIFIED AZERBAIJAN RED DATA BOOK SPECIES

Fabaceae	*Astragalus bakuensis*
Apiaceae	*Ferula persica*
Poaceae	*Ammochloa palaestina*
Asteraceae	*Cladochaeta candidissima*
Fabaceae	*Clycyrrihza glabra* (proposed)
Nitrariaceae	*Nitraria schoberii* (proposed)

APPENDIX B – HYDRODYNAMIC AND DISPERSION MODELING FOR THE AZERI, CHIRAG, GUNASHLI FIELD OFFSHORE BAKU, AZERBAIJAN: PHASE 2

ASA DRAFT FINAL REPORT

TITLE

Hydrodynamic and Dispersion Modeling for the Azeri, Chirag, Gunashli Field Offshore Baku, Azerbaijan: Phase 2

AUTHORS

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CLIENT

RSK Environment, Ltd.

PROJECT NUMBER

ASA 01-210

April 2002

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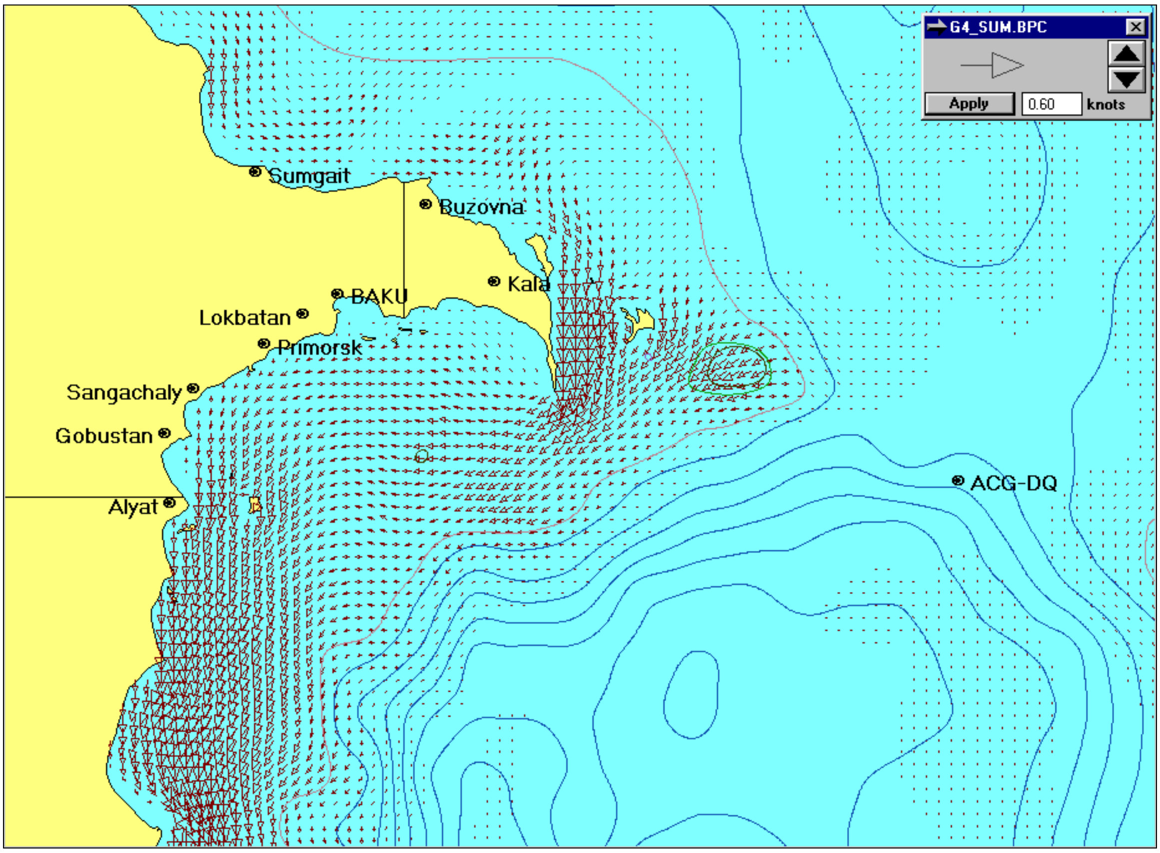

Executive Summary

RSK Environment Ltd. (RSK), contracted with Applied Science Associates, Inc. (ASA) of Narragansett, RI USA to provide environmental modeling support for the Phase II Environmental Impact Statement (EIS) to be developed for the Azeri, Chirag, Gunashli Field offshore Baku, Azerbaijan. The primary purpose of the environmental modeling was to simulate cooling water discharge and the deposition of mud and cuttings from drilling operations conducted by the East and West PDUQ Platforms. In support of the above objectives hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; thermal dispersion simulations were conducted to characterize cooling water discharges using the United States Environmental Protection Agency's Visual Plumes near field dispersion modeling system; and mud and drill cutting simulations were conducted using ASA's MUDMAP.

Hydrodynamic simulations were conducted for the Caspian Sea using HYDROMAP. The simulations were conducted during the summer and winter seasons of the year 2000, June through August and December through January, respectively. The computational grid covered the entire Caspian Sea with coarse resolution in the northern Caspian on the order of 20 km and finer resolution in the southern Caspian with resolutions on the order of 5 and 2.5 km in the Baku region. The environmental forcing for the hydrodynamic model consisted of wind data obtained from the numerical atmospheric model: NCEP reanalysis, provided by NOAA-CIRES Climate Diagnostics Center, Boulder Colorado. The hydrodynamic model was validated using current meter data collected by the Azerbaijan International Operating Company along a pipeline route between Chirag and Sangachal Bay within the Caspian Sea during the winter season from 01 February to 01 April 2000. The validation consisted of both qualitative and quantitative measures. The validation showed the model to reproduce the major current trends within the region very well with the model being more energetic than the data at offshore data collection stations and slightly less energetic at near shore data collection stations. The difference between the energetic state of the model and data was within commonly accepted modeling guidelines except for one station offshore Kala that can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid.

Thermal dispersion simulations were conducted for cooling water discharges at four locations within the Azeri, Chirag, Gunashli Field using the United States Environmental Protection Agency's Visual Plumes modeling system. The simulations were conducted under stagnant conditions during the summer and winter seasons. These conditions were chosen in order to determine the worst-case dispersion of the thermal effluent relative to the water quality criteria for cooling water effluent specified by the International Finance Corporation Environmental Health and Safety Guidelines. Under the cooling water release conditions specified the simulations showed no violation of the above stated water quality criteria.

A series of mud and drill cutting simulations were conducted for 48 wells, each at the East and West PDUQ's, during average and maximum current conditions for the summer and winter seasons. In general the heavier cuttings settled very near the drill site with lighter particle being carried downstream by the current before settling. The maximum deposition thickness during the winter season under average current conditions was 208 cm at the East PDUQ and 203 cm at the West PDUQ. The maximum deposition thickness during the winter season under maximum current conditions was 89 cm at the East PDUQ and 144 cm at the West PDUQ. The maximum deposition thickness during the summer season under average current conditions was 211 cm at the East PDUQ and 210 cm at the West PDUQ. The maximum deposition thickness during the summer season under maximum current conditions was 208 cm at the East PDUQ and 177 cm at the West PDUQ.

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1. Introduction

RSK Environment Ltd. (RSK), contracted with Applied Science Associates, Inc. (ASA) of Narragansett, RI USA to provide environmental modeling support for the Phase II Environmental Impact Statement (EIS) to be developed for the Azeri, Chirag, Gunashli Field offshore Baku, Azerbaijan. The primary purpose of the environmental modeling was to simulate cooling water discharge and the deposition of mud and cuttings from drilling operations conducted by the East and West PDUQ Platforms. In support of the above objectives hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; thermal dispersion simulations were conducted to characterize cooling water discharges using the United States Environmental Protection Agency's Visual Plumes near field dispersion modeling system; and mud and drill cutting simulations were conducted using ASA's MUDMAP.

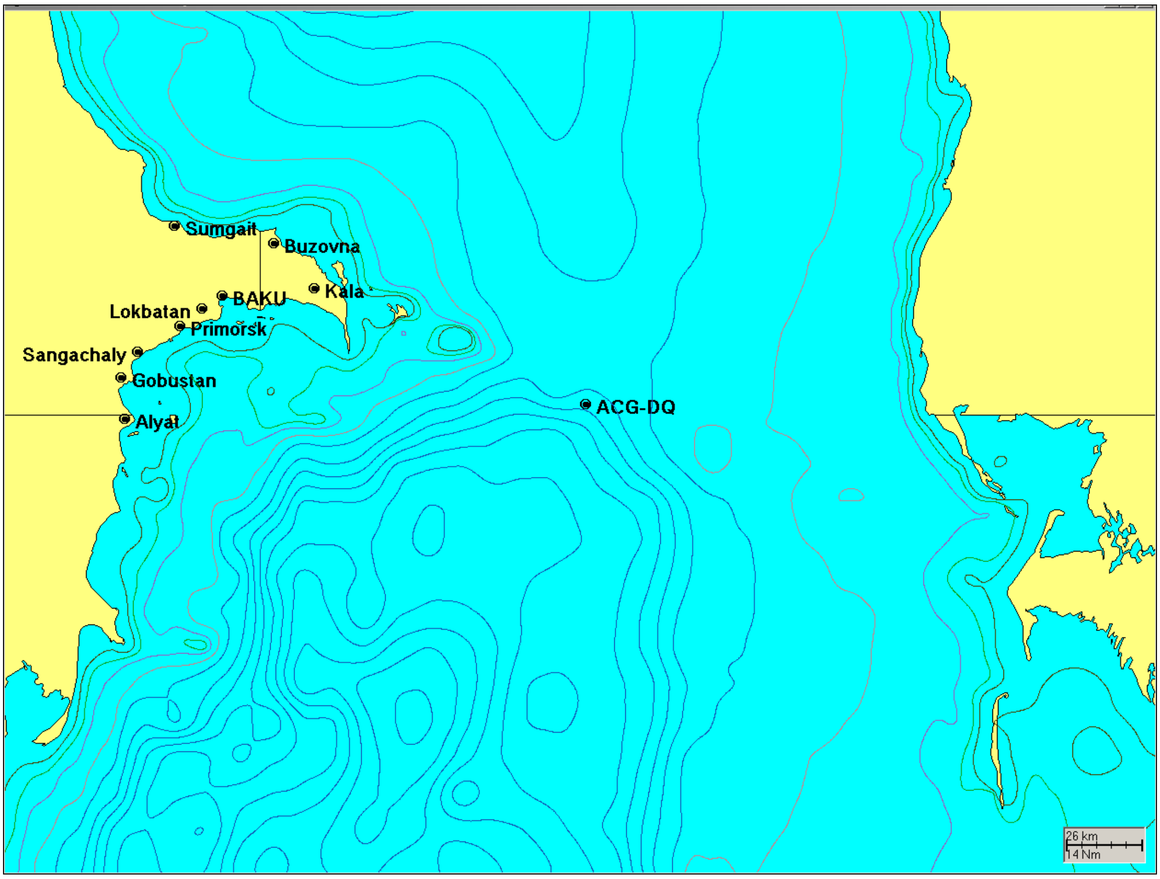

Figure 1. Northern Caspian Sea offshore Baku, Azerbaijan.

This reports documents the development of the hydrodynamic simulations and the objective environmental modeling. Section 1 discusses the purpose of the study and provides a description of the study area.
Section 2 describes the models used for the environmental simulations. Section 3 presents the development, confirmation and application of the hydrodynamic model to the study area. Section 4 presents the simulation of the cooling water discharges. Section 5 documents the simulated deposition of drill cuttings and mud from the East and West PDUQ platforms. Section 6 presents the major conclusions of the study and Section 7 list references.

1.1 Study Area

The Azeri, Chirag, Gunashli Field is located within the southern Caspian Sea approximately 75km offshore Baku, Azerbaijan (Figure 1). The Caspian Sea (Figure 2) is the largest inland water body on the planet and has no connections to the world oceans. It is elongated lattitudinally with a north to south length of 1030 km, a maximum width of 435 km and an average depth of 208 m. The sea is divided into three parts, the Northern, Middle and Southern Caspian with total sea areas of approximately 25%, 37.5% and 37.5% respectively. However, the ratio of total water volumes are dramatically different for each region with the Northern Caspian containing approximately 0.5%, The Middle Caspian containing approximately 34% and the Southern Caspian containing approximately 66% of the total water volume.

Figure 2. Caspian Sea.

Since the sea is not connected to the ocean the main cause of currents is wind action, especially in the surface layer, and variations in density. The currents in the southern Caspian Sea have been characterized as having no general quasi-steady pattern (Kosarev, 1994) but rather the currents correspond to the main wind fields and in calm weather only weak currents exist due to density difference. Thus the strongest and most stable of currents are set in motion by regional winds that cover broad areas while in the coastal areas the currents are influenced by local winds and the geometry of the region. Figure 3 presents typical current patterns for the Mid to Southern Caspian for northwesterly and southwesterly winds as presented in Klevstova (1966). The currents moving along the western coast of the Southern Caspian typically follow the wind however near the Baku archipelago the currents are usually opposing the wind. Current velocities along this shore typically reach 10-20 cm/s with light winds, 30 cm/s due to moderate winds and 40-50 cm/s under the influence of strong winds.

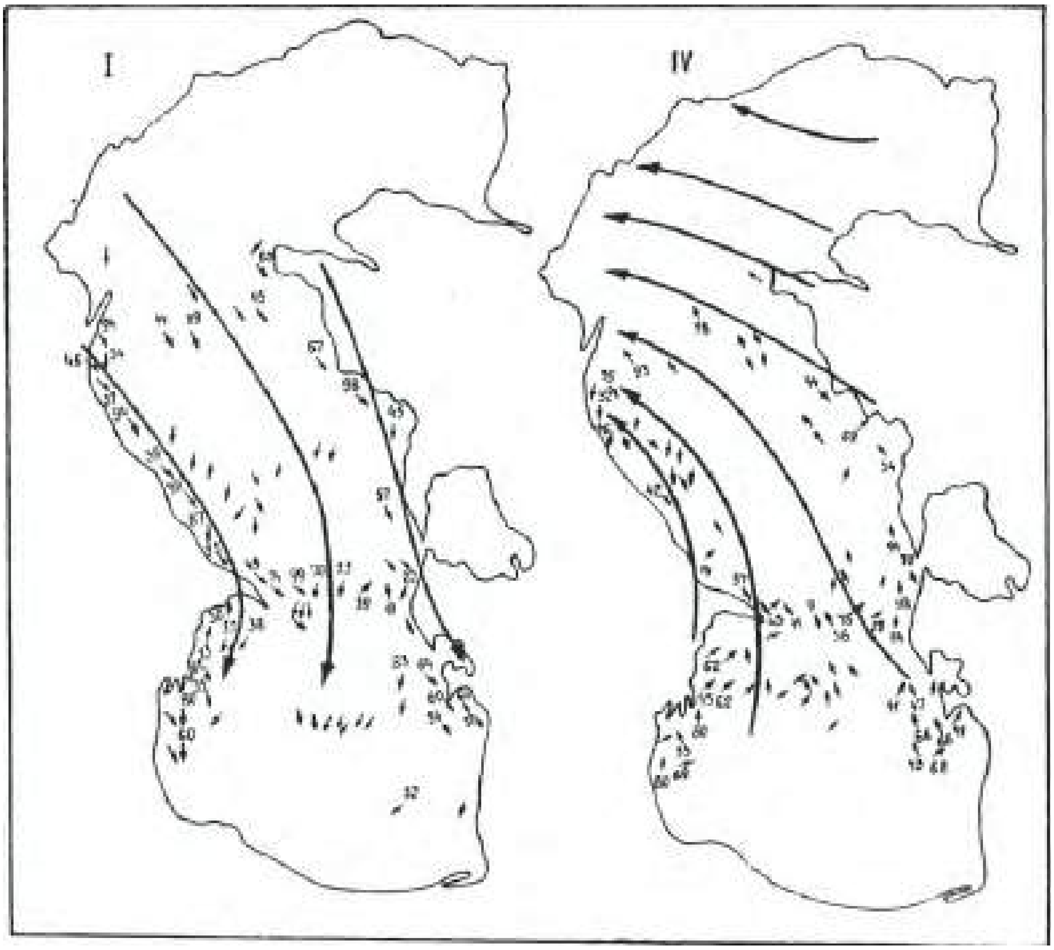

Figure 3. Surface currents developed from the influence of northwesterly (I) and southeasterly (IV) winds (Klevtsova, 1966). Long arrows represent wind direction, short arrows represent currents and the numbers indicate stability values in %.

Due to the large latitudinal variations of the Caspian Sea the distribution of temperature during the winter in the surface layers are not homogeneous and thermal gradients are small due to the intensive development of convectional mixing (Kosarev, 1994). During the summer the climatic conditions influencing the Caspian region are fairly uniform thus causing very little latitudinal thermal variation in the surface layers. However, during the summer thermoclines appear at 20-30 m with a characteristically strong thermal gradient (Kosarev, 1994). Figures 4 and 5 present characteristic water surface temperatures over the Caspian Sea, as presented in Kosarev (1994), for the months of February and August, respectively.

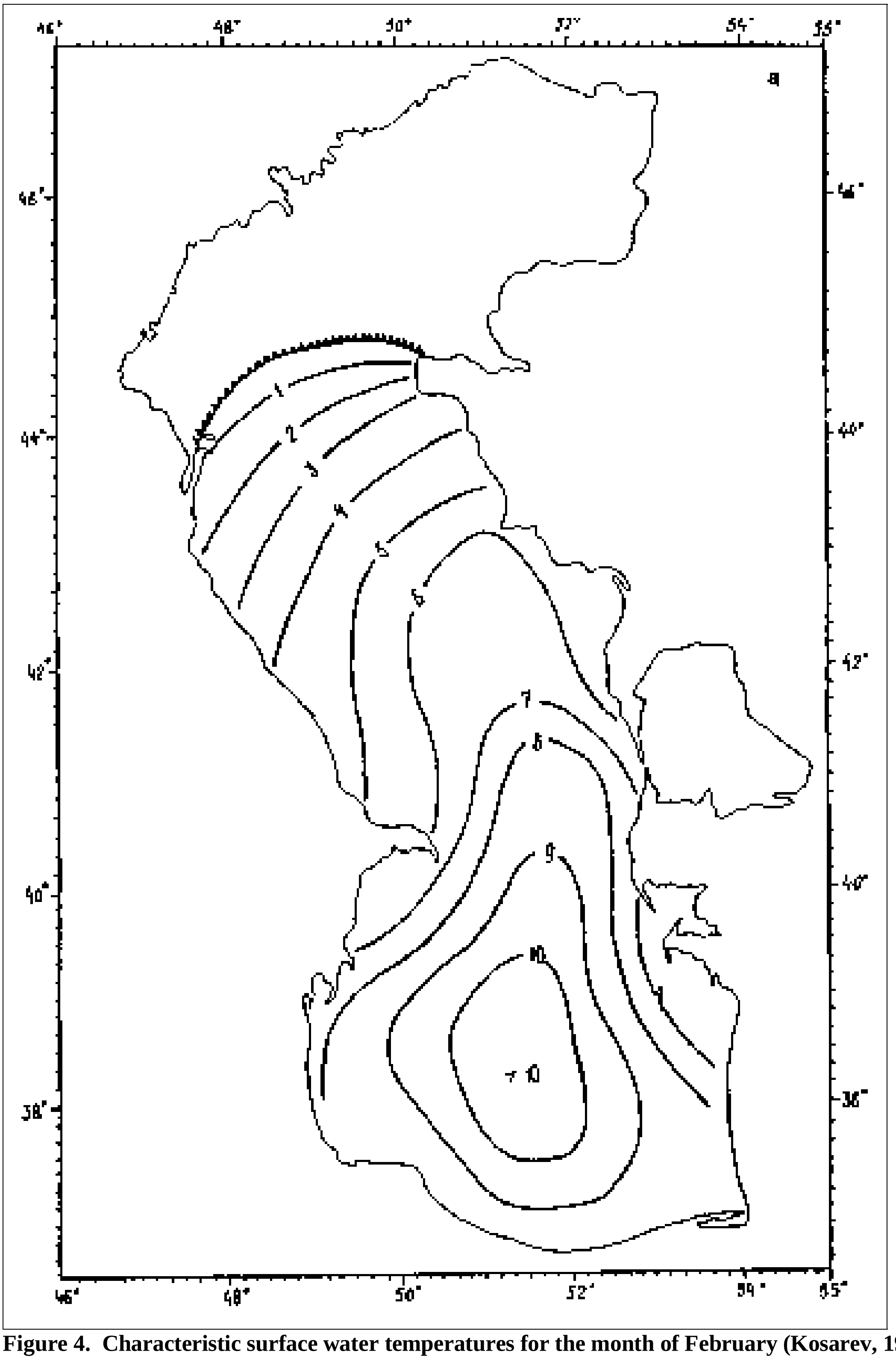

Figure 4. Characteristic surface water temperatures for the month of February (Kosarev, 1994).

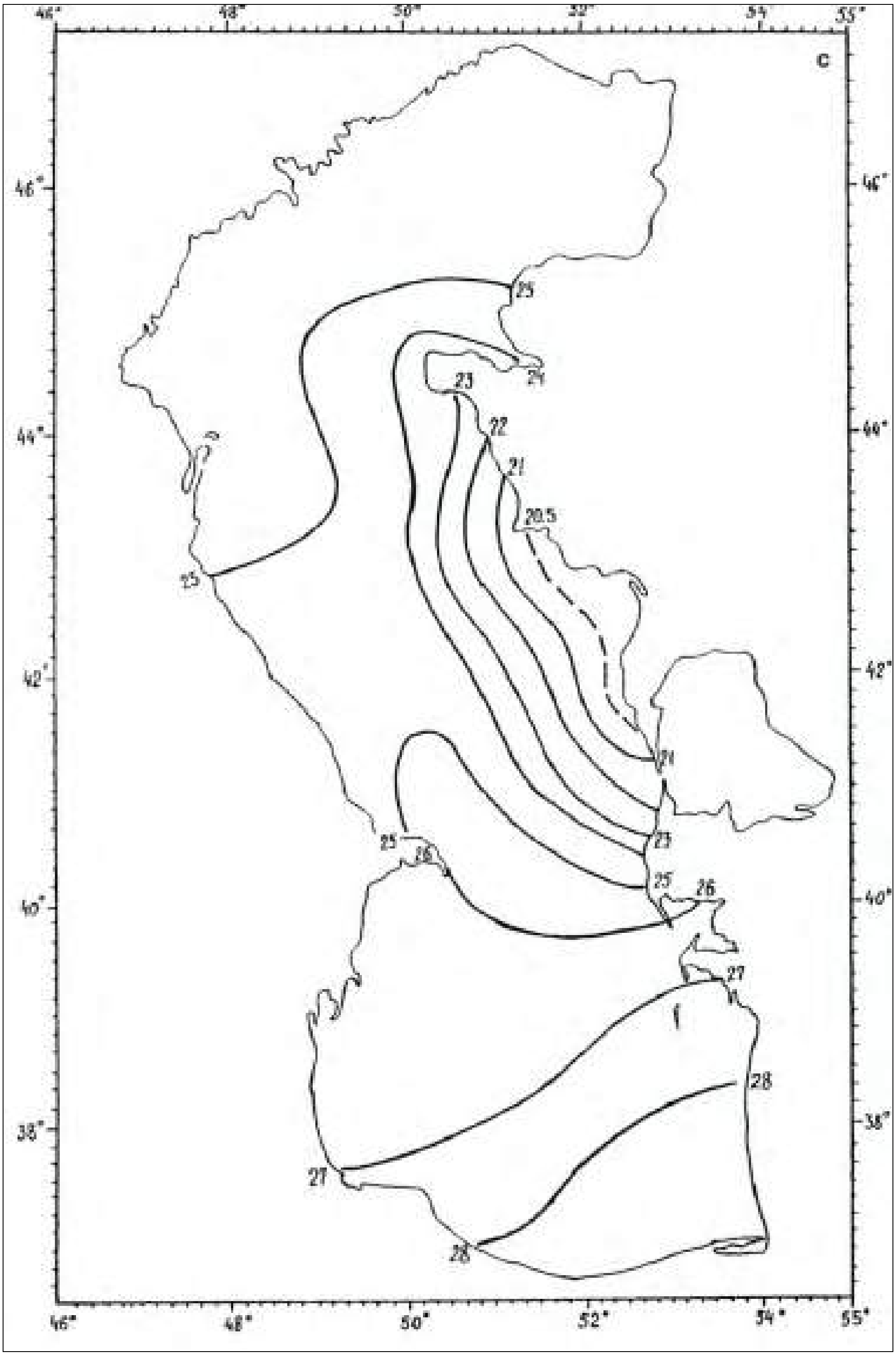

Figure 5. Characteristic surface water temperatures for the month of August (Kosarev, 1994).

2. Model Systems Description

In support of project objectives, stated in section 1, hydrodynamic simulations were developed for the entire Caspian Sea with high resolution in the area offshore Baku using ASA's HYDROMAP; thermal dispersion simulations were conducted to characterize cooling water discharges using the

USEPA Visual Plumes near field dispersion modeling system; and mud and drill cutting simulations were conducted using ASA's MUDMAP. The following sections provide a description of each modeling systems functionality and purpose.

2.1 HYDROMAP

HYDROMAP, developed by ASA, is a globally re-locatable hydrodynamic model capable of simulating complex circulation patterns due to tidal forcing and wind stress quickly and efficiently anywhere on the globe. HYDROMAP employs a novel step-wise-continuous-variable-rectangular gridding strategy with up to six levels of resolution. The term step-wise continuous implies that the boundaries between successively smaller and larger grids are managed in a consistent integer step.

The hydrodynamic model solves the three-dimensional conservation equations in spherical coordinates for water mass, density, and momentum with the Boussinesq and hydrostatic assumptions applied. These equations are solved subject to the following boundary conditions, 1) At land boundaries the normal component of velocity is set to zero. 2) At the open boundaries the sea surface elevation is specified as a series of temporal sine or cosine waves each with its own amplitude and phase appropriate gradients of the local surface elevation. 3) At the sea surface the applied stress due to the wind is matched to the local stress in the water column and the kinematic boundary condition is satisfied, 4) At the sea floor a quadratic stress law, based on the local bottom velocity, is used to represent frictional dissipation and a friction coefficient parameterizes the loss rate. The numerical solution methodology follows that of Davies (1977a, b) and Owen (1980). The vertical variations in horizontal velocity are described by an expansion of Legendre polynomials. The resulting equations are then solved by a Galerkin weighted residual method in the vertical and by an explicit finite difference algorithm in the horizontal. A space staggered-grid scheme in the horizontal plane is used to define the study area. Sea surface elevation and vertical velocity are specified in the center of each cell while the horizontal velocities are given on the cell face. To increase computational efficiency, a "split-mode" or "two mode" formulation is used (Owen, 1980; Gordon, 1982). In the split-mode, the free-surface elevation is treated separately from the internal, three-dimensional flow variables. The free-surface elevation and vertically integrated equations of motion (external mode), for which the Courant-Friedrichs-Lewis (CFL) limit must be met, is solved first. The vertical structure of the horizontal components of the current then may be calculated such that the effects of surface gravity waves are separated from the three-dimensional equations of motion (internal mode). Surface gravity waves, therefore, no longer limit the internal mode calculations and much longer time steps are possible. A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Owen (1980).

2.2 Visual Plumes

Visual Plumes is a mixing zone modeling application developed by the United States Environmental Protection Agency’s, National Exposure Research Laboratory, Ecosystems Research Division. The Visual Plumes system incorporates initial dilution models that simulate single and submerged plumes in arbitrarily stratified flow. Predictions from this system include dilution, rise, diameter as well as other important plume variables. A detailed description of the Visual Plumes system is available in Frick et al., 2001.

2.3 MUDMAP

MUDMAP is a personal computer-based model developed by ASA to predict the near and far field transport, dispersion, and bottom deposition of drill muds and cuttings and produced water

(Spaulding et al; 1994; Spaulding, 1994). In MUDMAP, the equations governing conservation of mass, momentum, buoyancy, and solid particle flux are formulated using integral plume theory and then solved using a Runge Kutta numerical integration technique. The model includes three stages: convective descent/ascent, dynamic collapse and far field dispersion. It allows the transport and fate of the release to be modeled through all stages of its movement. The initial dilution and spreading of the plume release is predicted in the convective descent/ascent stage. The plume descends if the discharged material is denser than the local water at the point of release and ascends if the density is lower than that of the receiving water. In the dynamic collapse stage, the dilution and dispersion of the discharge is predicted when the release impacts the surface, bottom, or becomes trapped by vertical density gradients in the water column. The far field stage predicts the transport and fate of the discharge caused by the ambient current and turbulence fields.

MUDMAP is based on the theoretical approach initially developed by Koh and Chang (1973) and refined and extended by Brandsma and Sauer (1983) for the convective descent/ascent and dynamic collapse stages. The far field, passive diffusion stage is based on a particle based random walk model. This is the same random walk model used in ASA's OILMAP spill modeling system (ASA, 1999).

MUDMAP uses a color graphics-based user interface and provides an embedded geographic information system, environmental data management tools, and procedures to input data and to animate model output. The system can be readily applied to any location in the world. Application of MUDMAP to predict the transport and deposition of heavy and light drill fluids off Pt Conception, California and the near field plume dynamics of a laboratory experiment for a multi-component mud discharged into a uniform flowing, stratified water column are presented in Spaulding et al. (1994). King and McAllister (1996, 1998) present the application and extensive verification of the model for a produced water discharge on Australia's northwest shelf. GEMS (1998) present the application of the model to assess the dispersion and deposition of drilling cuttings released off the northwest coast of Australia.

3. Hydrodynamic Simulations

3.1 Grid Generation and Bathymetry

The computational domain of the hydrodynamic simulation consisted of the entire Caspian Sea in order to minimize the complexity of environmental forcing data. The computational grid developed for this area was handled through the application of HYDROMAP's step-wise-continuous-rectangular gridding strategy (Isaji 2001). In the northern Caspian Sea coarse grid resolution, on the order of 20 km, is sufficient in order to capture the large-scale dynamics and appropriate volumetric transport of water. The grid resolution was increased in the southern Caspian, 41.5°N southward, to approximately 5 km while a very fine scale grid of 2.5 km was applied within the Baku region of study. Figures 6 and 7 show the entire computational grid and the fine resolution grid within the Baku region, respectively.

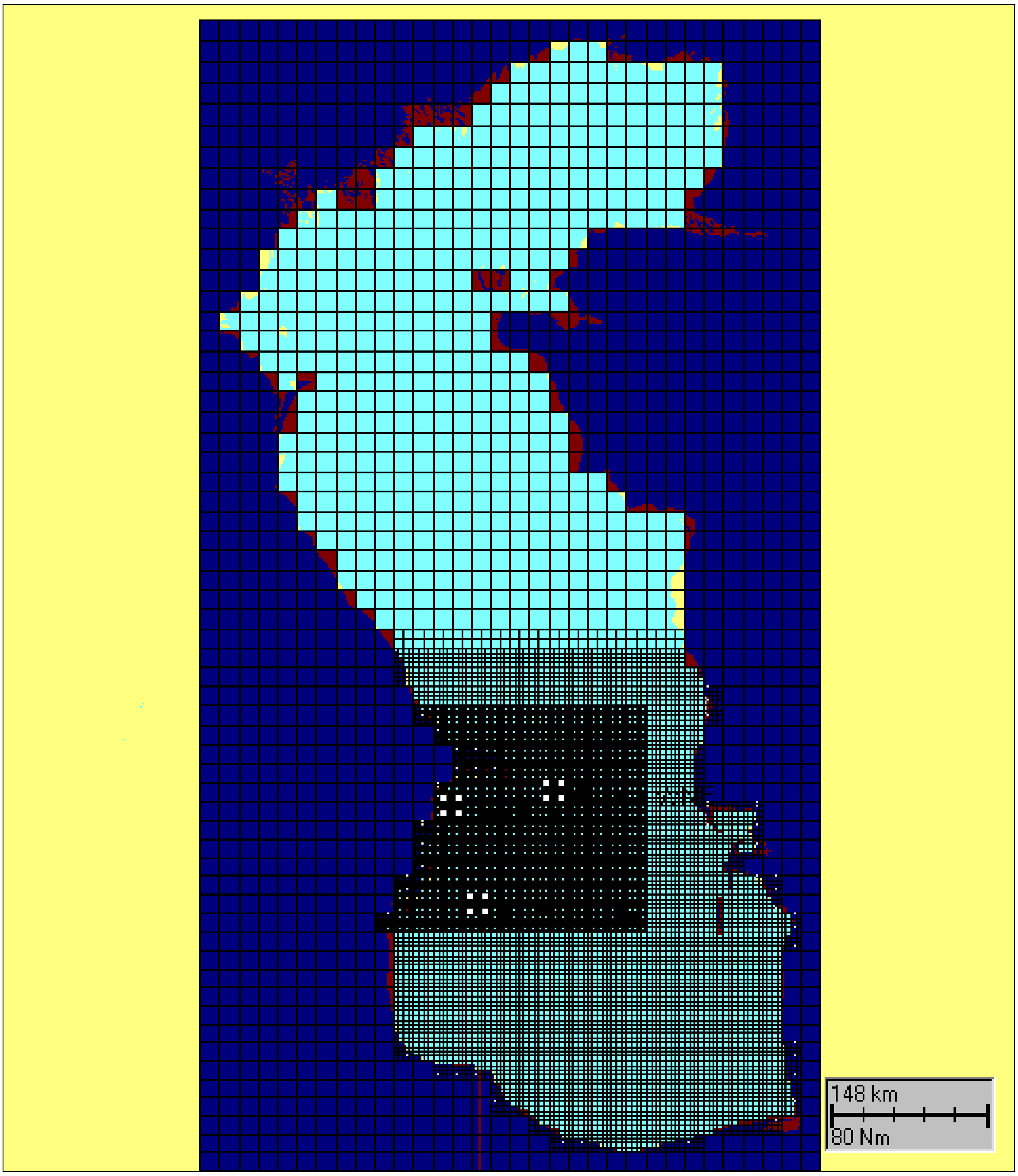

Figure 6. Caspian Sea hydrodynamic simulation computational grid.

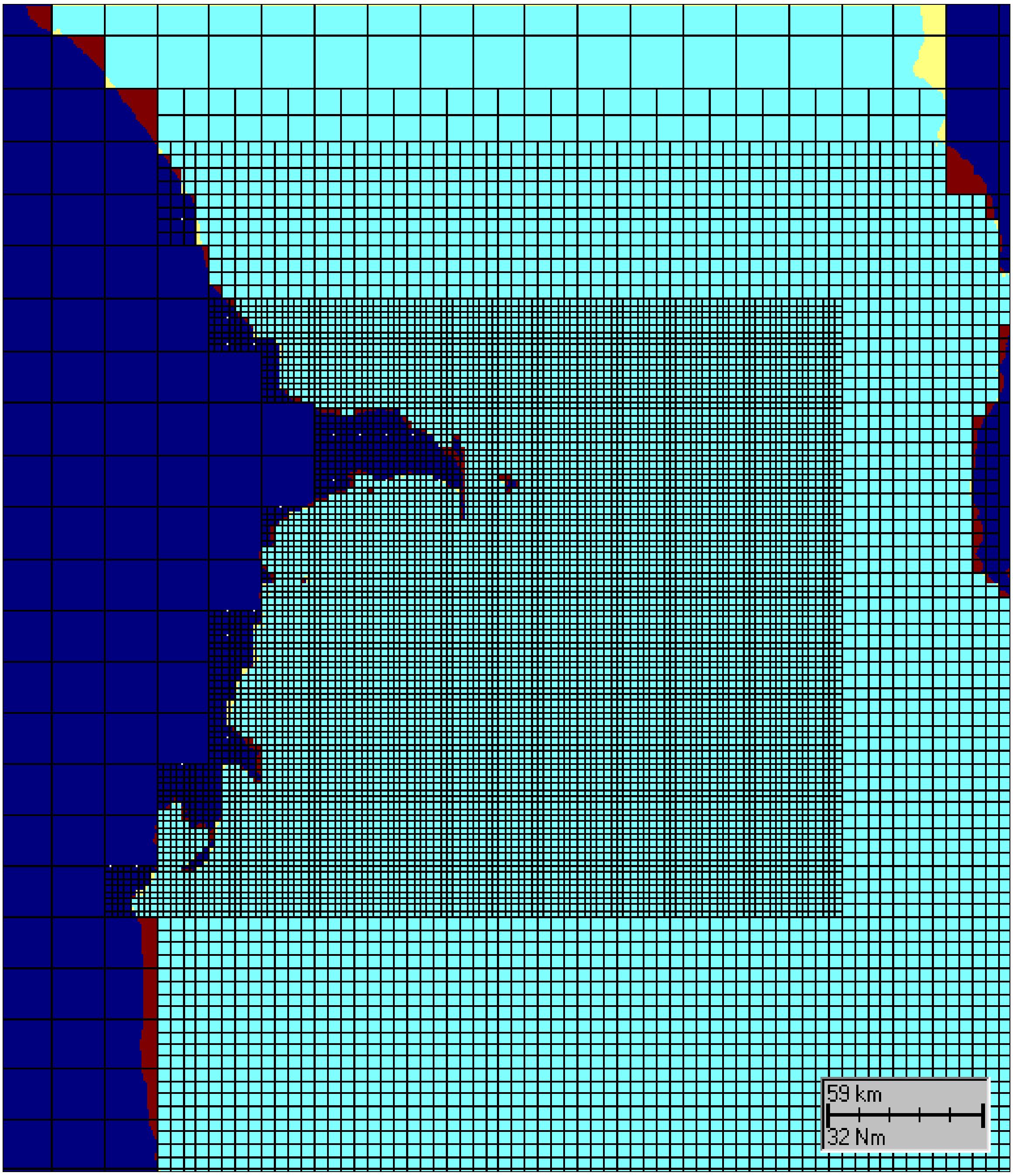

Figure 7. Computational grid offshore Baku.

Each cell within the computational grid requires a discrete depth value. These data were developed from the navigational charts published by the Navigation and Oceanography Department of the Defense Ministry of the USSR and bathymetric isolines provided by the Caspian Environment Program (http://caspianenvironment.org). Figure 1 presents a sample of the bathymetric isoline offshore Baku.

3.2 Model Environmental Forcing Data

Environmental forcing data is used by the model to drive the circulation throughout the computational domain. These time varying data can be river flow input, atmospheric effects such as wind, air temperature, and solar radiation, tides and density gradients. Since the Caspian Sea is an enclosed sea with no attachment to the world ocean the primary forcing is wind stress. The wind data used in this study are output from a numerical atmospheric model: NCEP model reanalysis, provided by the NOAA-CIRES Climate Diagnostics Center, Boulder, Colorado, from their Web site at *http://www.cdc.noaa.gov/*. Data from 18 model grid locations, covering the entire Caspian Sea, were downloaded from the NOAA/CDC ftp site for the 10m elevation for the years 1991 through 2000 (ten years). Wind roses for these data were generated in order to determine the seasonal time periods for the hydrodynamic simulations. Figure 8 presents monthly wind roses for these 10 years of data from a model grid location at 41.68° N 50.77° E.

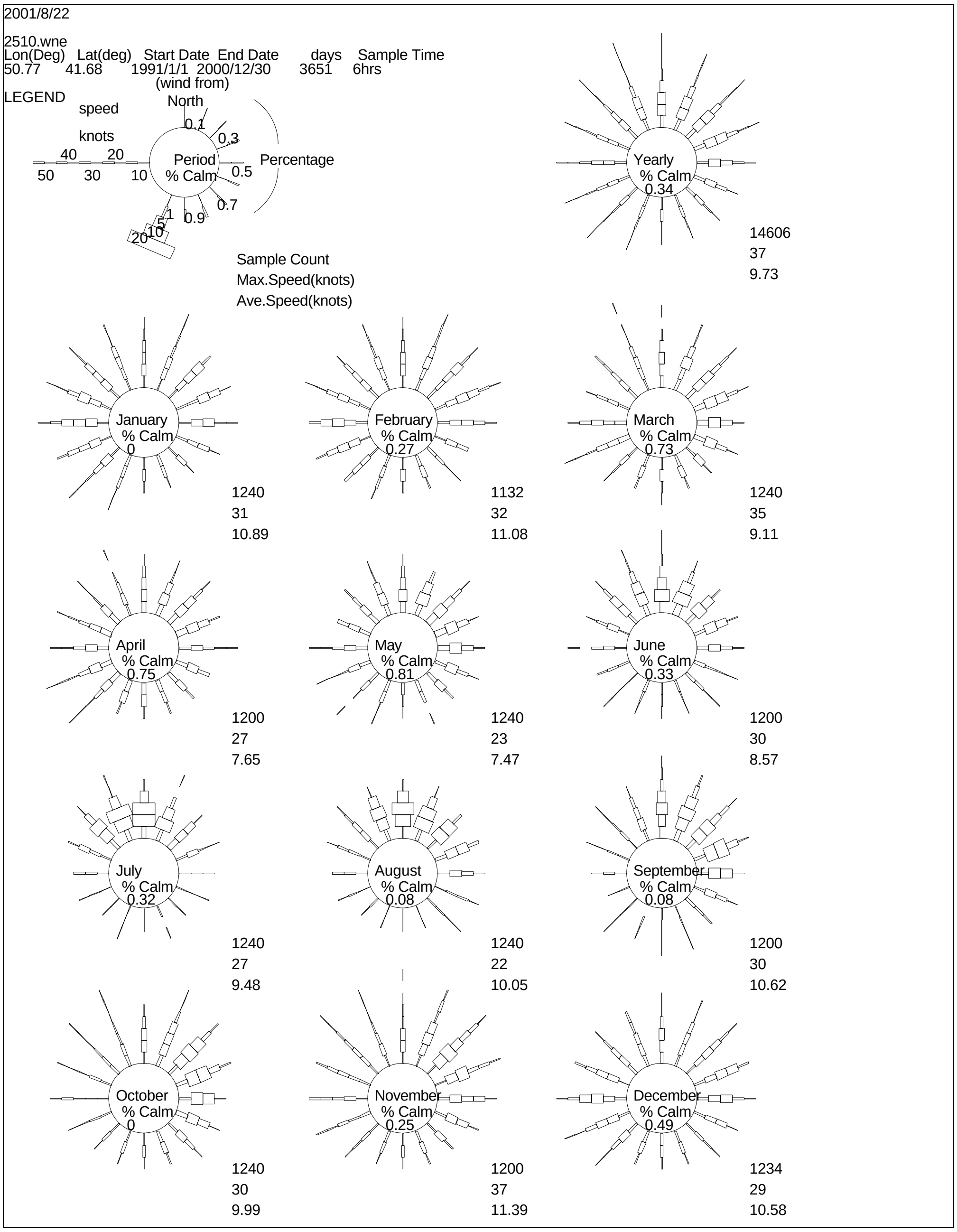

Figure 8. Wind rose generated from 10 years of NCEP model output at 41.68° N 50.77° E for the years 1991 through 2000.

Through inspection of the NCEP model output, the winter season was chosen to be from December through January, while the summer season was chosen as June through August. Within each season two characteristic two-week periods were established based upon the wind climatology during which the hydrodynamic, thermal dispersion, anti-foulant dispersion, and mud and drill cutting simulations were conducted. The first of the two-week periods for the winter is from 01 January to 15 January. This period is characterized by strong winds primarily from the northeast. The second of the two-week periods for the winter season is from 15 January to 31 January. This period is characterized by strong winds highly varying from the north and south. The first of the two-week periods for the summer is from 13 July to 28 July. This period is characterized by light variable winds predominantly from the northern and eastern quadrants. The second of the two-week periods established for the summer was from 02 August to 17 August. This period is characterized by strong winds predominantly from the north. Once these periods were established the year 2000 was determined to be a typical year due to its having characteristics similar to those present in the 10 year wind rose plot (Figure 8). All simulations were conducted during this year using NCEP model output as the environmental forcing. Figure 9 presents monthly wind roses for NCEP model output data for the year 2000 from a model grid location at 41.68° N 50.77° E.

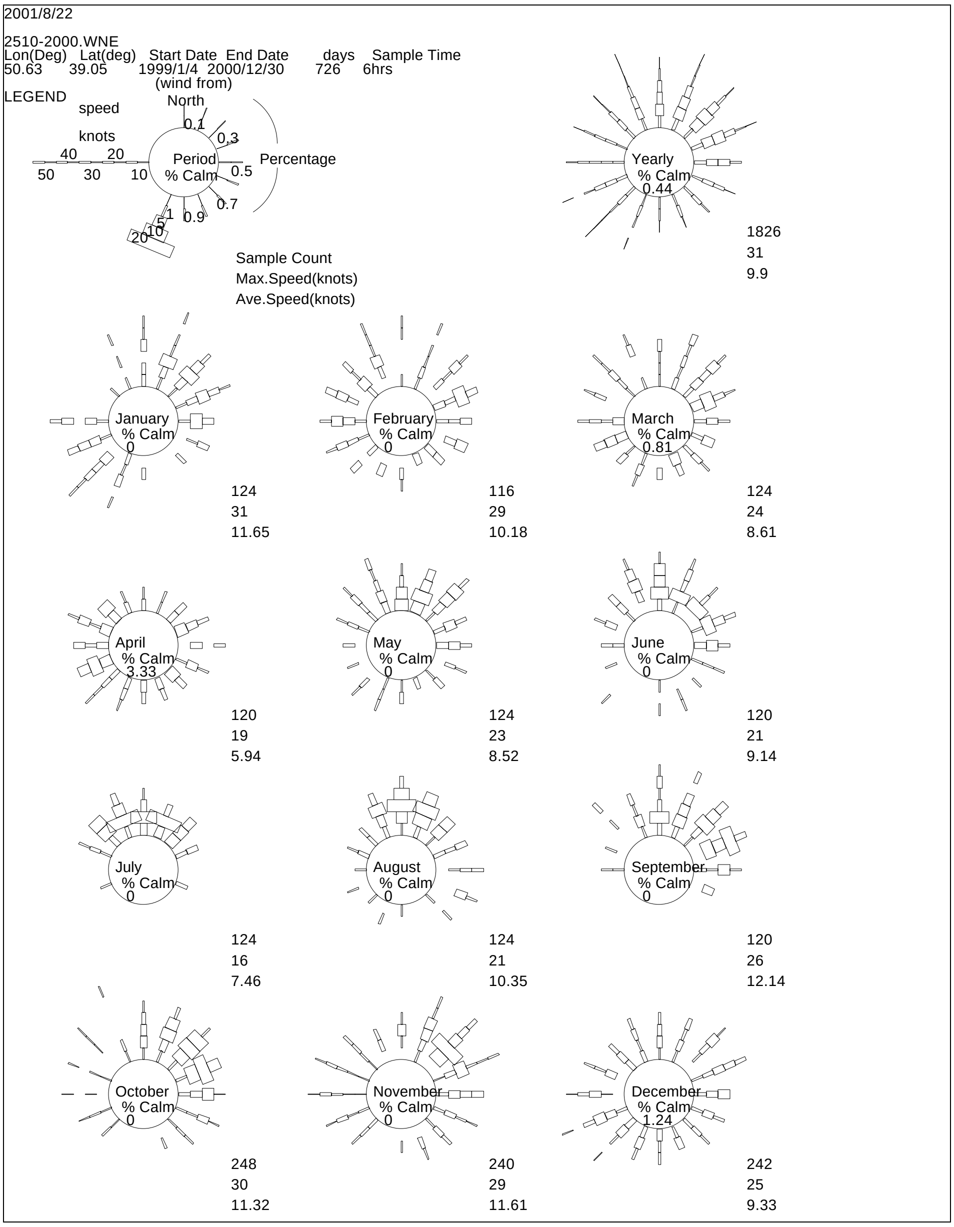

Figure 9. Wind rose generated from NCEP model output at 41.68° N 50.77° E for the year 2000.

3.2 Model Validation

The hydrodynamic model was validated through a comparison to current measurements collected by the Azerbaijan International Operating Company along a proposed pipeline route between Chirag and Sangachal in the Caspian Sea for the winter season from 01 February 2000 to 01 April 2000. Figure 10 shows the location of the data collection points designated KP174, KP145, KP115, KP85, KP65, and KP45. Note no data was available for site KP85 during this period.

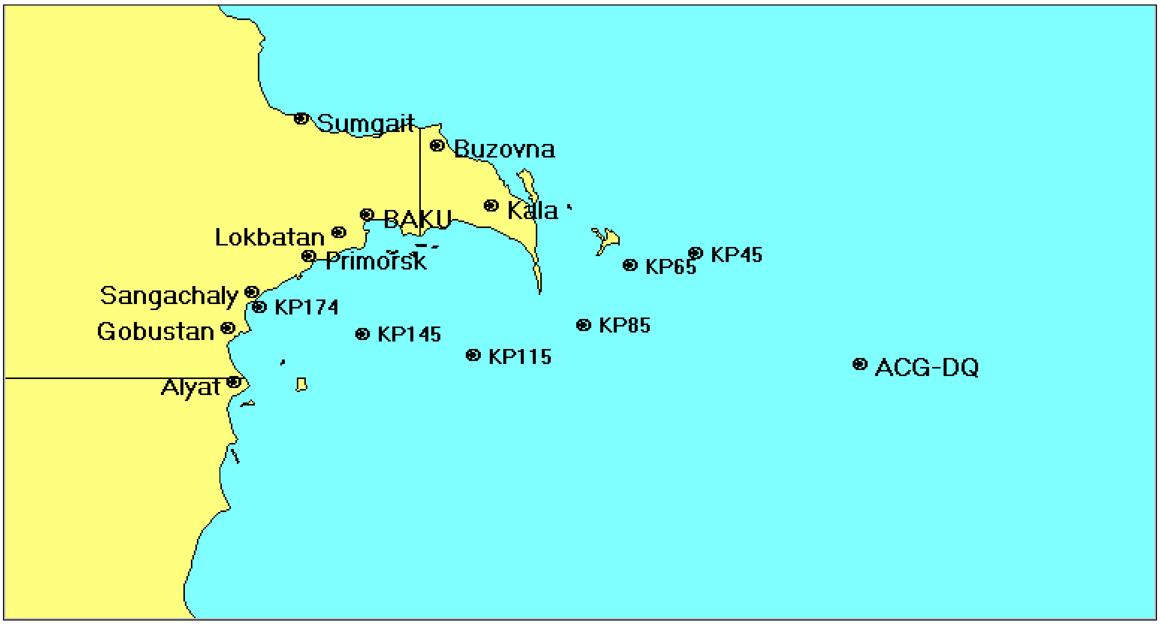

Figure 10. Current measurement data collection sites.

The observational data was prepared for comparison to the model predictions by first applying a bandpass filter with a frequency range of 12 and 0.25 cycles/day. This removed spurious non-weather related events from the data sets, which is appropriate since the models only environmental forcing was wind stress. Once the filtering was complete the data was sub-sampled to match the hydrodynamic model output time step of 1 hour. The processed data was then compared to the model output using both qualitative and quantitative methods.

The qualitative comparison consisted of plotting the model output and current data together. This comparison provides information on the model's ability to predict the range of variability evident in the current data. Figures 11 through 15 present the qualitative model to data comparisons for the north-south (V) velocity component, the east-west velocity component (U), the current speed and direction as a function of time. At site KP174 (Figure 11) the model predicts the amplitude and variability of the V-component with reasonable accuracy, however the model under predicts the U-component. At site KP145 (Figure 12) the model over predicts the V-component at times but captures the local events and features of the current. At site KP115 (Figure 13) the model is out of phase at times with the observed current and over predicts certain events. At site KP65 (Figure 14) the model reproduces major trends extremely well, however the model is less energetic than the data for the U-component. At site KP45 (Figure 15) the model again reproduces the structure of the currents extremely well with slightly higher speeds during certain events.

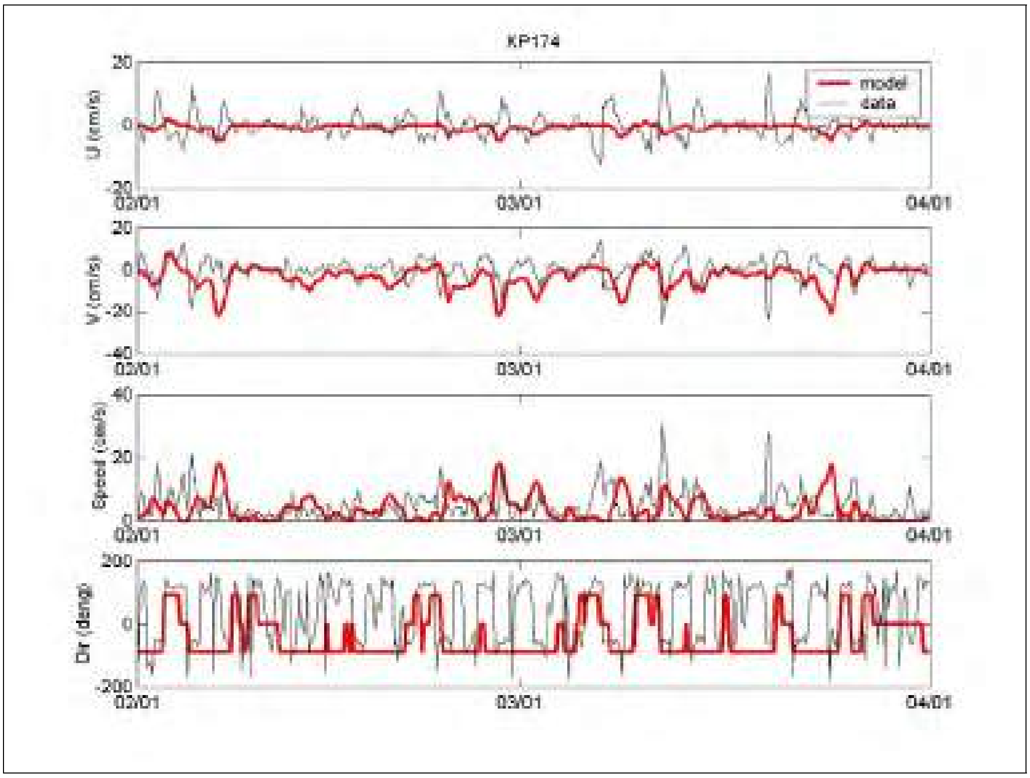

Figure 11. Qualitative model to data comparison at site KP174.

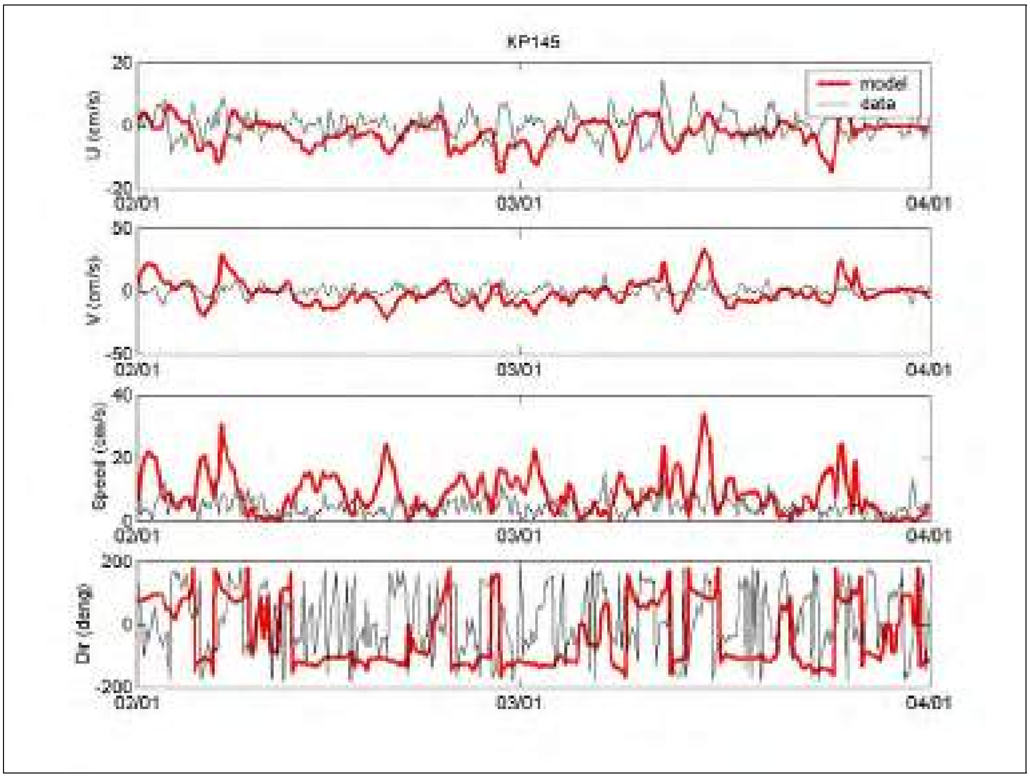

Figure 12. Qualitative model to data comparison at site KP145.

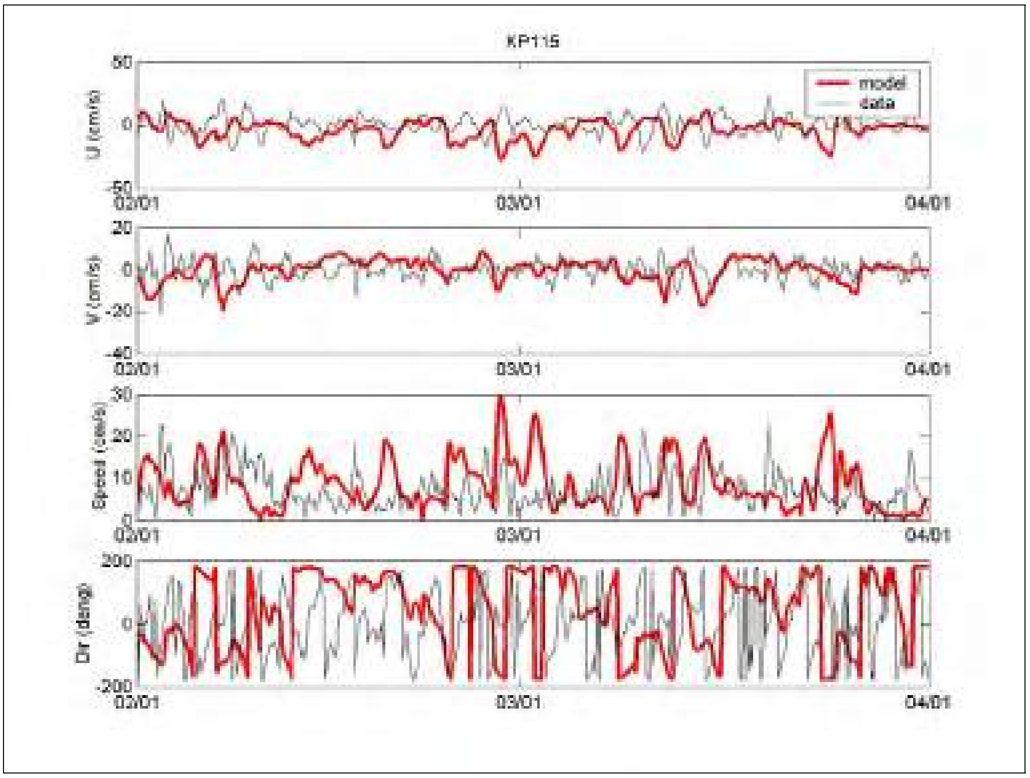

Figure 13. Qualitative model to data comparison at site KP115.

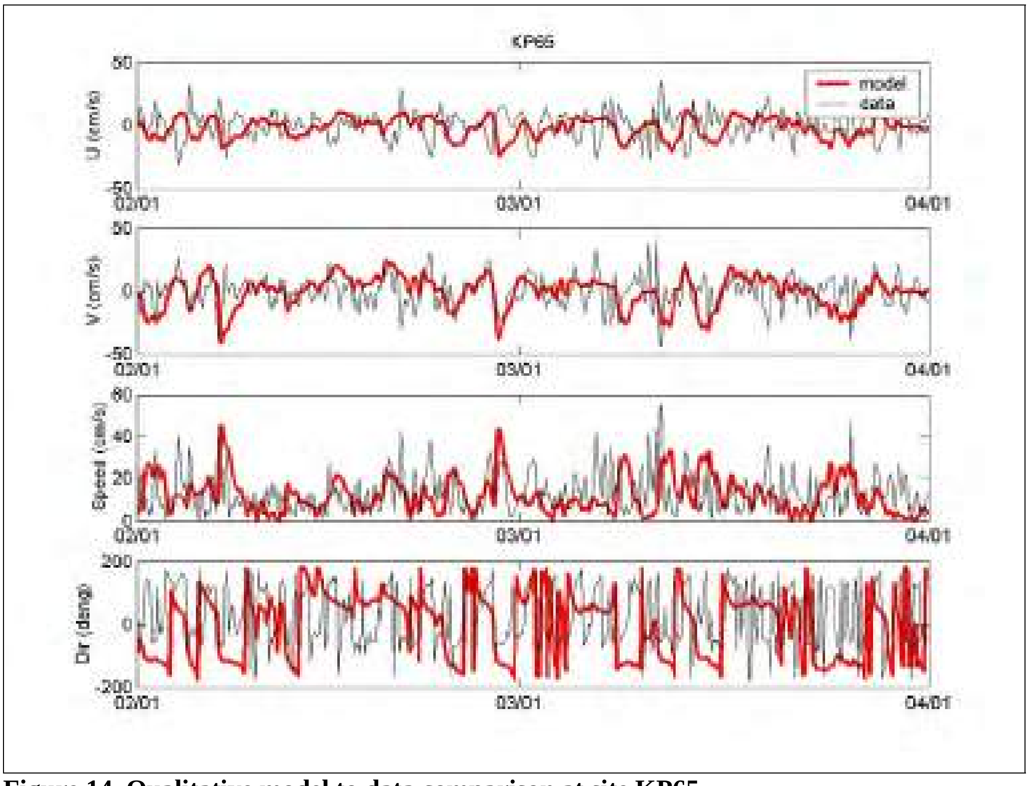

Figure 14. Qualitative model to data comparison at site KP65.

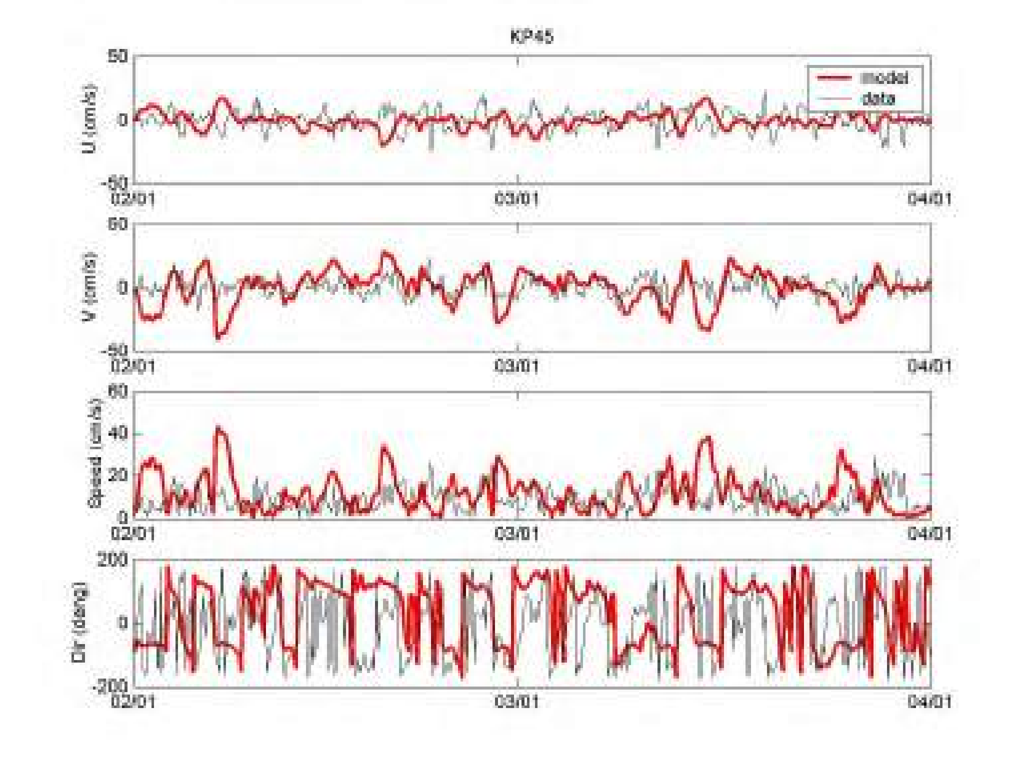

Figure 15. Qualitative model to data comparison at site KP45.

Qualitative comparisons are statistical measures that can be applied to model predictions and field data sets that provide a numerical assessment of the comparison. These statistical measures can be grouped into two major components: those measures that describe an individual set of data and those that relate the degree of difference between two data sets. The individual statistics (Table 1) used in this study are the mean speed, maximum speed and minimum speed of the model predictions and field data sets. The error statistic (Table 1) used in this study was the relative mean error which measures the difference between calculated and observed mean values and provides a useful indicator of model performance. The individual statistics show the model to be slightly less energetic than the data at site KP174 and KP65 and more energetic at sights KP145, KP115 and KP45. The relative mean error estimates are within the commonly accepted level of 30% as described by McCutcheon, et al. (1990), except at site KP145. The overly energetic state of the model at this location is most likely due to some local bathymetric or shoreline characteristic not resolved by the computational grid.

Table 1. Quantitative model to data comparison statistics.

Location	**Mean (cm/s)**		**Maximum (cm/s)**		**Minimum (cm/s)**		**Relative Mean Error (%)**
	Data	Model	Data	Model	Data	Model	
KP174	4.95	3.48	30.52	18.00	0.03	0.00	30
KP145	4.69	8.70	14.95	34.01	0.04	0.00	86
KP115	7.52	8.52	23.00	29.73	0.17	0.00	13
KP65	13.07	12.06	54.98	45.69	0.81	0.00	8
KP45	9.08	11.56	29.48	43.32	0.23	0.00	27

3.3 Model Application

The hydrodynamic model was applied to the winter and summer seasons for the year 2000, as described in the previous section. For each season the characteristic seasonal current patterns presented in Figures 3 are reproduced. Figures 16 and 17 present representative current patterns predicted by the hydrodynamic model for the winter and summer seasons, respectively.

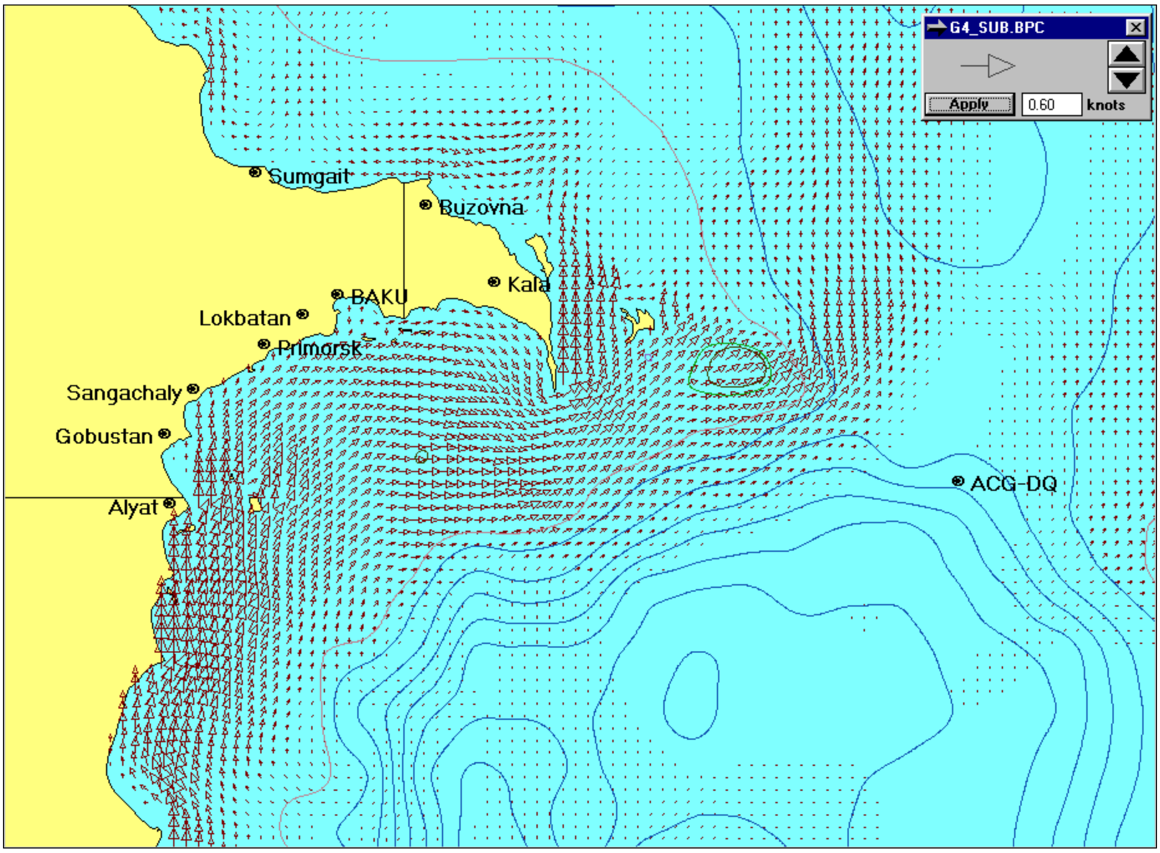

Figure 16. Characteristic hydrodynamic model output for the winter season.

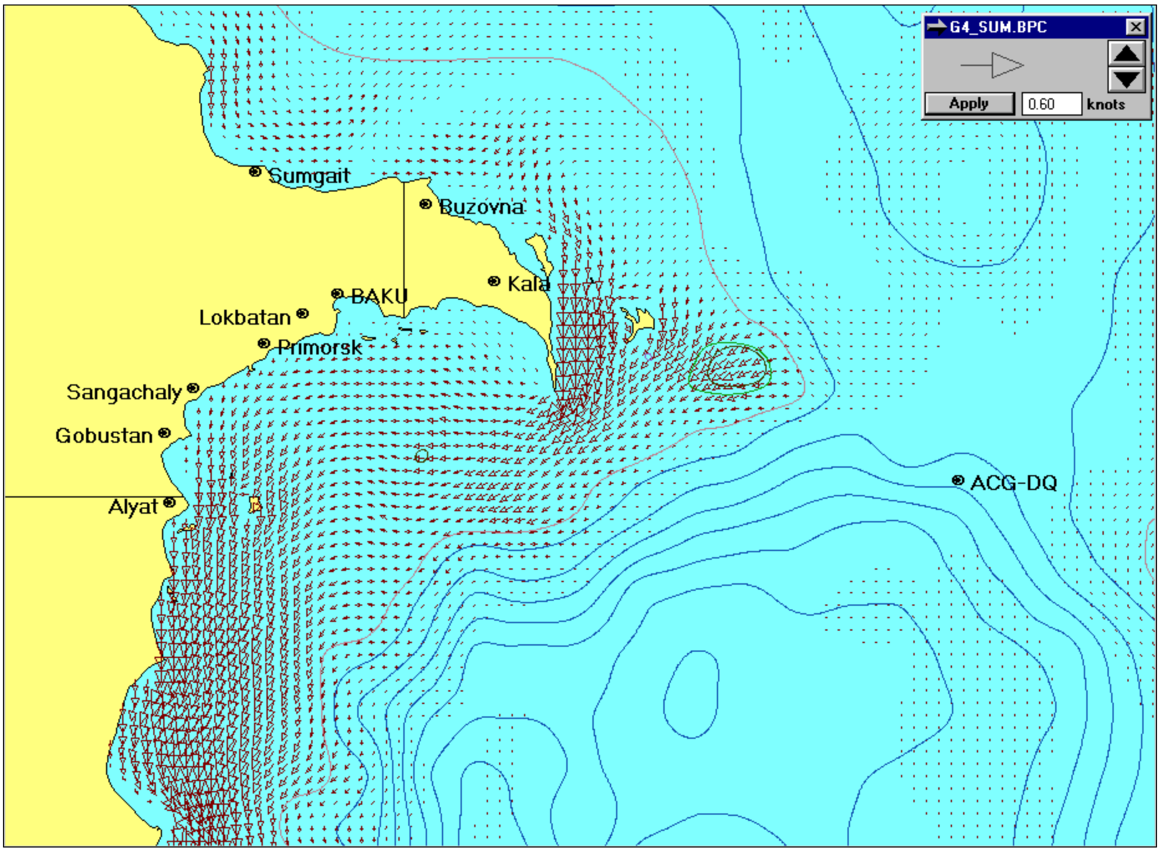

Figure 17. Characteristic hydrodynamic model output for the summer season.

4. Thermal Dispersion Simulations

4.1 Scenario Specification

Thermal dispersion simulations were conducted for the release of cooling water at the East Azeri, West Azeri, CWP and PDQ locations under stagnant conditions during the summer and winter seasons. These conditions were chosen in order to determine the worst-case dispersion of the thermal effluent relative to the water quality criteria for cooling water effluent specified by the International Finance Corporation Environmental Health and Safety Guidelines. Table 2 lists the thermal effluent release parameters. Due to the depth of the water column, in excess of 150 m, and the stagnant flow condition to be used in the simulations it was possible to combine the East Azeri, West Azeri and PDQ simulations into one, hereafter referred to as Azeri.

Table 2. Thermal Effluent Release Parameters

	East Azeri	West Azeri	CWP	PDQ
Longitude	51° 27’ 6”	51° 18’ 32”	51° 21’ 40”	51° 21’ 40”
Latitude	40° 01’ 11”	40° 03’ 20”	40° 01’ 53”	40° 01’ 53”
Intake Depth (m)	101	101	101	74
Discharge Depth (m)	67	67	40	67
Caisson Diameter (mm)	800	800	1500	800
Discharge Rate (m^3/hr)	1700	1700	10161	1700
Discharge Temperature (°C)	25	25	25	25

The vertical structure of temperature for each season was developed from data provided by URS Dames and Moore, during the Phase I EIA for this region, and characteristic temperature profiles of the entire southern Caspian Sea as presented in Kosarev (1994). The summer season is characterized as having two dominant thermal layers with surface and bottom temperatures of approximately 25 and 7°C, respectively, with the major thermocline at approximately 40m depth. The winter season is characterized as being thermally well mixed with surface to bottom gradients no greater than 1°C. Table 3 presents the vertical structure of temperature used for the cooling water thermal dispersion simulations.

Table 3. Seasonal vertical structure of temperature

Depth (m)	Summer Temperature (°C)	Winter Temperature (°C)
Surface	25.0	7
10	24.1	7
20	24.0	7
30	24.0	7
50	9.3	7
75	7.9	7
100	7.3	7
150	6.5	7
200	6.8	7

4.2 Water Quality Standard

The water quality criteria for the cooling water effluent, as listed in the International Finance Corporation Environmental, Health and Safety Guidelines, states that "the resulting temperature increases should be no more than 3°C at the edge of the zone where initial mixing and dilution take place. Where the zone is not defined, use 100 meters from the point of discharge". Since no mixing zone is specified for the study region 100 meters will be used as the distance threshold.

4.3 Simulation Results

The results of the thermal discharge simulations are presented below in Figures 18-21 and Table 4. At no time was the water quality standard violated. The temperatures presented in the figures are at the center of the plume. Temperatures away from the center of the plume will be much cooler. An important feature to note in the results below is the downward travel of the plume, this is due to the discharge being directed straight down. This configuration will cause the plume pass through two primary phases balancing the momentum of the jet against the buoyancy of the plume. The first phase will be downward travel due to the momentum effects of the discharge jet being greater than the buoyant forces. Once the energy from the jet has diminished the effects of buoyancy will dominate causing the plume to travel upwards.

Figure 18 presents the results of the thermal dispersion simulation at the CWP location during the winter season. The thermal effluent is released at a depth of 40 m and travels downward, due to the momentum of the discharge, to a depth of 60 m. At this depth the plume has cooled to within 3°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend to the surface. As the plume approaches the surface it further cools to within 1°C of the ambient temperature. This entire process takes slightly more than seven minutes to complete with the plume cooling to within 3°C of ambient within two minutes at a depth of 60 m.

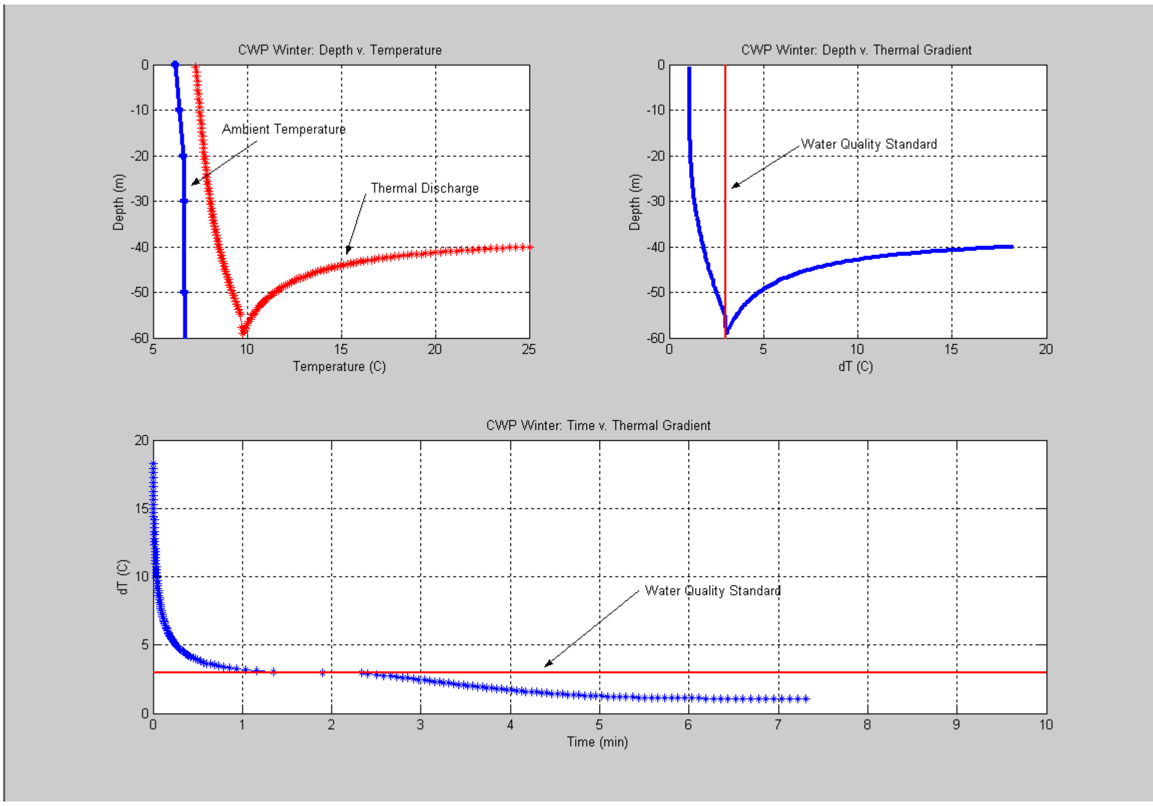

Figure 18. Thermal dispersion results at the CWP location during the winter.

Figure 19 presents the results of the thermal dispersion simulation at the CWP location during the summer season. The thermal effluent is released at a depth of 40 m and travels downward, due to the momentum of the discharge, to a depth of 50 m. At this depth the plume has cooled to within 6°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend towards the surface. However, the presence of the summer pycnocline causes the plume to become trapped, where ambient conditions are reached, at a depth of approximately 42 m. This entire process takes slightly more than 1.6 minutes to complete with the plume cooling to with 3°C of ambient within 1.4 minutes at a depth of 48 m.

Figure 20 presents the results of the thermal dispersion simulation at the Azeri location during the winter season. The thermal effluent is released at a depth of 67 m and travels downward, due to the momentum of the discharge, to a depth of 75 m. At this depth the plume has cooled to within 4°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend to the surface. As the plume approaches the surface it further cools to less than 1°C of the ambient temperature. This entire process takes approximately 10 minutes to complete with the plume cooling to with 3°C of ambient within two minutes at a depth of 65 m.

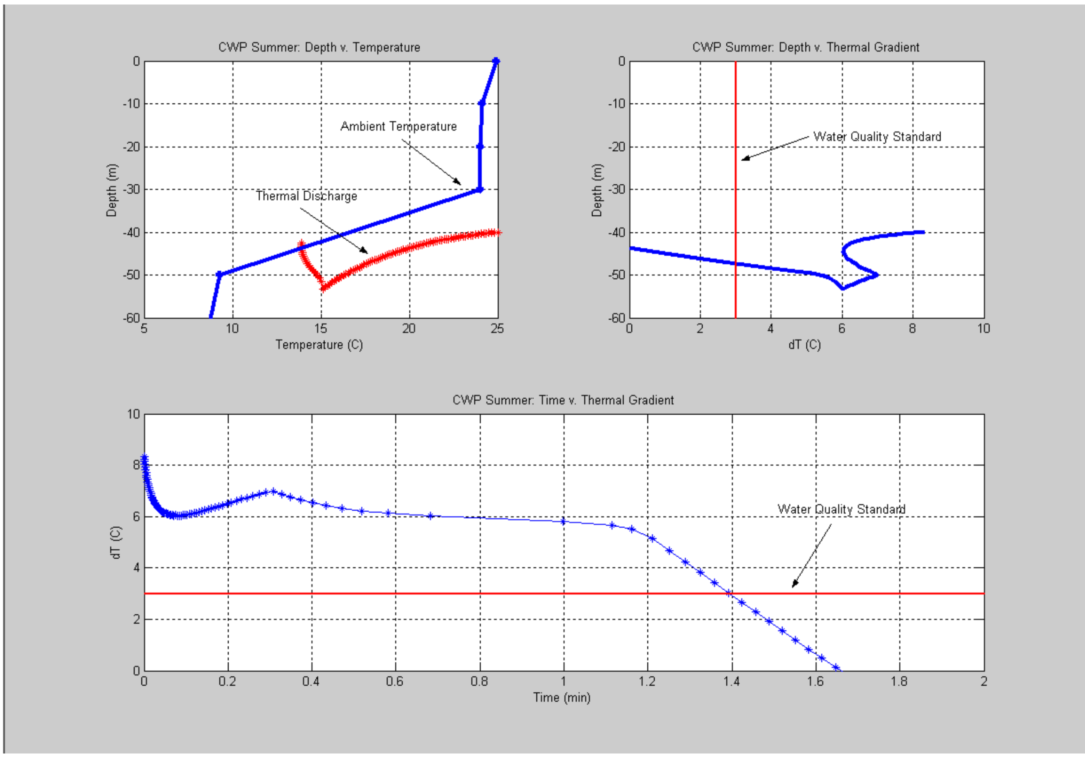

Figure 19. Thermal dispersion results at the CWP location during the summer.

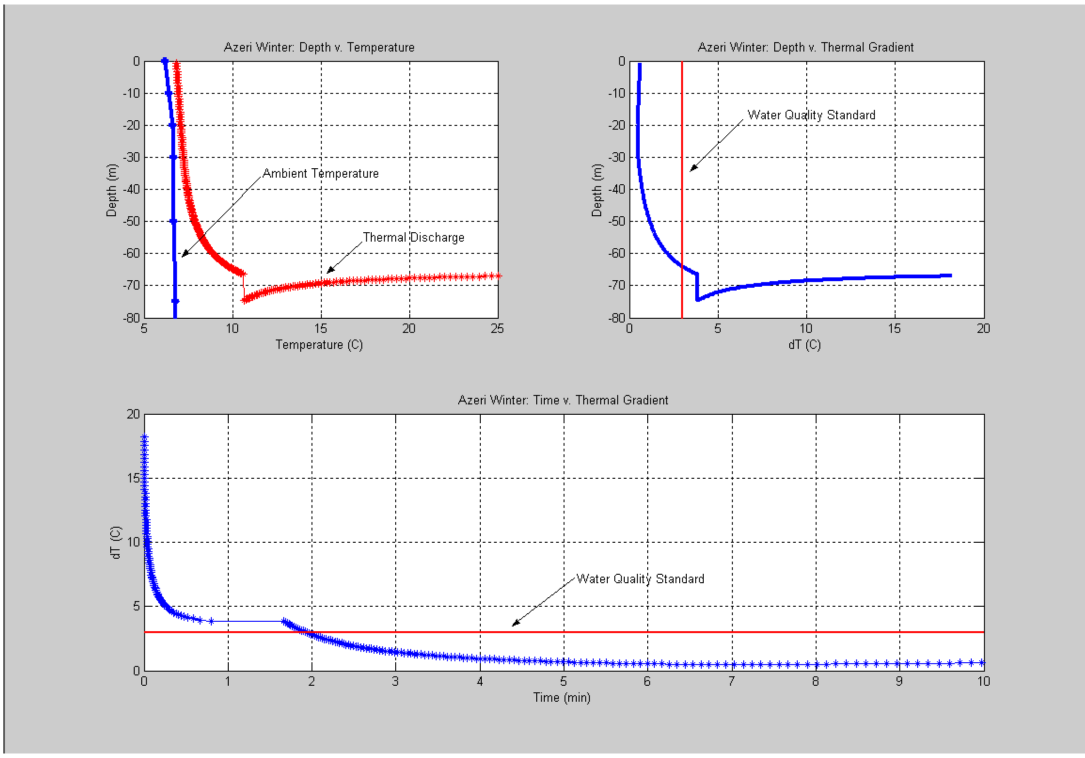

Figure 20. Thermal dispersion results at the Azeri location during the winter.

Figure 21 presents the results of the thermal dispersion simulation at the Azeri location during the summer season. The thermal effluent is released at a depth of 67 m and travels downward, due to the momentum of the discharge, to a depth of 73 m. At this depth the plume has cooled to within 4°C of the ambient temperature and the buoyancy of the plume becomes the dominant force causing the plume to ascend towards the surface. However, the presence of the summer pycnocline causes the plume to become trapped, where ambient conditions are reached, at a depth of approximately 50 m. This entire process takes four minutes to complete with the plume cooling to with 3°C of ambient within 1.5 minutes at a depth of 70 m.

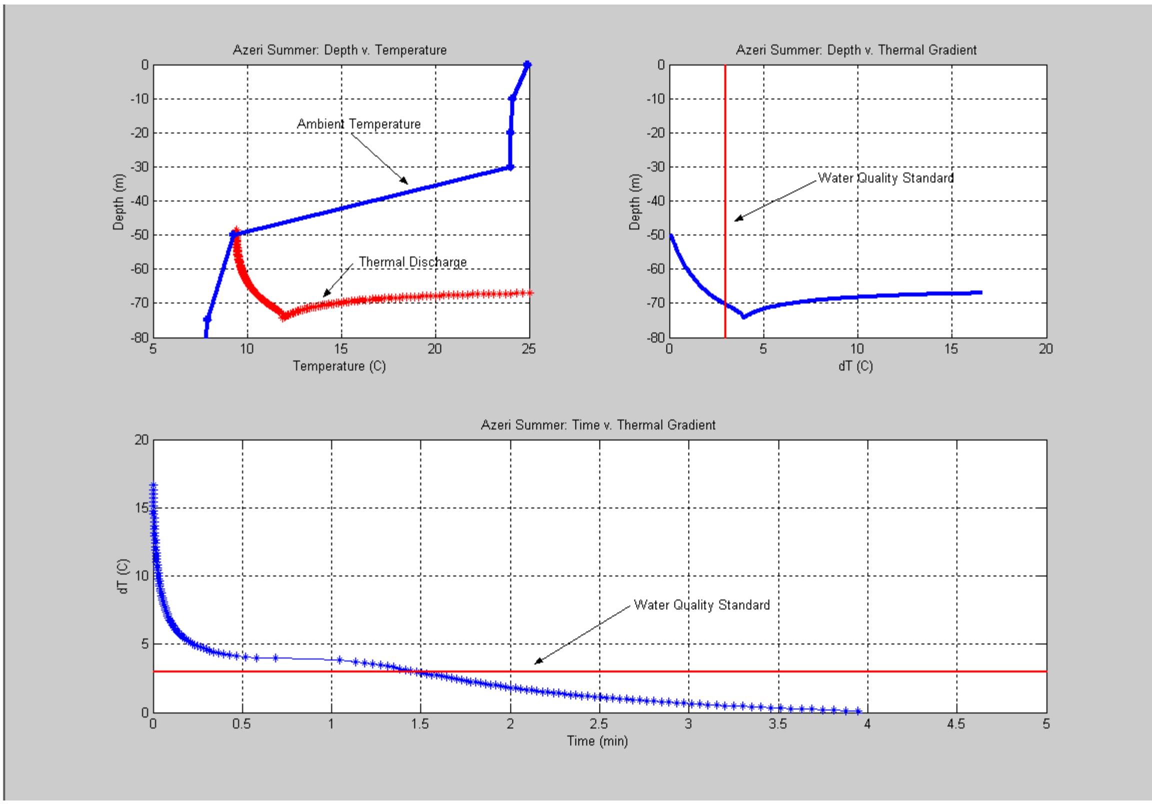

Figure 21. Thermal dispersion results at the Azeri location during the summer.

Table 4 presents the maximum diameter at the CWP and Azeri locations during the summer and winter seasons. During the winter the maximum plume diameter is 23 m at the CWP location and 20 m at the Azeri location. During the summer the maximum plume diameter is 17 m at the CWP location and 11 m at the Azeri location.

Table 4. Maximum Plume Diameter

Scenario	Plume Diameter (m)
CWP Winter	23
CWP Summer	17
Azeri Winter	20
Azeri Summer	11

5. Drill Cuttings and Mud Release Simulations

5.1 Scenario Specification

Forty-eight wells are to be drilled at the East and West PDUQ locations, respectively, and the drill cuttings produced from the 26-inch hole section will be discharged. The discharge is to take place 97 m below the sea surface resulting in a total discharge volume of 17,885 m^3, at each location, with the drill operations estimated to last 8 hours. Table 5 summarizes the release scenario specifications.

Table 5. 26 inch Drill Hole Specifications

Release coordinates East PDUQ:	51° 27' 6.8068 E , 40° 1' 11.0458" N
Release coordinates West PDUQ:	51° 18' 33.1424" E , 40° 3' 20.6350" N
Release depth:	97 m
Total volume of 26" cuttings:	17,885 m^3
Total drilling time per well:	8 hrs
Specific gravity of cuttings:	2.2

Table 6 presents the mud and drill cuttings grain size distribution used for the simulations discussed below. Only the average specific gravity of the mixture to be released was available. Therefore, the distribution presented in Table 6 is a "typical distribution" based upon ASA's experience. If further work is to be conducted within the region it is recommended that sediment cores and samples of the drilling mud are collected and analyzed for the actual grain size distribution.

Table 6. Grain Size Distribution and Associated Fall Velocity

Nominal Grain Size (microns)	Specific Gravity	Percentage of Total Mass	Fall Velocity (m/hr)
12500	2.2	85	2234.16
9625	2.2	1.25	1960.47
6750	2.2	1.25	1641.77
3875	2.2	1.25	1243.93
1000	2.2	1.25	631.92
74	2.2	10	6.81

In order to bound the trajectory and the eventual bottom thickness contours of the mud and drill cutting releases, simulations were conducted during average and maximum flow events during the summer and winter periods. Figures 22-25 present time series, from the hydrodynamic model, of the average and maximum current events at the East and West PDUQ's during both seasons. The currents present during the winter are on average twice as energetic as those present during the summer. This is attributed to the presence of stronger coherent winds fields during the winter season. The currents at the West PDUQ are generally more energetic than those present at the East PDUQ during both the summer and winter seasons due to the greater depth of the eastern location. The start time of each simulation conducted during the winter season was 21 January at 1600 hrs and 09 January at 1200 hrs for the maximum and average current conditions, respectively. While, the start time of each simulation conducted during the summer season was 05 August at 1600 hrs and 22 July at 0000 hrs for the maximum and average current conditions respectively.

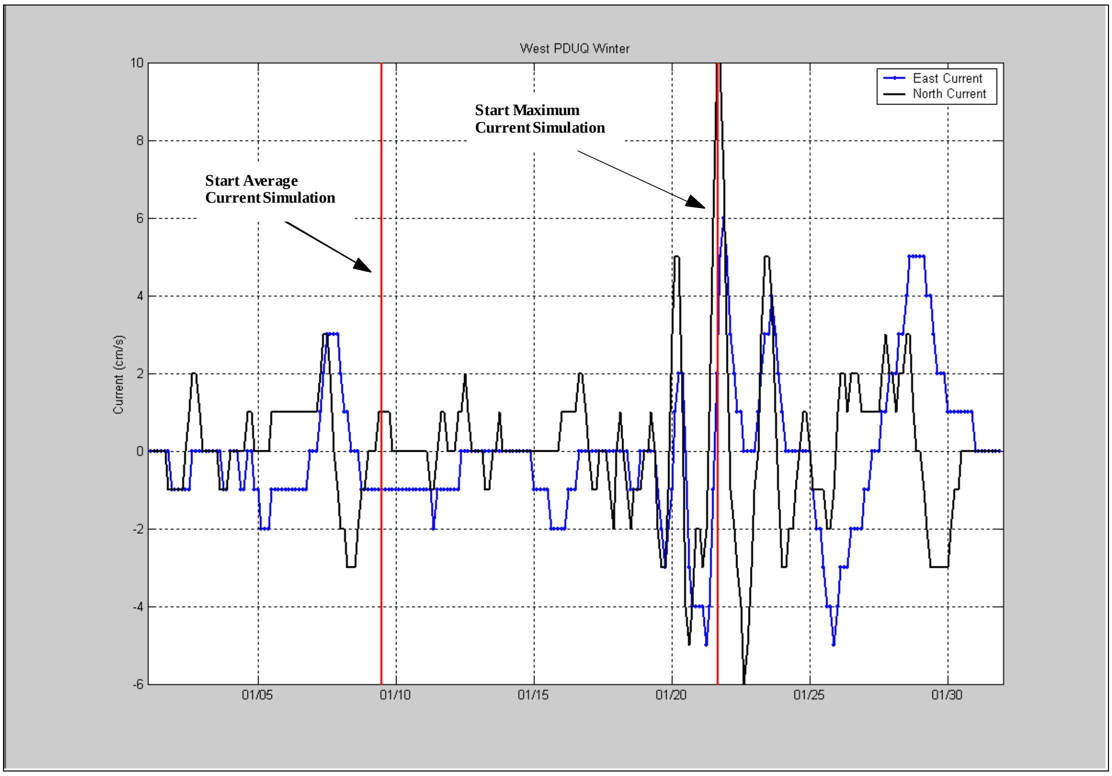

Figure 22. Simulated average and maximum current conditions present at the West PDUQ during the winter season.

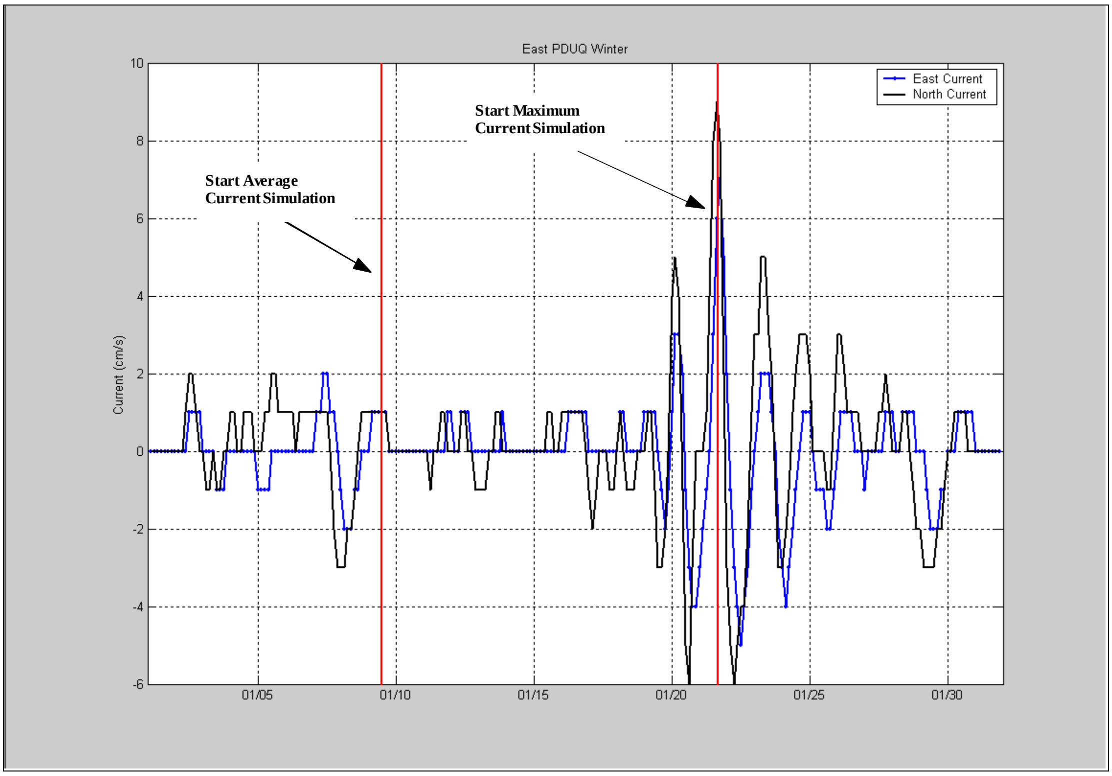

Figure 23. Simulated average and maximum current conditions present at the East PDUQ during the winter season.

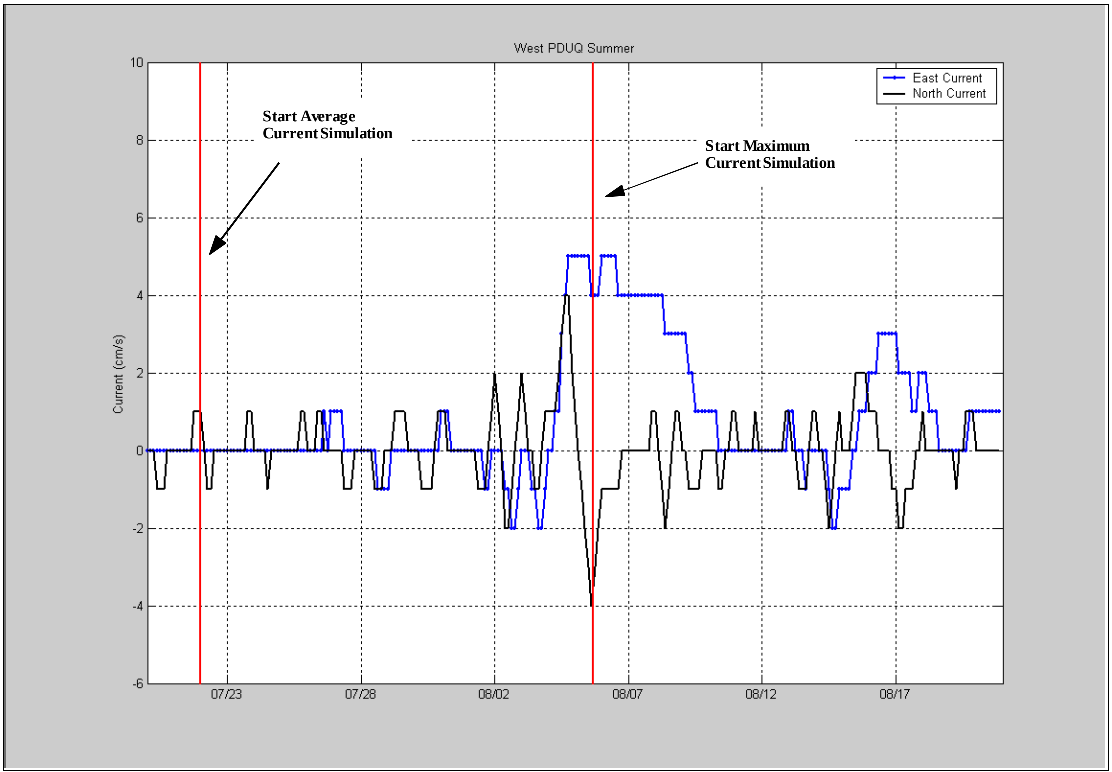

Figure 24. Simulated average and maximum current conditions present at the West PDUQ during the summer season.

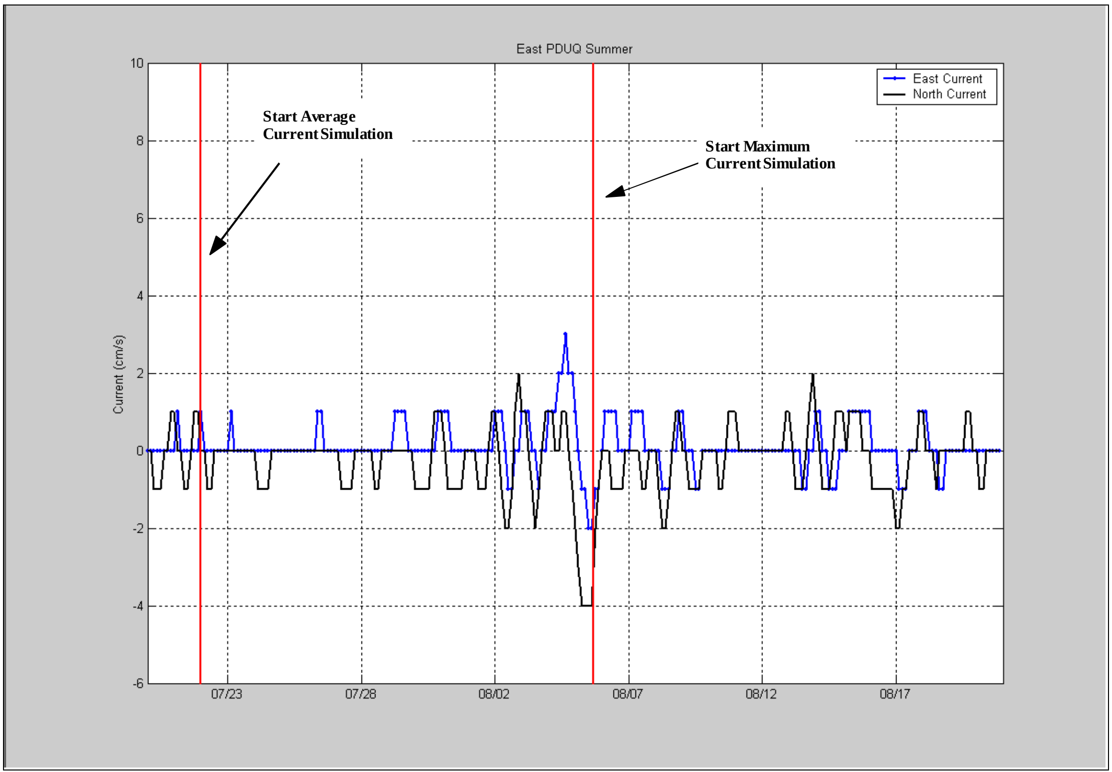

Figure 25. Simulated average and maximum current conditions present at the East PDUQ during the summer season.

5.2 Simulation Results

Figure 26 presents the percentage of the total mass deposited on the bottom versus time for the 48 wells at the East PDUQ for average and maximum current conditions during the summer and winter seasons. After eight hours 90% of the cuttings, corresponding to the larger particles, have deposited on the bottom under all current conditions while the rate at which the remaining 10%, corresponding to the finer particles, deposit varies for each current condition. During the average winter current conditions the finer particles begin to reach the bottom after 15 hours with 100% deposited after 24 hours. During the maximum winter current conditions the finer particles begin to reach the bottom after 19 hours with 100% deposited after 35 hours. During the average summer current conditions the finer particles begin to reach the bottom after 14 hours with 100% deposited after 25 hours. During the maximum summer current conditions the finer particles begin to reach the bottom after 15 hours with 100% deposited after 28 hours.

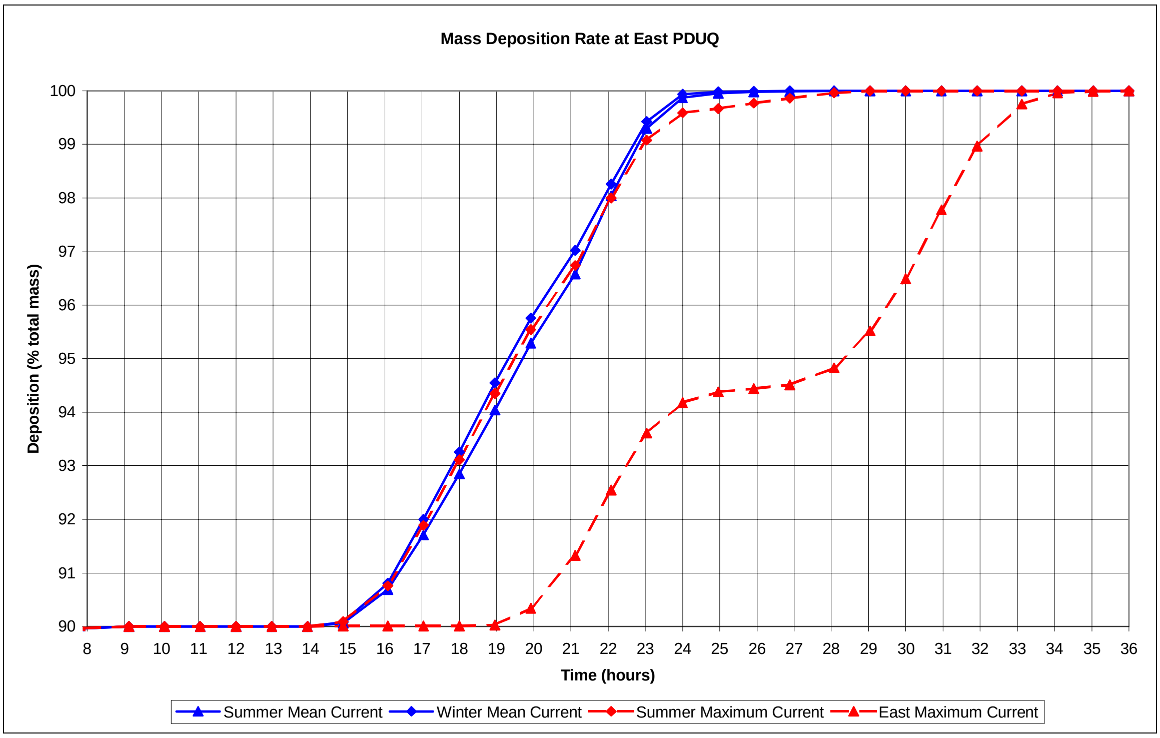

Figure 26. Mass deposition rates during the winter and summer seasons under average and maximum current conditions at the East PDUQ.

Figure 27 presents the percentage of the total mass deposited on the bottom versus time for the 48 wells at the West PDUQ for average and maximum current conditions during the summer and winter seasons. After eight hours 90% of the cuttings, corresponding to the larger particles, have deposited on the bottom under all current conditions while the rate at which the remaining 10%, corresponding to the finer particles, deposit varies for each current condition. During the average winter current conditions the finer particles begin to reach the bottom after 15 hours with 100% deposited after 28 hours. During the maximum winter current conditions the finer particles begin to reach the bottom after 15 hours with 100% deposited after 39 hours. During the average summer current conditions the finer particles begin to reach the bottom after 19 hours with 100% deposited after 29 hours. During the maximum summer current conditions the finer particles begin to reach the bottom after 21 hours with 100% deposited after 31 hours.

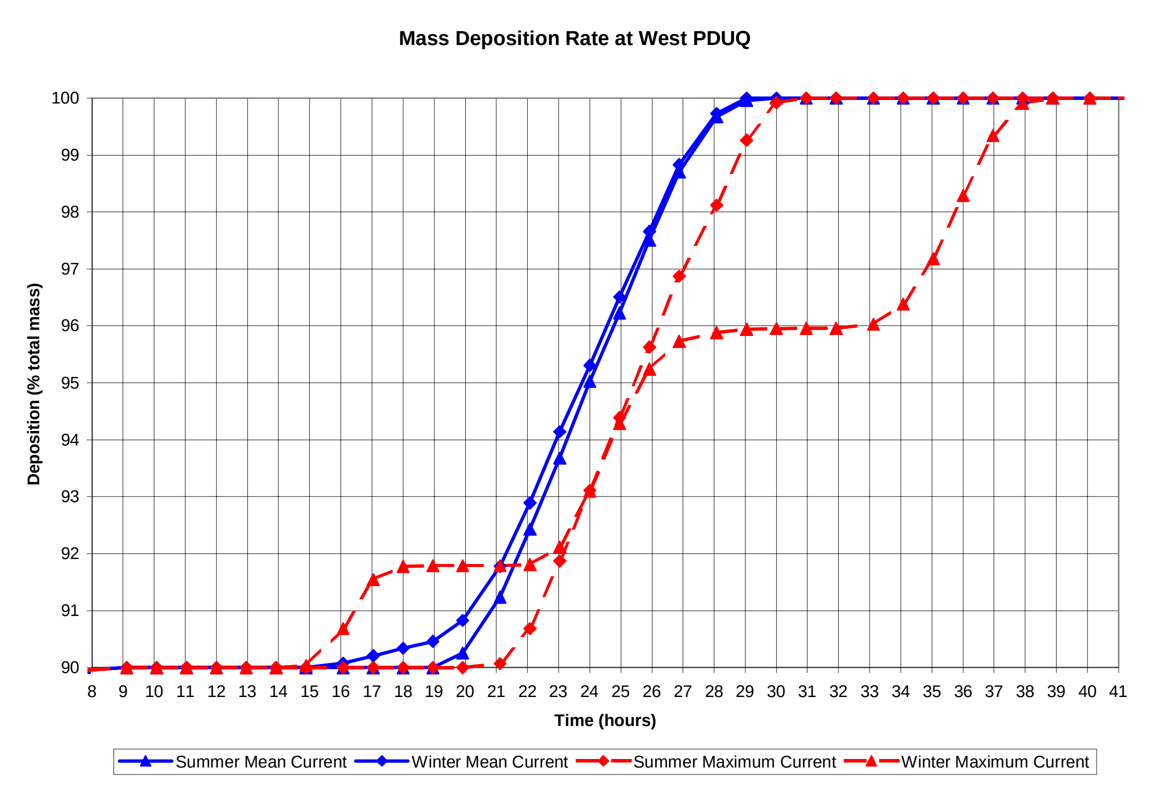

Figure 27. Mass deposition rates during the winter and summer seasons under average and maximum current conditions at the West PDUQ.

The maximum deposition of the 48 wells at each location occurred within 50 m of the release location. During the winter under average and maximum current conditions at the East PDUQ the maximum deposition was 208 and 89 cm, respectively. During the summer under average and maximum current conditions the maximum deposition at the East PDUQ was 211 and 208 cm, respectively. During the winter under average and maximum current conditions at the West PDUQ the maximum deposition was 203 and 144 cm, respectively. During the summer under average and maximum current conditions the maximum deposition at the West PDUQ was 210 and 177 cm, respectively. Table 7 summarizes these results.

Table 7. Maximum Deposition at East PDUQ Due to Seasonal Current Variations

Seasonal Current Condition	East PDUQ Maximum Deposition (cm)	West PDUQ Maximum Deposition (cm)
Winter Average	208	203
Winter Maximum	89	144
Summer Average	211	210
Summer Maximum	208	177

Figure 28 presents the deposition pattern for the discharge mud and drill cuttings at the East PDUQ location during the summer under average current conditions. The deposition pattern is offset to the south in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 198 m with deposition thickness ranging from 211 to 4 cm.

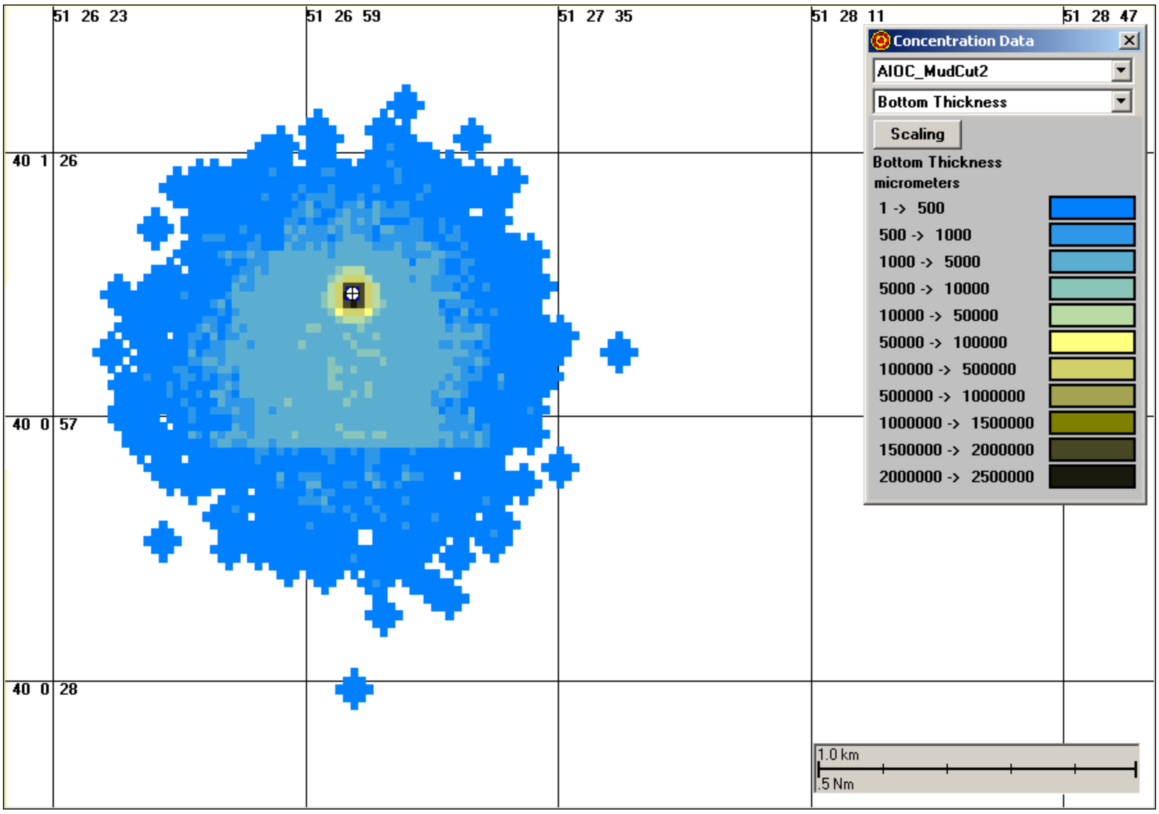

Figure 28. Depositional pattern at the East PDUQ under average current conditions during the summer season.

Figure 29 presents the deposition pattern for the discharge mud and drill cuttings at the East PDUQ location during the summer under maximum current conditions. The deposition pattern is offset to the south-southeast in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 213 m with deposition thickness ranging from 208 to 8 cm.

Figure 30 presents the deposition pattern for the discharge mud and drill cuttings at the East PDUQ location during the winter under average current conditions. The deposition pattern is roughly centered on the release site in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 170 m with deposition thickness ranging from 208 to 3.5 cm.

Figure 31 presents the deposition pattern for the discharge mud and drill cuttings at the East PDUQ location during the winter under maximum current conditions. The deposition pattern is bimodal with an offset to the southwest in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 190 m with deposition thickness ranging from 89 to 15 cm.

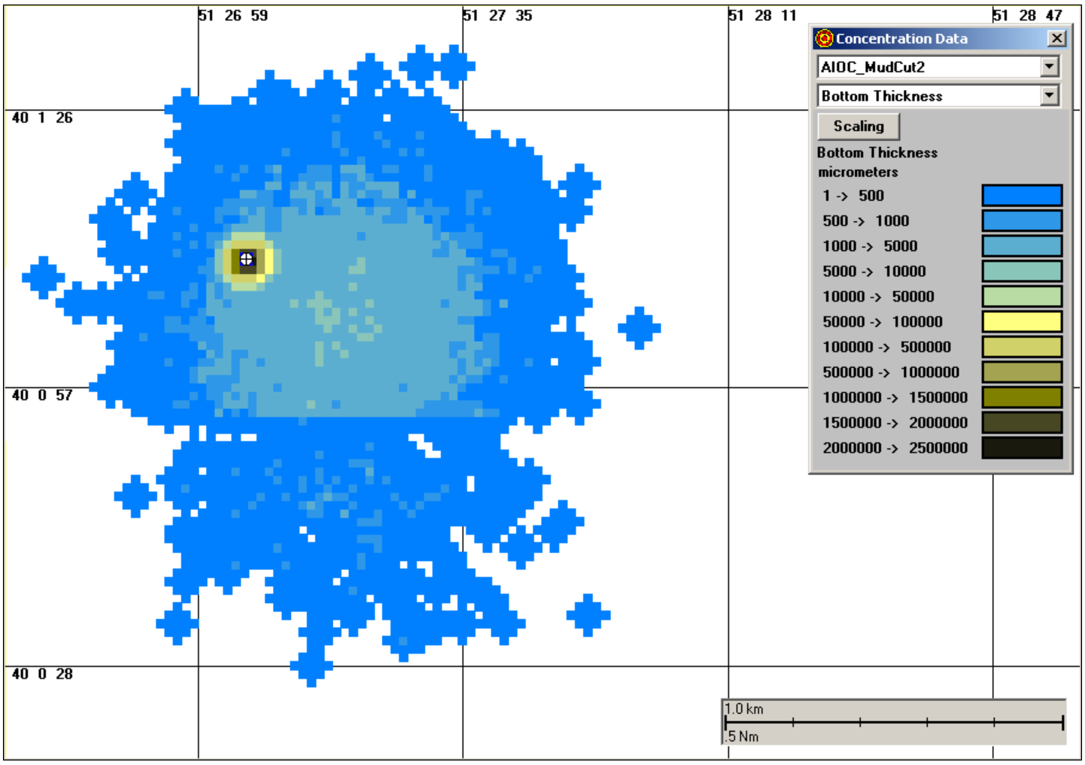

Figure 29. Depositional pattern at the East PDUQ under maximum current conditions during the summer season.

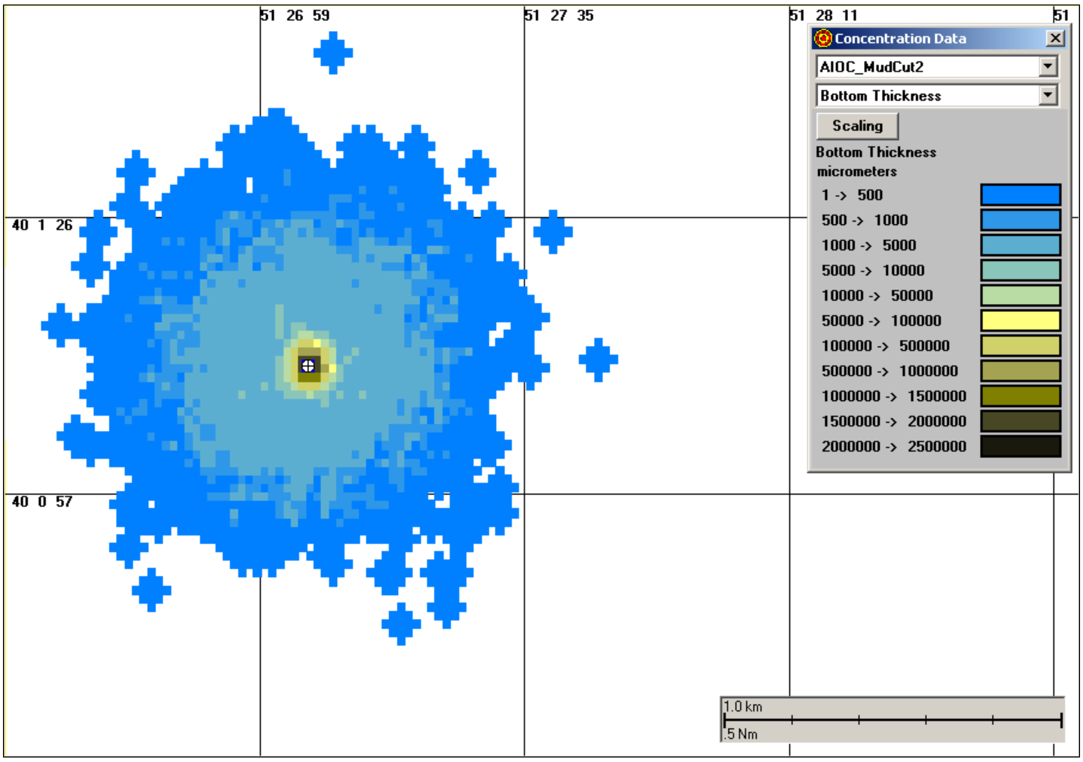

Figure 30. Depositional pattern at the East PDUQ under average current conditions during the winter season.

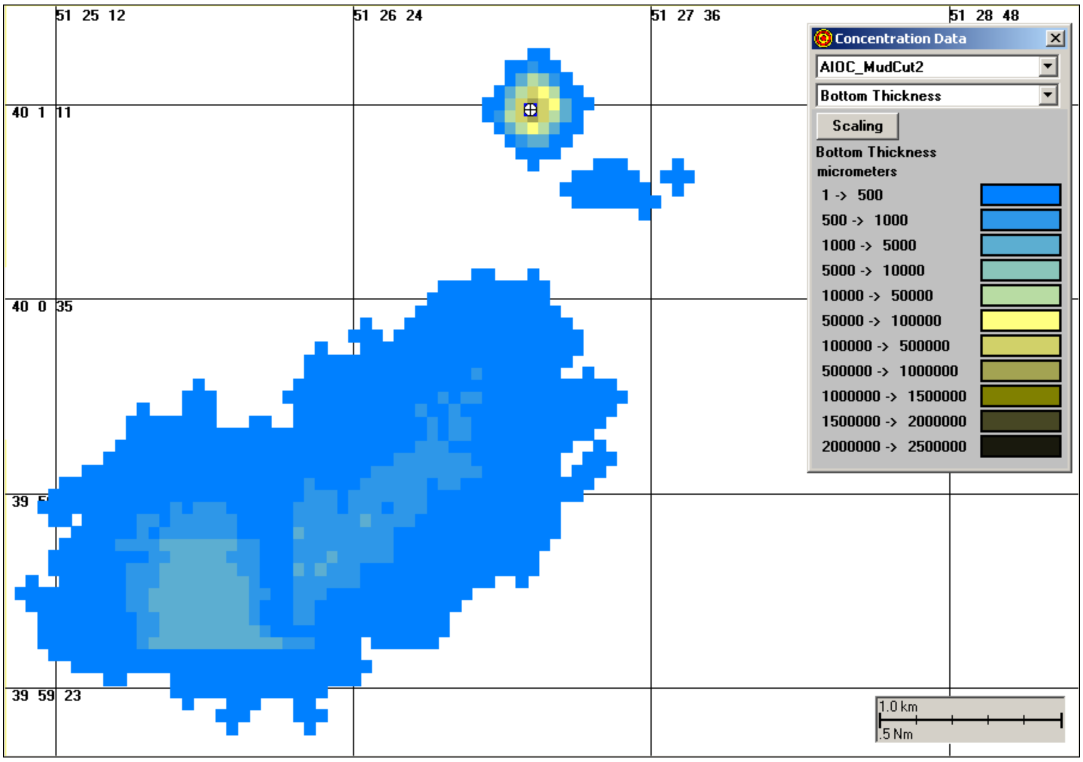

Figure 31. Depositional pattern at the East PDUQ under maximum current conditions during the winter season.

Figure 32 presents the deposition pattern for the discharge mud and drill cuttings at the West PDUQ location during the summer under average current conditions. The deposition pattern is roughly centered on the release site in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 208 m with deposition thickness ranging from 210 to 1 cm.

Figure 33 presents the deposition pattern for the discharge mud and drill cuttings at the West PDUQ location during the summer under maximum current conditions. The deposition pattern is bimodal with an offset to the southeast in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 211 m with deposition thickness ranging from 177 to 5 cm.

Figure 34 presents the deposition pattern for the discharge mud and drill cuttings at the West PDUQ location during the winter under average current conditions. The deposition pattern is offset to the west in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 180 m with deposition thickness ranging from 203 to 5.5 cm.

Figure 35 presents the deposition pattern for the discharge mud and drill cuttings at the West PDUQ location during the winter under maximum current conditions. The deposition pattern has three primary deposition regions with an offset to the east in which the region of highest deposition is apparent surrounding the release site. The deposition thickness in the region surrounding the release site extends radially for approximately 260 m with deposition thickness ranging from 144 to 5 cm.

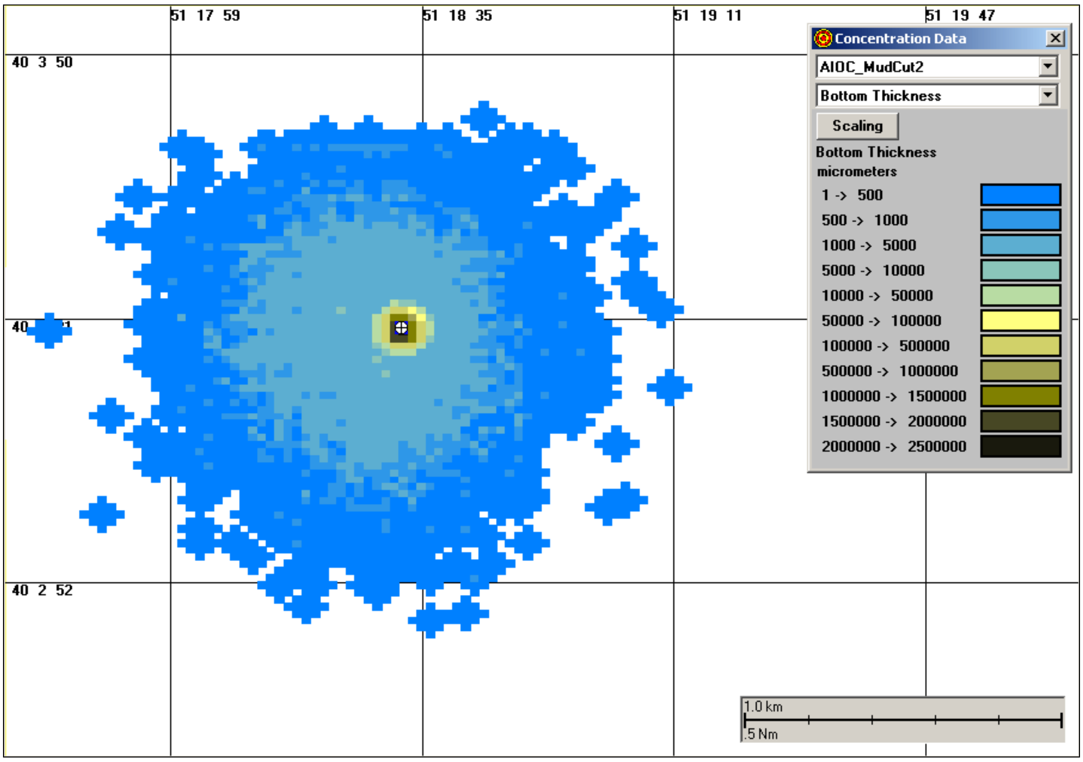

Figure 32. Depositional pattern at the West PDUQ under average current conditions during the summer season.

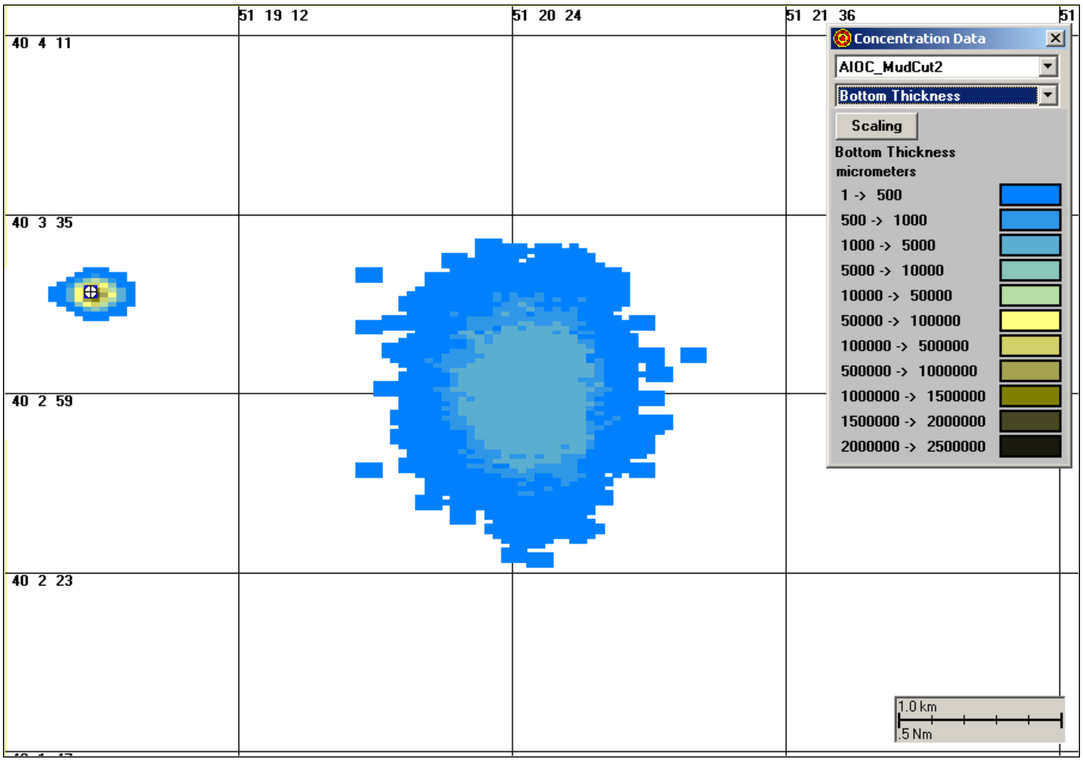

Figure 33. Depositional pattern at the West PDUQ under maximum current conditions during the summer season.

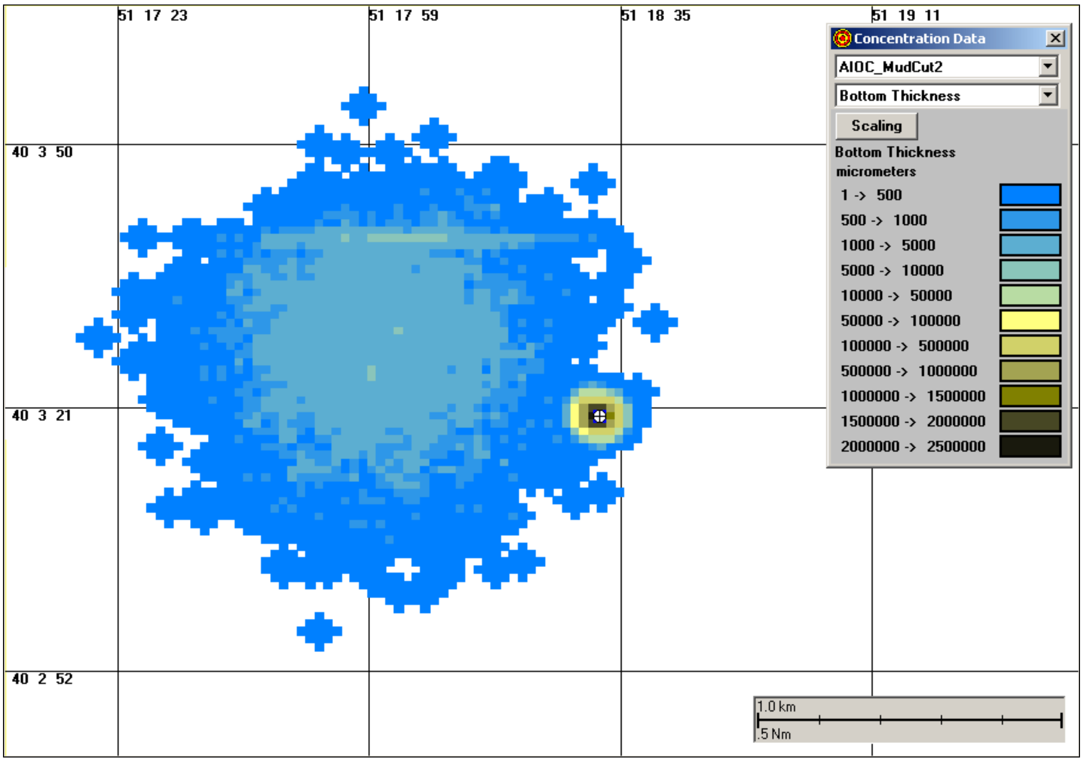

Figure 34. Depositional pattern at the West PDUQ under average current conditions during the winter season.

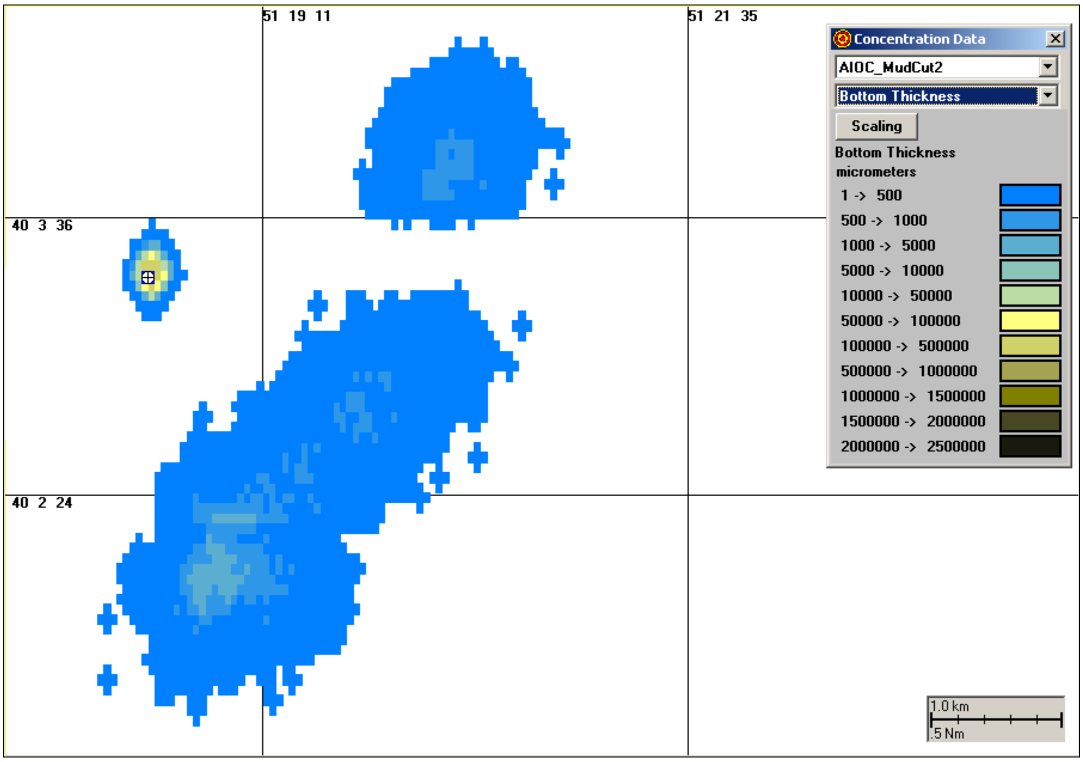

Figure 35. Depositional pattern at the West PDUQ under maximum current conditions during the winter season.

5.3 Settling Distribution Overlap Potential

The operation of multiple well sites in the region presents the potential for the deposition of the mud and drill cuttings to overlap. Figure 36 presents the deposition pattern outlines from all simulations conducted at the East and West PDUQ's during the summer and winter seasons under average and maximum current conditions. The deposition patterns for the two locations do not overlap and are separated by a minimum distance of 10 km.

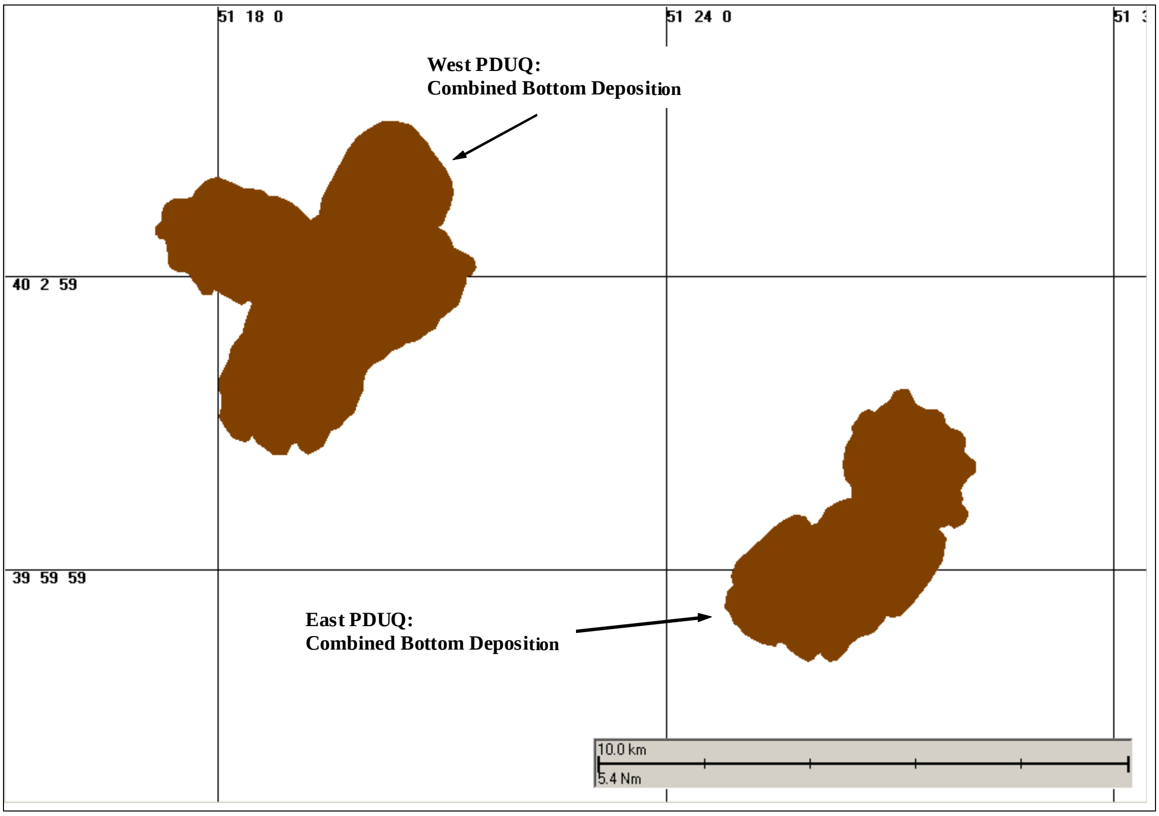

Figure 36. Deposition pattern outlines from all simulations conducted at the East and West PDUQ's.

6. Summary

Hydrodynamic simulations were conducted for the Caspian Sea using HYDROMAP. The simulations were conducted during the summer and winter seasons of the year 2000, June through August and December through January, respectively. The computational grid covered the entire Caspian Sea with coarse resolution in the northern Caspian on the order of 20 km and finer resolution in the southern Caspian with resolutions on the order of 5 and 2.5 km in the Baku region. The environmental forcing for the hydrodynamic model consisted of wind data obtained from the numerical atmospheric model: NCEP reanalysis, provided by NOAA-CIRES Climate Diagnostics Center, Boulder Colorado. The hydrodynamic model was validated using current meter data collected by the Azerbaijan International Operating Company along a pipeline route between Chirag and Sangachal Bay within the Caspian Sea (Figure 10) during the winter season from 01 February to 01 April 2000. The validation consisted of both qualitative and quantitative measures. The validation showed the model to reproduce the major current trends within the region very well (Figures 11-15) with the model being more energetic than the data at offshore data collection stations and slightly less energetic at near shore data collection stations. The difference between the energetic state of the model and data was within commonly accepted modeling guidelines except for one station offshore Kala that can be attributed to local bathymetric or shoreline characteristics not resolved by the computational grid.

Thermal dispersion simulations were conducted for cooling water discharges at four locations within the Azeri, Chirag, Gunashli Field using the United States Environmental Protection Agency's Visual Plumes modeling system. The simulations were conducted under stagnant conditions during the summer and winter seasons. These conditions were chosen in order to determine the worst-case dispersion of the thermal effluent relative to the water quality criteria for cooling water effluent specified by the International Finance Corporation Environmental Health and Safety Guidelines. Under the cooling water release conditions specified the simulations showed no violation of the above stated water quality criteria.

A series of mud and drill cutting simulations were conducted for 48 wells at the East and West PDUQ locations, respectively, during average and maximum current conditions for the summer and winter seasons. In general the heavier cuttings settled near the drill site with lighter particles being carried downstream by the current before settling. The predicted deposition pattern during the average winter conditions is centered on the release site at the East PDUQ and offset to the west at the West PDUQ with maximum deposition thicknesses of 208 and 203 cm, respectively. The predicted deposition pattern during the maximum winter conditions at the East PDUQ is offset to the southwest and offset to the east at the West PDUQ with maximum deposition thicknesses of 89 and 144 cm, respectively. The predicted deposition pattern during the average summer conditions is slightly offset to the south at the East PDUQ and centered around the release site at the West PDUQ, with maximum deposition thicknesses of 211 and 210 cm, respectively. The predicted deposition pattern during the maximum summer conditions is offset to the south-southeast at the East PDUQ and offset to the southeast at the West PDUQ, with maximum deposition thicknesses of 208 and 177 cm, respectively.

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